Mississippi Valley Division,
Regional Planning and Environment Division South

Pearl River Basin, Mississippi, Federal Flood Risk Management Project

Appendix F - Preliminary Mitigation Plan
July 2025

Table of Contents

List of Figures

List of Tables

Section 1 Overview

This document outlines the unavoidable direct habitat impacts and preliminary mitigation plan associated with the Pearl River (PR) Flood Risk Management (FRM) Project. All Alternatives would incur unavoidable direct and indirect habitat impacts that would require compensatory mitigation.

Indirect impacts have not been quantified yet and therefore the mitigation need for indirect impacts has not been determined. The current revised draft environmental impact statement (RDEIS) includes qualitative assessments of indirect impacts. The indirect impacts and associated mitigation requirements will be determined and quantified in subsequent phases using a certified model and would consider wetland impacts up to the 5-year floodplain as this would capture a more accurate estimate of the nature and magnitude of potential wetland impacts.

Project descriptions (PD) can be found in Section 3 and Appendix I of the RDEIS. PDs have been refined and minor changes made to acreages since development of this preliminary mitigation plan has begun. However, this plan does not reflect all those changes since, in subsequent phases, the PDs will likely be refined even further, and a project specific mitigation plan will be developed. The revisions to the PDs that are worth noting are the elimination of Alt C (which was included in the 2024 draft EIS), the addition of the Canton Club Levee to the non-structural plan (A1), and the addition of the Canton Club, McLeod, Richland, and Cany Creek levees to Alts D (now D1) and E (now E1). Although Alternative C from the NFI 211 report and the 2014 DEIS was previously screened from further review, its prior habitat analysis provides mitigation data relevant to the current alternatives. Via this context, Alternative C is discussed throughout this document.

Per the Water Resources Development Act (WRDA) 1986 (Public Law 99-662), as amended, the Secretary shall not select a project alternative in any report, unless such report contains a recommendation with a specific plan to mitigate for unavoidable damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses created by such project. “Specific plan” is also defined in WRDA 86, as amended, to include specific components. This preliminary plan addressed each of those components at a general level. This preliminary mitigation plan was developed for planning and decision-making purposes in an effort to comply with these requirements while also satisfying the direction of the Secretary.

When a recommendation is made by the Assistant Secretary of the Army (ASA) on which FRM alternative(s) to fully analyze, the US Army Corps of Engineers (USACE) will prepare additional National Environmental Policy Act (NEPA) documentation to fully

assess the detailed impacts. This additional NEPA document will include a project specific mitigation plan which will include all required components (see Section 2). Construction of any FRM features will not commence in waters of the United States, or in any fish and wildlife habitat, until the USACE has coordinated with the interagency mitigation team (IMT) on the mitigation plan for each compensatory mitigation feature and all in-lieu fee program/mitigation bank credits have been purchased and/or compensatory mitigation sites have been secured for each mitigation feature (e.g., acquired via fee title acquisition or protected via conservation easement).

USACE will continue to coordinate with Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) and the non-federal interest regarding potential impacts to the Lefleur's Bluff State Park as a result of the PR FRM Project. USACE has requested input from MDWFP regarding properties MDWFP would be interested in receiving as a substitution for USACE' S consideration in mitigating potential impacts to park property from the PR FRM project. These lands will be included in the project specific mitigation plan.

The NFI has coordinated with the adjacent Mississippi Department of Transportation (MDOT) mitigation bank (Fannye Cook Natural Area) and has determined that there would be no direct impacts. However, indirect impacts cannot be ruled out at this time. In subsequent phase(s), USACE and the NFI, in coordination with MDOT would conduct a detailed analysis to determine if there would be any indirect impacts to the MDOT mitigation bank. This analysis would be included in the subsequent NEPA document.

An Interagency Mitigation Team (IMT) was developed which initially included the U.S. Fish and Wildlife Service (the Service), USACE, Rankin Hinds Pearl River Flood & Drainage Control District (non-federal interest (NFI)) and MDWFP (identified as the initial IMT). Since the release of the draft EIS, the Environmental Protection Agency (EPA) Region 4 has been included on the team (identified as the IMT). Federally identified Tribes will be included in subsequent phase(s) to ensure that cultural keystone species, specifically rivercane, are appropriately considered during development of the detailed mitigation plan. The IMT will work closely to complete the project specific mitigation plan in subsequent phase(s).

The following steps will take place during development of the project specific mitigation plan.

- Identify appropriate species and habitat models for direct and indirect impacts and mitigation
- Model certification (if needed)
- Collect field data at project and mitigation sites
- Conduct certified habitat models on project area to determine units of impact per habitat type
- Conduct certified habitat models on mitigation sites to determine units provided per habitat type

- Identify additional mitigation lands if needed and conduct certified habitat models on those lands
- Develop mitigation actions needed at each site (i.e. plantings, hydrological manipulation, earthwork, other construction activities)
- Develop project specific success criteria per habitat type
- Develop project specific monitoring and adaptive management plans per habitat type

Section 2 Requirements

The authority and requirements for compensatory habitat mitigation are found in Federal laws and regulations. The legal foundation for habitat mitigation includes the Clean Water Act, various Water Resources Development Acts, and other environmental laws. These laws are implemented and administered through rules, guidance, regulations, and policies issued by the agencies in the Executive Branch. Other forms of mitigation, such as plans for cultural resources conservation or induced flood damages, may also be required for a project. Those types of mitigation requirements are not directly related to fish and wildlife habitat impacts and are not covered in this plan.

The relevant laws and regulations specific to compensatory habitat mitigation planning for Corps of Engineers civil works projects are listed in Annex F2. The specific procedures to develop a civil works compensatory habitat mitigation plan are found in Engineer Regulation 1105-2-100, Appendix C.

For purposes of this plan, compensatory habitat mitigation is defined as "the restoration (re-establishment or rehabilitation), enhancement, and/or preservation of fish and wildlife habitat for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization have been achieved" (see 40 CFR 230.92). Implementation guidance for Section 1163 of the WRDA 2016 requires functional assessments be performed to define habitat impacts and to set mitigation requirements for impacted habitats. Additionally, the Service's mitigation policy is to compensate for unavoidable impacts to resources by replacing or providing substitute resources or environments through the restoration, establishment, enhancement, or preservation of resources and their values, services, and functions.

In kind mitigation would replace natural resource functions similar to those lost or degraded as a result of construction and operation of the PR FRM project. Such compensation sites would be in a similar geomorphic position (e.g. riverine wetlands up to the 5-year floodplain) to areas adversely affected by the project and would support communities of fish and wildlife species similar to those adversely affected by the project.

Alternative D1 includes a fish passage to allow aquatic species access above the proposed weir. This minimizes impacts to federally listed and other aquatic species in the PR. Alternative D1 also reduces the footprint of the FRM project area (previously eliminated Alternative C) thereby minimizing impacts to various habitat types and avoiding impacts to HTRW sites. Alternative E1 reduces the footprint even more than Alternative D1 by not including a new weir which avoids impacts to riverine habitat and to federally listed aquatic species. Alternatives D1 and E1 include armoring on the western bank of the PR to enhance the integrity of the bank and preserve the oxbow lakes adjacent to that

bank. Even after such minimization and avoidance measures, unavoidable impacts to fish and wildlife are anticipated for each Alternative.

Section 3 Coordination and Collaboration

Development of a mitigation plan involves extensive coordination and collaboration with the state and federal natural resource agencies, landowners, the NFI, and the public. An IMT has been developed and the team has contributed expertise and information to support the identification of impacts, potential mitigation strategies, and the future development of compensatory habitat mitigation plan alternatives. The views of resource agencies and others will be considered in the development of the draft and final recommended plan. These organizations are offered the opportunity to continue to play a role in all phases of the project. The cooperating and participating agencies are listed below.

- Rankin Hinds Pearl River Flood & Drainage Control District (Non-Federal Interest)
- Environmental Protection Agency (EPA) Region 4
- Mississippi Department of Environmental Quality (MDEQ)
- Federal Emergency Management Agency (FEMA) Region IV
- Mississippi Department of Wildlife Fisheries and Parks (MDWFP)
- Mississippi Department of Marine Resources (MDMR)
- Mississippi Natural Resources Conservation Service (MNRCS)
- LA Department of Wildlife and Fisheries (LDWF)
- LA Department of Environmental Quality (LDEQ)
- Louisiana Department of Natural Resources (LDNR)
- Louisiana Coastal Protection and Restoration Authority (CPRA)
- U.S. Fish and Wildlife Service Jackson District
- U.S. Fish and Wildlife Service Lafayette District
- Mississippi Department of Archives & History

Public input was sought during public meetings and during review of the draft 2024 EIS. Comments from the public related to habitat impacts and mitigation were considered in the development of this preliminary mitigation plan and will continue to be considered during development of the project specific mitigation plan and subsequent NEPA document(s).

Section 4 Inventory and Categorize Ecological Resources

Fish and wildlife habitat within the study area includes the Pearl River main stem and tributaries, the Ross Barnett Reservoir, a number of oxbow lakes formed by channel cutoffs resulting from prior channelization of the River and several other smaller lakes or ponds. Many of the oxbow lakes and sloughs are associated with riverine forested wetland ecosystems dominated by hardwoods interspersed with cypress-tupelo brakes. The majority of wetland habitat in the Project Area consists of riverine bottomland hardwood forests which require periodical flooding at intervals at least 1-5 years to deliver their full suite of wetland ecological functions. In addition, upland habitats are present on the higher elevations that contain both pine and mixed pine and hardwood timber stands. There are several areas located throughout the study area that have been converted to more early successional scrub-shrub (S-S) and emergent habitat types as a result of timber harvesting activities and floodway management. This forested wetland complex, in association with the river and its other aquatic habitats, provides habitat for many fish and wildlife species, resulting in a high species diversity.

Previous reports and documents were relied on heavily for existing conditions and habitat resources found in the project area. Sources of habitat data include information from resource agencies, published reports, and agency records. Table 1 describes how each data source could be used in developing the mitigation plan.

Table1 Data Sources

Year	Source of Information	Information	Use in Mitigation Planning
2006	U. S. Army Engineer Research and Development Center (ERDC)	Pearl River Watershed Feasibility Study Two Lakes Flood Control Plan Aquatic Evaluation	Identification of impacts to riverine habitat
2014	Rankin-Hinds Pearl River Flood and Drainage Control District	Habitat Evaluation Procedures (HEP) Report Rankin-Hinds County Mississippi Flood Damage Reduction Project	Identification of impacts to specific species.
2019	USFWS	Biological Opinion	Identification of habitat types and locations in the study area. Identification of impacts to habitat types in study area. Identification of mitigation strategies.
2020	USFWS	Fish and Wildlife Coordination Act Report Pearl River Basin, Mississippi Federal Flood Risk Management Project, Hinds and Rankin Counties, MS	Identification of habitat types and locations in the study area. Identification of impacts to habitat types in study area. Identification of mitigation strategies.
2023	USACE	Regulatory In-lieu fee and Bank Information Tracking System (RIBITS)	Identification of available mitigation bank credits.

The habitat types within the project areas include mixed forested wetlands, emergent wetlands, mixed S-S wetlands, mixed upland forests, upland S-S, grassland, evergreen forest, and riverine. Table 2 shows the habitat resources in the project areas and the type of impact to the resource. These resources are recognized as significant across institutional, public, and technical perspectives.

Table2 Ecological Resources Within the project areas

Habitat	Type of Impact
Emergent wetland/palustrine	Direct due to excavation and fill
Lacustrine	Direct due to excavation and fill
Mixed forested wetland	Direct and indirect due to excavation and fill
Mixed S-S Wetland	Direct and indirect due to excavation and fill
Riverine	Direct and indirect due to excavation and weir
Upland Evergreen Forest	Direct due to fill
Upland Mixed Forest	Direct due to excavation and fill
Upland S-S	Direct due to excavation and fill

The Pearl River flows through the project areas (see Figure 1). It provides in-stream habitat for a variety of fish, mollusks, amphibians, and reptiles. Other wildlife, including mammals, and birds use the river for watering and foraging. Several federally listed and proposed species, the threatened Gulf sturgeon, the threatened ringed sawback (map) turtle, the threatened Pearl River map turtle, the proposed threatened alligator snapping turtle, and the proposed threatened Louisiana pigtoe mussel are found in parts of the river.

As previously stated, all alternatives would result in habitat impacts that would require mitigation. Below is summary of the actions that would incur impacts. Detailed project descriptions are located in Appendix I of the RDEIS.

Alt A1 includes nonstructural components such as elevation and floodproofing as well as construction of a levee segment of approximately 1.4 miles in the Canton Club neighborhood.

Alternative D1 includes nonstructural and structural components. Structural components consist of channel improvements (excavation), Federal levee improvements (excavated material plan), raising an existing non-Federal ring levee, the construction of 4 localized levees, armoring of Mays Lake and the existing J W Fewell weir, hardpoints at the tributaries, construction of a weir with a low-flow gate structure and other related features, construction of a fish passage. Excavating the floodplain and constructing a weir would widen the footprint of the Pearl River in this area and would create a lake of approximately 1,556 acres. Approximately 601 acres of the existing mainstream of the PR is included in the 1,556 acres. This conversion is likely to eliminate riverine habitat that many aquatic species depend on. For this draft it is assumed that Alternative D1 would convert the riverine system within the project area to a lake. Velocity analysis, like that conducted for

previously eliminated Alternative C, will be conducted to better understand the potential impact of Alternative D1 on the riverine system.

Alternative E1 includes all features of Alternative D1 except for the new weir and associated features.

Forested wetlands are a significant natural resource in the project area. Forested wetland ecosystems dominated by hardwoods interspersed with cypress-tupelo brakes are found in areas along the Pearl River. Deciduous and evergreen trees fill the landscape, and herbaceous vegetation grows in areas with open canopy. Wildlife, including mammals, birds, amphibians, and reptiles use the forest habitat. These animals may be resident or transient depending on the species. Seasonal rainfall flooding plays a role in habitat composition associated with tolerance of rapid rises and short duration high flows down the river. Hurricanes and tropical storms occasionally impact the area with high winds and heavy rainfall. In addition to bottomland hardwood and cypress-tupelo habitat, smaller areas of upland hardwoods, mixed hardwood-pine woodlands, S-S, pasture, and cropland are present in the study area. S-S habitat often occurs along the flanks of ridges, the edge of riverbanks and oxbows, and in the southern portion of the basin in marshes altered by spoil deposition or drainage projects. Typically, S-S habitat is bordered by marsh or open water at lower elevations and by developed areas, cypress-tupelo swamp, or bottomland hardwoods at higher elevations. Figure 1 shows the different habitat types and where they occur in the project area.

Alt A1 would remove approximately 1.5 acres of forested wetlands and 9 acres of forested uplands while Alternatives D1 and E1 would remove approximately 740 acres of forested wetlands and 260 of forested uplands due to excavation and fill activities. A1 would remove approximately .04 of an acre and E1 approximately .1 of an acre of stream habitat while D1 would remove approximately 232 acres of riverine habitat. Stream impacts associated with A1 and E1 would be associated with intermittent and perennial feeder streams flowing into the Pearl River, whereas D1 impacts would be to both feeder streams and the Pearl River mainstream. Lacustrine habitat impacts would be self-mitigated by Alternative D1 but E1 would remove approximately 81 acres of lacustrine habitat.

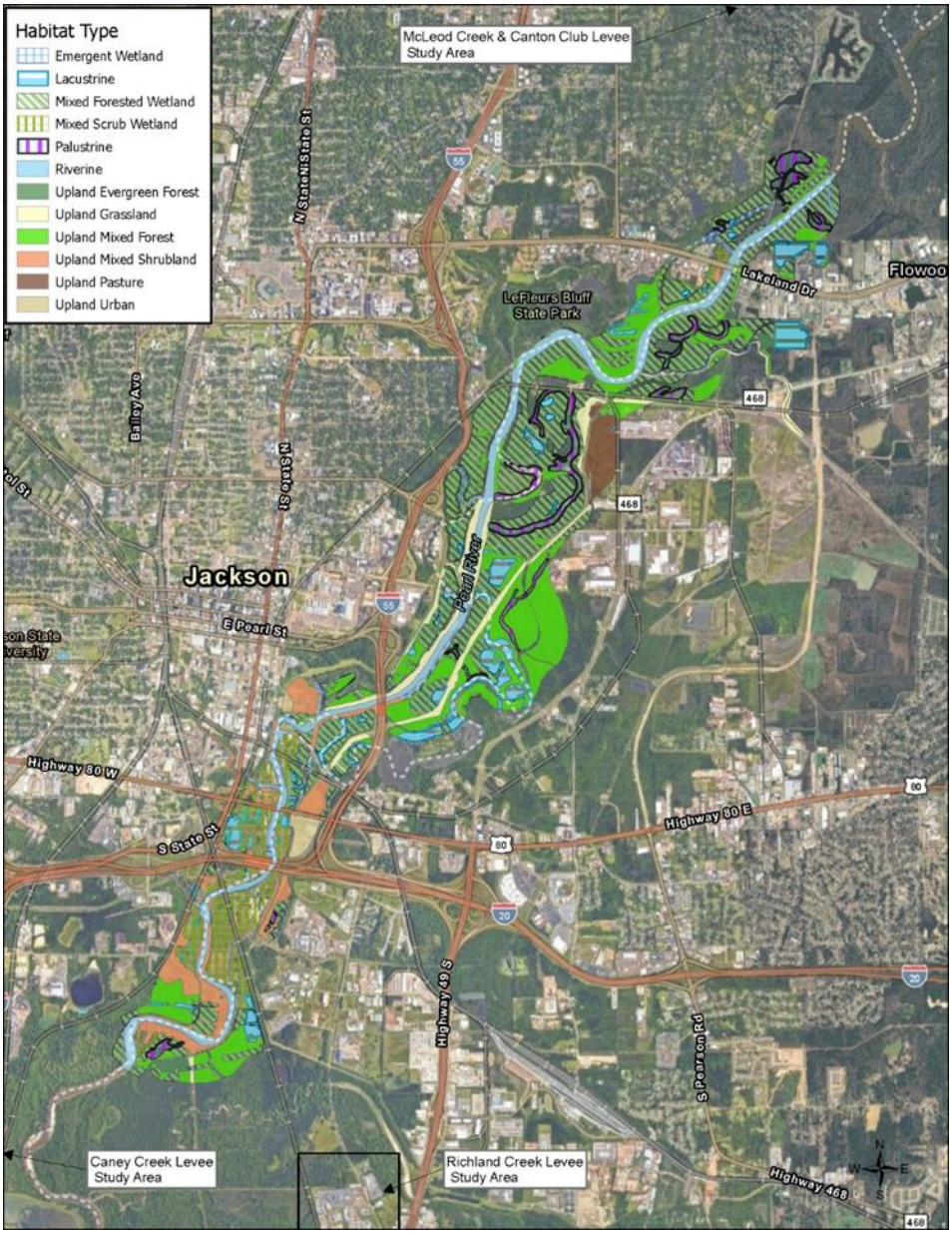

Figure 1 – Habitat in the Study Area

This figure was generated using field data, corroborated by National Wetland Inventory (NWI) and aerial imagery

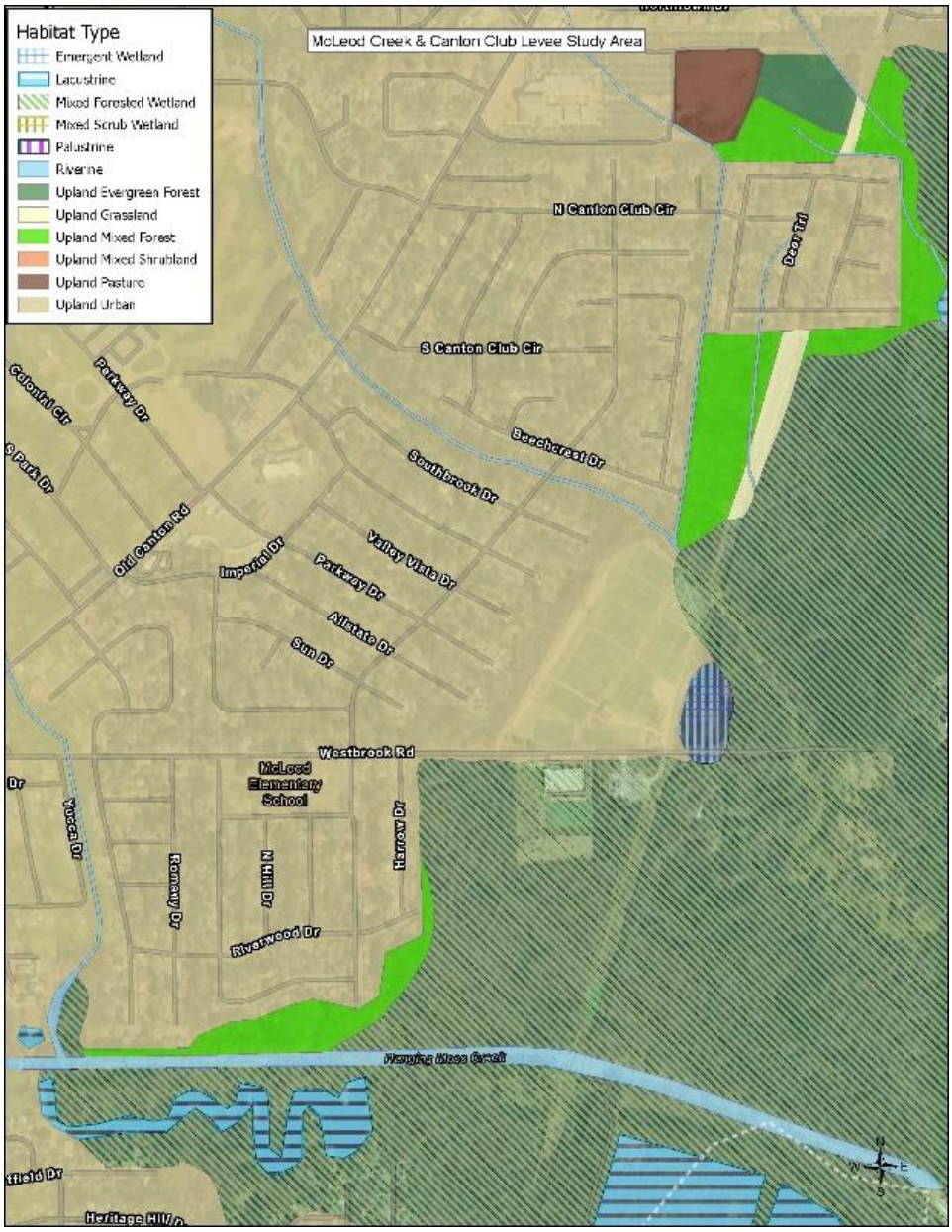

Figure 2 Habitat in McLeod & Creek levee area

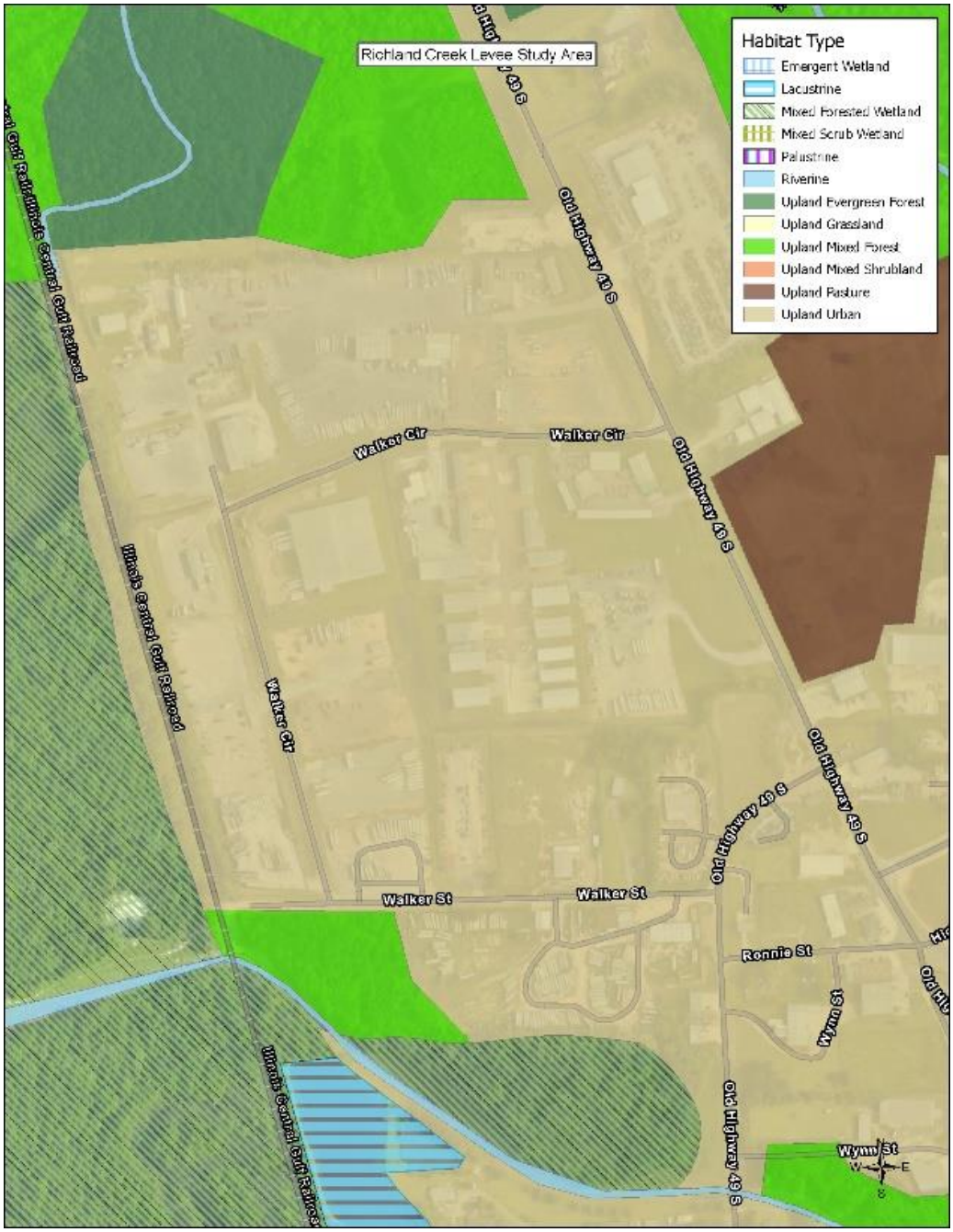

Figure 3 Habitat in Richland & Canton Club levee areas

Figure 4 Habitat in Caney Creek levee area

Figures 2, 3, and 4 were generated using the NWI and Google Earth Imagery

Section 5 Determine Significant Net Losses

The initial interagency team determined that using the 2014 HEP analysis results (Annex F1) would be acceptable for the direct impacts on fish and wildlife habitat in this phase. Natural succession and landscape changes have occurred since the 2014 HEP analysis. Additionally, since the 2014 analysis, the Alt C footprint was reduced resulting in a reduction of forested uplands impacts. Therefore, the 2014 HEP acreages aren't consistent with the existing habitat acreages. Table 3 displays a comparison of the 2014 HEP analysis Alternative C habitat acres to the existing habitat acres. Indirect impacts have not been quantified yet and therefore the mitigation need for indirect impacts has not been determined. The indirect impacts and associated mitigation requirements will be quantified and determined in subsequent phases using a certified model. The current EIS includes qualitative assessments of indirect impacts.

Table 3 Alternative C (since eliminated) Direct Habitat Impact Changes from 2014 to Current

Habitat Type	Acres of Impact 2014 HEP	Description of Habitat Change	Current Acres of Impact
Emergent Wetlands	59	S-S wetlands that converted to emergent	315
Lacustrine/Open Water	200		200
BLH wet	912	No longer lumped together as forested wetlands	762
Swamp			150
Scrub-shrub wetlands	256	Converted to Emergent for conveyance improvement	147
Riverine	287		287
Forested Uplands	536	Reduction in project footprint reduced acres of impact	696
palustrine	147	Palustrine acres re-categorized to S-S wetlands	0
upland evergreen	14		14
upland grassland	152		152
upland pasture	54		54
upland shrub	209	Natural succession to forested uplands	0

Numbers are approximated and have been rounded for simplicity.

The initial IMT met on several occasions to discuss direct habitat impacts and assumptions to apply to mitigation for this phase. The following assumptions were agreed upon by the initial IMT.

- Upland grassland and pasture would not be mitigated.
- Lacustrine habitat would be self-mitigated by Alt D1 (creation of 1,556 acres of lake would more than replace impacts).
- S-S wetlands would be mitigated with BLH.
- Upland evergreen would be mitigated with forested uplands.
- Emergent wetlands are not a habitat that naturally exists in this area. The emergent wetlands that currently exist are due to maintenance activities (such as mowing) and therefore impacts would be mitigated with BLH.
- Acres of direct forested wetlands and uplands habitat impact due to Alt D1 and E1 were determined by overlaying the footprints of each with the existing habitat map.
- Functional assessments (AAHUs) related to direct forested wetlands and uplands habitat impacts due to Alt D1 and E1 were calculated by applying the percent acres decrease from Alt C (since eliminated) to both alternatives to the AAHUs of Alt C.
- Preliminary riverine impacts were determined by using the Engineering Research and Development Center (ERDC) 2006 HEP model results (HSI) and applying acres of each alternative.
- It is assumed that any recreational features implemented by the NFI would occur within the already impacted footprint (i.e. fill areas) and would not impact any of the mitigation features required for threatened and endangered species under the Endangered Species Act. Therefore, additional forested and upland habitats would not be impacted.
- Habitat types within the levee reaches were determined using National Wetlands Inventory and U.S. Geological Survey mapping.
- Levee impacts were determined by using the AAHUs per acre of impacts for Alternative C (since eliminated) and applying those to the acres of each levee.
- Stream habitat impacted by levee construction would be lumped with riverine mitigation for alternative D1. For alternative A1 and E1, it is assumed, for this phase, that mitigation bank stream credits could be purchased.

Model outputs measure habitat value in “average annual habitat units” (AAHUs). Table 4 displays the impacts for each of the habitat types based on the initial IMT assumptions. In subsequent phase(s), the types of models would be revisited, agreed upon, and conducted to determine the project specific AAHUs of each habitat impacted and the mitigation potentials at proposed mitigation sites.

Table4PreliminaryDirectImpactsRequiringMitigationBasedoninitialIMTAssumptions

Habitat	Alt A1 (Acres)	Alt A1 (AAHU)	Alt D1 (Acres)	Alt D1 (AAHU)	Alt E1 (Acres)	Alt E1 (AAHU)
Lacustrine/Open Water	0	0	81 self-mitigating	497 self-mitigating	81	497
BLH wet	1.5	4	689	1,732	689	1,732
Swamp			55	135	55	135
Forested Uplands	9	35	260	999	260	999
Riverine/stream	.04	.03	232	164	.1	.1

**Numbers are approximated and have been rounded for simplicity.*
**All impacts are preliminary and will be revisited in subsequent phases.*

Section 6 Mitigation Objectives

The number of AAHUs impacted per habitat type is equivalent to the number of AAHUs required for mitigation. The required acres, however, are not a one-to-one equivalency and are based on the habitat quality of the mitigation site and the mitigation strategy to be implemented. That being said, as stated prior, habitat mitigation requirements have not been adequately quantified at this time. Instead, impacts were determined using the 2014 HEP and the 2006 ERDC aquatic analysis results. During subsequent phase(s) appropriate certified models would be conducted to determine the mitigation requirements for each habitat type impacted.

This preliminary plan focuses on combining some habitat types for mitigation purposes. The following preliminary mitigation objectives would be satisfied in the Pearl River watershed. Lacustrine impacts are assumed to be self-mitigated with Alt D1. If Alternative E1 were to be implemented, then lacustrine habitat would need to be mitigated.

It should be noted that these are preliminary objectives based on this preliminary analysis and during a later phase(s), and development of a project specific mitigation plan, the habitat models would need to be revisited to accurately determine the units of impact for each habitat type and the mitigation strategy to sufficiently compensate for the impacts.

Alt A1

- Compensate for the loss of 4 AAHUs BLH
- Compensate for the loss of 35 AAHUs forested uplands
- Compensate for the loss of .03 AAHUs stream habitat

Alt D1

- Compensate for the loss of 1,732 AAHUs BLH
- Compensate for the loss of 135 AAHUs swamp
- Compensate for the loss of 999 AAHUs forested uplands
- Compensate for the loss of 164 AAHUs riverine habitat

Alt E1

- Compensate for the loss of 497 AAHUs of lacustrine habitat
- Compensate for the loss of 1,732 AAHUs BLH
- Compensate for the loss of 135 AAHUs swamp
- Compensate for the loss of 999 AAHUs forested uplands
- Compensate for the loss of .1 AAHUs stream habitat

These objectives will be refined in subsequent phases when habitat appropriate certified models are conducted on the project impact sites. For this phase, the team has used assumptions based on the 2014 HEP analysis and similar recently constructed USACE mitigation projects to determine the acres required to satisfy these objectives and associated habitat mitigation costs.

Based on the 2014 HEP analysis, approximately 5,512 acres would sufficiently mitigate for the lost functions and values (AAHUs) of forested wetlands and uplands due to direct impacts. Based on average mitigation potentials (lift) at similar and recently constructed USACE mitigation projects, approximately 11,612 acres would be required to sufficiently mitigate for the same lost functions and values (AAHUs) due to direct impacts. There are concerns and uncertainties associated with both approaches.

Of the 5,512 acres identified, approximately 70% is existing forest. When assessing lands to be used for compensatory mitigation, the existing condition of that land directly reflects on the potential of that land to replace the lost functions and values. i.e. if the condition is already ideal, then there would be very little to no lift associated with the mitigation activities and therefore, more acres would be needed to compensate for the AAHUs of impact. Additionally, as priorly stated, indirect impacts have not yet been identified. Once identified, the mitigation need for those indirect impacts would increase the number of acres required for mitigation. That being said, the IMT is concerned that 5,512 acres would not be sufficient to mitigate the lost functions and values (AAHUs) of the forested wetlands and uplands associated with the direct and indirect impacts of the project.

The average potentials used to determine the required 11,612 acres were generated using a community-based model (wetland value assessment). The HEP is a species-based model and so applying those average potentials to the impacts that were determined using the HEP is likely not generating accurate numbers due to crossing of models. The concern is that the 11,612 acres generated might be an overestimate and therefore could be falsely inflating the costs.

Because of the uncertainties and concerns discussed above, the IMT has agreed to use a range to capture the potential acres required to sufficiently compensate for the lost functions and values due to the project. Subsequently, a range will also be used when discussing costs (see Section 10). Again, in subsequent phases, the impacts, required mitigation, and costs would be refined. The range of potential acres required for mitigation of forested wetlands and uplands would be somewhere between 5,512 and 11,612 acres. The range of costs is discussed in section 10.

Section 7 Land Considerations

The NFI has identified approximately 5,512 acres of land (Figure 6) that could be used to satisfy all, or a portion of, the forested wetlands and uplands mitigation needs. These lands are within the PR watershed and are available for acquisition. The IMT continues to assess the lands identified to determine what mitigation strategies could be implemented and how much of the mitigation need would be satisfied. The NFI has also identified approximately 5,550 acres of additional land west of the lands currently being considered. These lands are within the PR watershed along the Yockanookany River and would likely be available for acquisition if needed. Similar to the mitigation lands currently under consideration, these lands are predominantly existing forest and would therefore be considered preservation when implementing compensatory mitigation.

Obsolete aquatic barriers, currently under federal ownership (Figure 7), have been identified for replacement with rock chute which could satisfy all or a portion of the riverine mitigation need. This measure was carried forward for planning purposes only and is not the proposed or recommended measure for riverine mitigation. In subsequent phase(s), full analysis would need to be conducted on this, and other measures identified in Section 9 to determine the amount of mitigation (number of AAHUs) each could produce. A project specific mitigation plan will be developed which will include proposed measures for riverine and other habitat mitigation.

Preliminary lacustrine mitigation opportunities have been identified within the project boundaries and therefore additional land considerations is not needed.

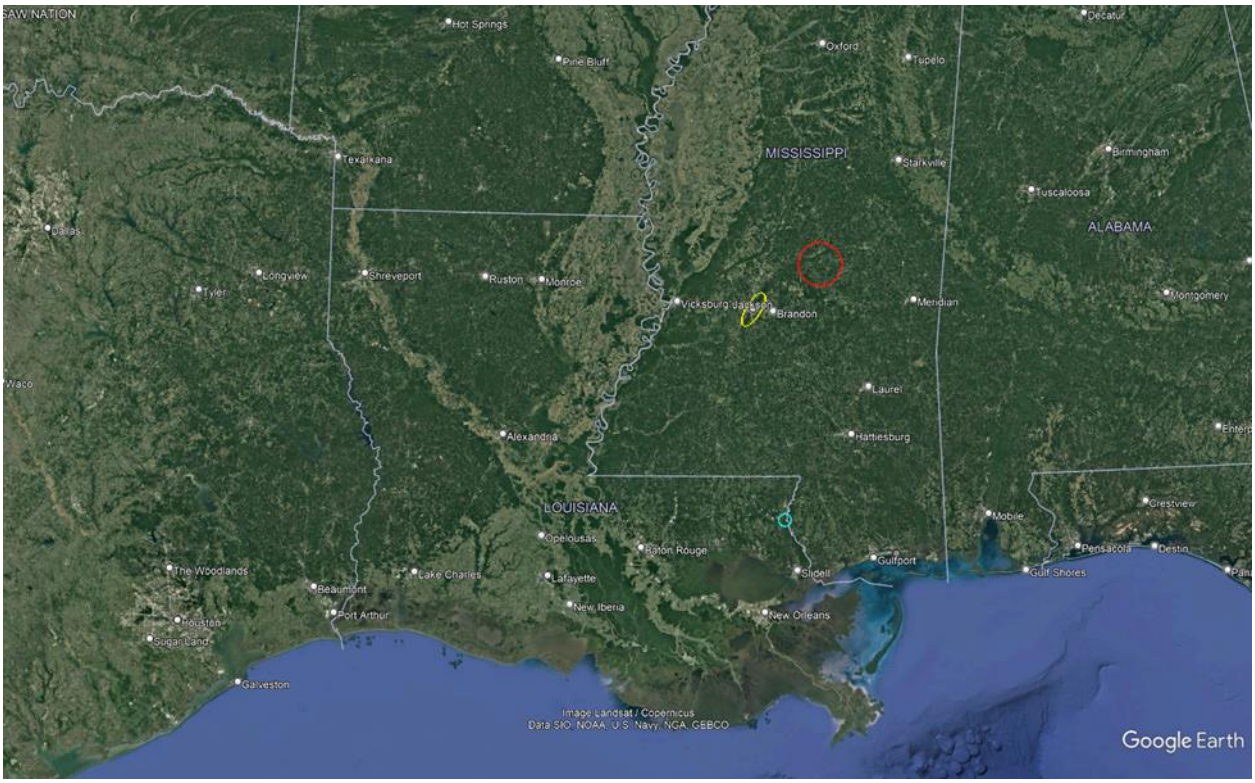

Figure 5 – Locations of FRM project and Lacustrine Mitigation (yellow), Potential Forested Wetlands and Uplands Mitigation (red), Potential Riverine Mitigation (blue).

Note: all mitigation measures are preliminary and not proposed. Future analysis in subsequent phase(s) will identify proposed mitigation measures.

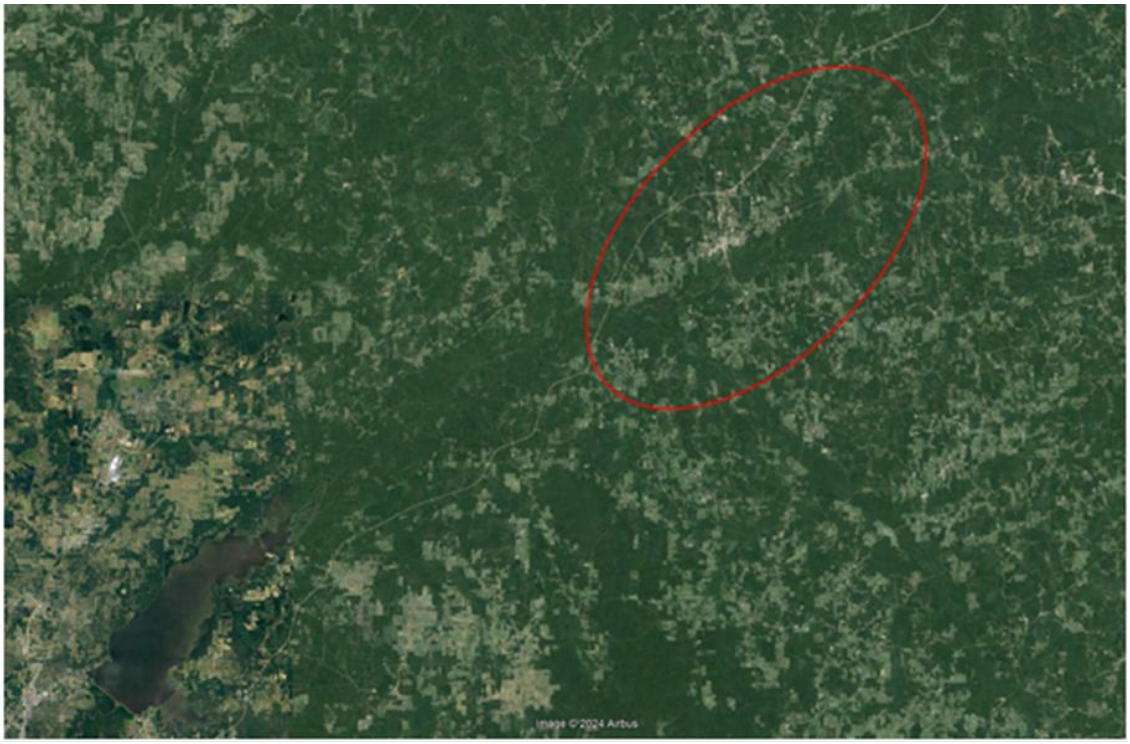

Figure 6 - General area of potential forested wetlands and uplands mitigation lands (measures 2-4, 6-8, 10-12)

Note: all mitigation measures are preliminary and not proposed. Future analysis in subsequent phase(s) will identify proposed mitigation measures.

Figure 7 – Location of obsolete aquatic barriers for potential replacement (measures 18 and 22)

Note: all mitigation measures are preliminary and not proposed. Future analysis in subsequent phase(s) will identify proposed mitigation measures.

Section 8 Identify and Assess Potential Mitigation Strategies

- Planning strategies are different means employed to develop a plan to achieve a project goal. The use of one or more strategies helps planning teams focus on an approach to developing a plan. For mitigation planning work, strategies may range from the purchase of mitigation bank credits to the construction of a project or projects to achieve the objectives and compensate for unavoidable impacts to habitat. Strategies may also involve different approaches to site selection such as the use of public lands or identifying contiguous sites that would potentially enhance wildlife corridors or expand wildlife pockets. In addition, implementation guidance for the Water Resources Development Act of 2016, Section 1163 requires the Corps of Engineers to consider mitigation bank credits or in-lieu fee programs where appropriate. Consideration of these options as mitigation strategies may be helpful when available.
- Some strategies that may be considered for this mitigation project are described below. These, and other yet to be identified strategies may be considered in any combination to achieve full compensation for impacts to each habitat type. Further planning and analysis would be completed during later phase(s) to determine which strategies, stand alone or combined, would fully compensate for habitat impacts.
- Purchase of credits from mitigation bank or in-lieu-fee program. Commercial mitigation banks sell credits for mitigation work performed at an approved mitigation site. The banks are approved and legally bound through banking instruments that hold the bank owners to certain standards of performance and reporting. The use of mitigation banks for a project may offer advantages to the government and non-federal sponsor by reducing performance risk and eliminating project specific requirements for operations and maintenance work and development of monitoring and adaptive management plans.
- Approved in-lieu-fee arrangements may also be considered for compensatory mitigation. The USACE, in consultation with the IMT, should carefully evaluate the demonstrated performance of natural resource management organizations (e.g., governmental organizations, land trusts) prior to approving them to manage in-lieu-fee arrangements.
- • Construction of a habitat restoration project. Habitat restoration could be accomplished by establishing desired in-kind habitat within areas that were historically of the same habitat.
- • Construction of a habitat enhancement project. Habitat enhancement could be accomplished by performing various prescribed treatments to degraded habitats (as discussed in section 9).
- • Construction of a habitat preservation project. Preservation would consist of no prescribed treatment other than purchasing and perpetually protecting land of suitable in-kind habitat.

Section 9 Identify Measures and Alternative Mitigation Plans

Management measures are actions or activities that work towards accomplishing planning objectives. A measure may stand alone as a single activity that serves as an alternative plan or two or more individual measures may be combined to form an alternative plan. The IMT identified 24 potential mitigation measures for further consideration and analysis in subsequent phase(s). It is possible that additional measures are identified at a later date and would be considered for analysis if warranted. It is important to note that the measures carried forward for planning purposes are not necessarily the proposed mitigation measures. A summary of general mitigation measures for each habitat type is provided below.

9.1 BLH

- Measure 1 – Purchase credits from an approved mitigation bank or in-lieu fee program. At the time of implementation, available in-kind credits would be purchased to satisfy as much of the mitigation need as possible.
- Measure 2 – Preservation would consist of purchasing suitable in-kind habitat and monitoring to ensure the species integrity of these areas.
- Measure 3 - Enhancement efforts would focus on the reduction of invasive species to no more than 5% coverage and select removal of undesirable species followed by planting of required native BLH species composition.
- Measure 4 - The restoration efforts would focus on conversion of silvicultural or agricultural lands to BLH habitat by removal of undesirable species and planting of native BLH species.

9.2 Swamp

- Measure 5 – Purchase credits from an approved mitigation bank or in-lieu fee program. At the time of implementation, available in-kind credits would be purchased to satisfy as much of the mitigation need as possible.
- Measure 6 – Preservation would consist of purchasing suitable in-kind habitat and monitoring to ensure the species integrity of these areas.
- Measure 7 - Enhancement efforts would focus on the reduction of invasive species to no more than 5% coverage and select removal of undesirable species followed by planting of required native swamp species composition.
- Measure 8 - The restoration efforts would focus on conversion of silvicultural or agricultural lands to swamp habitat by removal of undesirable species and planting of native swamp species.

9.3 Upland Mixed Forest

- Measure 9 – Purchase credits from an approved mitigation bank or in-lieu fee program. At the time of implementation, available in-kind credits would be purchased to satisfy as much of the mitigation need as possible.
- Measure 10 – Preservation would consist of purchasing suitable in-kind habitat and monitoring to ensure the species integrity of these areas.
- Measure 11 - Enhancement efforts would focus on the reduction of invasive species to no more than 5% coverage and select removal of undesirable species followed by planting of required native forested upland species composition.
- Measure 12 - The restoration efforts would focus on conversion of silvicultural or agricultural lands to forested upland habitat by removal of undesirable species and planting of native forested upland species.

9.4 Riverine

- Measure 13 – Purchase credits from an approved mitigation bank or in-lieu fee program. This measure addresses the objective through the purchase of in-kind credits from an approved mitigation bank located in the basin.
- Measure 14 - Hydrological enhancement through replacement of existing undersized and damaged culverts with larger culverts that would allow fish passage or replacement of functional aquatic barriers with arch span culverts.
- Measure 15 – Enhancement by opening historically lost habitat or connecting occupied and suitable unoccupied habitat.
- Reconnecting secondary channels
- Measure 16 – Restoration by creating nesting, breeding, and spawning habitat or refugia.
- Creation of gravel bars within the river downstream of the project area
- Measure 17 – Enhancement by increasing habitat quality and minimizing threats.
- Measure 18 – Restoration by replacing one or more obsolete aquatic barrier(s) downstream of FRM project with rock chutes. It is important to note that this measure was used for planning purposes but is not the proposed measure for implementation.
- Measure 19 – Preservation by maintaining habitat quality with streambank stabilization.
- Measure 20 - Preservation of essential breeding habitat or refugia.
- Preserve existing gravel bars downstream of project to promote sufficient spawning habitat
- Measure 21- Restoration by propagation and reintroduction of native species such as AL shad
- Measure 22 – Restoration by reconnecting the river with channel cuts around one or more obsolete aquatic barrier(s) downstream of FRM project.

9.5 Lacustrine

- Measure 23 – restoration by creating oxbow lake(s) within the newly excavated floodplain
- Measure 24 - restoration by creating ponds (similar to borrow pits) within the newly excavated floodplain

A qualitative analysis of the potential effectiveness of each measure towards achieving the mitigation planning objectives was performed. Table 5 summarizes the results of the initial screening of potential mitigation measures. After the effectiveness screening the team retained 24 measures for further consideration and potential combinability into alternative plans.

Table5 Initial Screening of Mitigation Measures

Measure	Screening Analysis	Screening Result
Measure 1	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 2	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 3	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 4	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 5	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 6	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 7	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 8	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 9	Unlikely to achieve mitigation goal as there are currently no upland forest mitigation banks in the PRB	Not carried forward for further analysis
Measure 10	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 11	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 12	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 13	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 14	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 15	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 16	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 17	Likely to achieve mitigation goal	Carried forward for further analysis

Measure	Screening Analysis	Screening Result
Measure 18	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 19	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 20	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 21	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 22	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 23	Likely to achieve mitigation goal	Carried forward for further analysis
Measure 24	Likely to achieve mitigation goal	Carried forward for further analysis

Each measure was further assessed to determine the potential for combining it with other measures to form mitigation plans. This assessment determines if a measure could stand alone as a plan and whether the measure had any restrictions that would prevent its combination with other measures. Results of the assessment are that none of the measures carried forward could stand alone as a plan due to the fact that mitigation for multiple habitat types is required and because the impacts to riverine habitat are so extensive. All of the measures carried forward have potential for combining with other measures.

The general measures were then combined into an array of general alternatives aligned with the mitigation planning strategies. A no action alternative is included as a basis for comparison as well as meeting the requirements of the National Environmental Policy Act.

- No Action Alternative. Under this scenario no mitigation work would be performed, and the structure, functions and values of parent project impacted habitats would be lost. The alternative is retained only for purposes of a baseline comparison against other action alternatives.
- Alternative 1 –Purchase of mitigation bank and/or In Lieu Fee credits.
- Based on an August 2024 search on RIBITS (https://ribits.ops.usace.army.mil), there are more than 10 mitigation banks with available credits within the PRB. At this time, only BLH, stream/riverine, and riparian credits are available at these banks. Many of the approved banks also have potential credits that may be released in the future. It is not known which banks would have available credits or how many credits might be available when the decision to purchase bank credits is made. Some banks may not have credits remaining, some may have more credits, some may be closed, and additional mitigation banks may be approved. The

bank(s) from which credits would be purchased would be selected through a solicitation process, through which any mitigation bank meeting eligibility requirements and having the appropriate resource type of credits could submit a proposal to sell credits. If appropriate and cost-effective, the USACE may choose to purchase mitigation bank credits from more than one bank to fulfill the compensatory mitigation requirements for a particular habitat type.

- Approved in-lieu-fee arrangements may also be considered for compensatory mitigation. The USACE, in consultation with the IMT, should carefully evaluate the demonstrated performance of natural resource management organizations (e.g., governmental organizations, land trusts) prior to approving them to manage in-lieu-fee arrangements.
- Alternative 2 – Corps Constructed Mitigation Alternative. This alternative would be a combination of restoration, enhancement, and/or preservation of BLH, swamp, upland forest, riverine, and lacustrine habitats. As previously stated, the IMT is currently assessing potential mitigation sites to determine how much of the mitigation need could be satisfied.
- Alternative 3 – combination of mitigation bank credit purchase and constructed mitigation. At the time of screening, and based on available credits in the watershed, it is assumed that a portion of the BLH, potentially swamp, and riverine mitigation needs could be satisfied through bank credit purchases. The remaining needs would be satisfied through the construction of a combination of restoration, enhancement, and/or preservation of BLH, swamp, upland forest, riverine, and lacustrine habitat.

Section 10 Define and Estimate Costs of Mitigation Plan by Alternatives

Available information including the NFI 2022 mitigation plan, records of available mitigation bank credit costs in the basin, and details from recently completed nearby projects were used to develop a range of parametric costs for planning and decision-making purposes. The NFI real estate costs and MVK construction and planting costs were applied to the range of acres previously discussed For monitoring costs, recently completed MVN mitigation monitoring costs per acre were used. Riverine mitigation costs were determined using costs of a recent dam removal and a rough order magnitude cost estimate for a designed rock chute. The lacustrine mitigation costs were simply a rough order magnitude design cost estimate. The parametric costs below were used for planning purposes and will be refined once a project specific mitigation plan is developed. The team will use various sources of information to estimate the costs of the plan. The study team will also consider other cost factors such as site access, fuel and equipment, and the availability of plant materials.

Table 6 Alternative A-1 Preliminary Habitat Mitigation Costs

Habitat Mitigation – Alt A1	Units	#of units (low)	# of units (high)	Cost (low)	Cost (high)
Forested Wetlands and Uplands					
Real Estate	acres	31	156	$76,967	$ 389,733
Construction	acres	31	156	$307,867	$ 356,328
Seedlings	seedling	9,298	10,761	$3,719	$ 4,304
Planting	seedling	9,298	10,761	$2,324	$ 2,690
Monitoring					
Mitigation	events	11	11	$33,188	$103,232
Total				$424,065	$856,288

Numbers are approximated and rounded for simplicity and were developed using the assumptions above.
These costs will be refined subsequent phase(s).

Table 7 Alternative D-1 Preliminary Habitat Mitigation Costs

Habitat Mitigation – Alt D1	Units	# of units (low)	# of units (high)	Cost (low)	Cost (high)
Forested Wetlands and Uplands					
Real Estate	acres	5,512	11,612	$13,780,000	$29,030,067
Construction	acres	5,512	11,612	$18,500,000	$26,541,775
Seedlings	seedling	558,700	801,562	$223,480	$320,625
Planting	seedling	558,700	801,562	$139,675	$200,390
Riverine Mitigation					
Riverine Mitigation	Sill	1	1	$8,300,000	$8,300,000
Monitoring					
Forested Mitigation	events	11	11	$3,968,118	$7,689,484
Riverine Mitigation	events	10	10	$398,000	$398,000
Total				**$45,309,273**	**$72,480,341**

Numbers are approximated and rounded for simplicity and were developed using the assumptions above.
Riverine mitigation costs are based on replacement of one obsolete aquatic barrier which is not the proposed measure but was used for planning purposes.
These costs will be refined subsequent phase(s).

Table 8 Alternative E-1 Preliminary Habitat Mitigation Costs

Habitat Mitigation – Alt E1	Units	# of units (low)	# of units (high)	Cost (low)	Cost (high)
Forested Wetlands and Uplands					
Real Estate	acres	5,512	11,612	$13,780,000	$29,030,067
Construction	acres	5,512	11,612	$18,500,000	$26,541,775
Seedlings	seedling	558,700	801,562	$223,480	$320,625
Planting	seedling	558,700	801,562	$139,675	$200,390
Lacustrine					
Lacustrine	acres	105	105	$14,000,000	$14,000,000
Monitoring					
Forested Mitigation	events	11	11	$3,968,118	$7,689,484
Lacustrine	events	10	10	$398,000	$398,000
Total				**$51,009,273**	**$78,180,341**

Numbers are approximated and rounded for simplicity and were developed using the assumptions above. These costs will be refined subsequent phase(s).

10.1 Recommended Compensatory Mitigation Plan

The recommended mitigation plan and its specific measures have not been identified as of yet. Instead, this preliminary mitigation plan has been developed for planning and decision-making purposes. The IMT is currently assessing and identifying lands that could potentially be suitable for mitigation. Once a FRM alternative is chosen for further analysis, a recommended mitigation plan, including specific measures, would be identified. However, based on available mitigation bank credits and previous studies, it is likely that the combination of mitigation bank credit purchases and Corps constructed mitigation would be the recommended mitigation plan.

10.2 Implementation Risks

The planning team identified a suite of foreseeable implementation risk factors across each phase of implementation (Pre-Construction Engineering and Design, Construction, and Operations). These factors are based upon experience from similar projects and the consideration of regional risks generally associated with design and construction work in wet environments. Each risk was assessed and assigned a significance level. Potential risk management measures were identified and will be considered should the need arise during implementation or adaptive management.

Table 9 Risk Assessment and Management Measures

Pre-Construction Engineering and Design Phase			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Authority for sill replacement	High	High	Identify and assess other measures to sufficiently mitigate riverine impacts during subsequent phase(s)
Public acceptability of sill replacement	High	High	Identify and assess other measures to sufficiently mitigate riverine impacts during subsequent phase(s)
Insufficient waterflow for fish passage	High	Medium	Coordinate design closely with engineering and the Service during PED
Increase in habitat impacts	Low	Low	Include mitigation sequence commitments in plans and specs (P&S) development. Employ Best Management Practices in P&S.
Poor soil conditions	Low	High	Address through design considerations. Inability to address could lead to change in mitigation site or plan.
Construction Phase			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Excessive rainfall or flooding	Medium	Medium	Plan for construction during more favorable weather seasons. Anticipate weather events before initiating weather-dependent phases of construction. Use appropriate equipment for site conditions.
Construction management	Medium	varies	Monitor use of Best Management Practices during construction work. Confirm construction as-built requirements are met. Document all conditions pre- and post-construction at site.
Maintenance Phase			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Storm impacts to mitigation	High	High	Incorporate engineering with nature elements into mitigation design. Develop a storm impact assessment and response plan. Employ adaptive management measures to address impacts that prevent the achievement of ecological success criteria.
Herbivory	High	varies	Monitor vegetation for survival and resistance to herbivores. Adaptively manage by implementing exclusion or treatment measures to address herbivore impacts as needed.

10.3 Preliminary Criteria for Determining Ecological Success

The following success criteria for forested wetlands and uplands restoration and enhancement measures are pulled from the USACE New Orleans District (MVN) general mitigation guidelines and were updated using USACE Vicksburg District (MVK) mitigation protocol. MVK has advised that ERDC conducts additional monitoring at mitigation sites within the district. These monitoring and success criteria are not included in the following. Preservation success criteria would simply be to ensure that existing forest conditions are maintained throughout the 50-year period. Site specific success criteria and monitoring plans would be developed in subsequent phase(s) once a FRM project is chosen for further analysis and a project specific mitigation plan is identified. These site-specific monitoring plans will include ERDC's monitoring and success criteria.

10.4 Preliminary BLH Mitigation Success Criteria

1. General Construction

For construction from existing land, complete all necessary earthwork and related construction activities in accordance with the mitigation work plan and the project plans and specifications (P&S). The necessary activities will vary with the mitigation site, but may include clearing, grubbing, and grading activities; construction of new water management features (weirs, flap-gates, diversion ditches, etc.); modifications or alterations to existing water control structures and surface water management systems; plantings; and eradication of invasive and nuisance plant species.

- a. Construction requirements
- b. Planting
- c. Construction or modification of water management features

2. Native Vegetation

- a. Initial Success Criteria: Achieve a minimum average survival of planted canopy species. This percentage would be determined during development of the project specific mitigation plan.
- b. Intermediate Success Criteria: Achieve a minimum average density of living native canopy species per acre (planted trees and/or naturally recruited native canopy species). This density would be determined during development of the project specific mitigation plan.
- c. Long-Term Success Criteria: Attain a minimum average canopy cover of planted and/or naturally recruited native canopy species. This percentage would be determined during development of the project specific mitigation plan.

3. Thinning of Native Vegetation (Timber Management)

The USACE, in cooperation with the IMT, may determine that thinning of the canopy and/or mid-story strata is warranted to maintain or enhance the ecological value of the site. This determination will be made approximately 15 to 20 years following successful completion of plantings. If it is decided that timber management efforts are necessary, the NFS will develop a Timber Stand Improvement/Timber Management Plan, and

associated long-term success criteria, in coordination with the USACE and IMT. Following approval of the plan, the NFS will perform the necessary thinning operations and demonstrate these operations have been successfully completed. Timber management activities will only be allowed for the purposes of ecological enhancement and maintenance of the mitigation site.

10.5 Preliminary Swamp Mitigation Success Criteria

The success criteria specified herein apply to both swamp restoration projects and swamp enhancement projects unless otherwise indicated.

1. General Construction

As applicable, complete all necessary initial earthwork and related construction activities in accordance with the mitigation work plan as well as the final project plans and specifications. The necessary activities will vary with the mitigation site. Examples include, but are not limited to clearing, grubbing, and grading activities; construction of new water management features (weirs, flap-gates, diversion ditches, etc.); modifications/alterations to existing water control structures and surface water management systems; construction of perimeter containment dikes and installation of fill (dredged sediments or other soil). These requirements classify as initial construction requirements.

- a. Construction requirements
- b. Planting
- c. Construction or modification of water management features

2. Native Vegetation

A. Initial Success Criteria: Achieve a minimum average survival of planted canopy species. This percentage would be determined during the development of the project specific mitigation plan. The surviving plants must approximate the species composition, and the species percentages specified in the initial planning's component of the Mitigation Work Plan.

B. Intermediate Success Criteria

- a. Achieve a minimum average density of living native canopy species per acre (planted trees and/or naturally recruited native canopy species). This density would be determined during the development of the project specific mitigation plan.
- b. Achieve a minimum average density of living bald cypress trees (planted trees and/or naturally recruited native canopy species). This density would be determined during the development of the project specific mitigation plan. The species composition of the additional native canopy species present must be generally consistent with the planted ratios for such species.

C. Intermediate Success Criteria

1. Demonstrate that vegetation satisfies USACE hydrophytic vegetation criteria. This criterion will thereafter remain in effect for the duration of the overall monitoring period.

2. Achieve one of the two following vegetative cover requirements:
    - A minimum average percent cover by native species in the canopy stratum, the midstory stratum, and the ground cover stratum. These percents would be determined during development of the project specific mitigation plans.

D. Long-Term Success Criteria

1. Demonstrate a minimum average diameter at breast height (DBH) of living bald cypress trees. This minimum DBH would be determined during development of the project specific mitigation plans. This criterion will thereafter remain in effect for the duration of the overall monitoring period.
2. Demonstrate a minimum average DBH of the other living native trees in the canopy stratum (trees other than bald cypress). This minimum DBH would be determined during development of the project specific mitigation plans. This criterion will thereafter remain in effect for the duration of the overall monitoring period.
3. Demonstrate a minimum average total basal area accounted for by all living native trees in the canopy stratum combined. This minimum basal area would be determined during development of the project specific mitigation plans. This criterion will thereafter remain in effect for the duration of the overall monitoring period.

E. Long-Term Success Criteria

1. Demonstrate that a minimum number of living native trees remain in the canopy stratum.
2. Demonstrate that either success criteria C.1 or C.2 above have been maintained.
3. 3. Thinning of Native Vegetation (Timber Management)

The USACE, in cooperation with the IMT, may determine that thinning of the canopy and/or midstory strata is warranted to maintain or enhance the ecological value of the site. If it is decided that timber management efforts are necessary, the NFS will develop a Timber Stand Improvement/Timber Management Plan, and associated long-term success criteria, in coordination with the USACE and Interagency Team. Following approval of the plan, the NFS will perform the necessary thinning operations and will demonstrate the successful completion of these operations. Timber management activities will only be allowed for the purposes of ecological enhancement of the mitigation site.

4. Hydrology

In a year having essentially normal rainfall, demonstrate compliance with each of the following criteria:

1. Achieve inundation of the majority of the mitigation area for a minimum amount of time. This minimum timeframe would be determined during the development of the project specific mitigation plan.
2. Achieve non-inundation of the majority of the mitigation (water table at or below the soil surface) for a minimum amount of time. This minimum timeframe would be determined during the development of the project specific mitigation plan.
3. The average maximum (peak) water table elevation must fall within a certain range above the soil surface. This range would be determined during development of the project specific mitigation plan.
4. The requirements above classify as intermediate success criteria.

10.6 Preliminary Forested Uplands Mitigation Success Criteria

1. General Construction
    a. For construction from existing land, complete all necessary earthwork and related construction activities in accordance with the mitigation work plan and the project plans and specifications (P&S). The necessary activities will vary with the mitigation site, but may include clearing, grubbing, and grading activities; construction of new water management features (weirs, flap-gates, diversion ditches, etc.); modifications or alterations to existing water control structures and surface water management systems; plantings; and eradication of invasive and nuisance plant species.
    b. Construction requirements
        - Planting
        - Construction or modification of water management features

2. Native Vegetation
    - Initial Success Criteria: Achieve a minimum average survival of planted canopy species. The minimum survival percentage would be determined during the development of the project specific mitigation plan.
    - Intermediate Success Criteria: Achieve a minimum average density of living native canopy species per acre (planted trees and/or naturally recruited native canopy species). The average density would be determined during development of the project specific mitigation plan.
    - Long-Term Success Criteria: Attain a minimum average canopy cover by planted and/or naturally recruited native canopy species. The average canopy cover percentage would be determined during the development of the project specific mitigation plan.

3. Thinning of Native Vegetation (Timber Management)

- The USACE, in cooperation with the IMT, may determine that thinning of the canopy and/or mid-story strata is warranted to maintain or enhance the ecological value of the site. If it is decided that timber management efforts are necessary, the NFS will develop a Timber Stand Improvement/Timber Management Plan, and associated long-term success criteria, in coordination with the USACE and IMT. Following approval of the plan, the NFS will perform the necessary thinning operations and demonstrate these operations have been successfully completed. Timber management activities will only be allowed for the purposes of ecological enhancement and maintenance of the mitigation site.

Preliminary Riverine Mitigation Success Criteria

The following preliminary success criteria were based on the replacement of aquatic barrier(s) with rock chute(s). However, the riverine mitigation measure(s) to be implemented has not been identified. Further analysis is needed to determine which measure(s) could potentially provide sufficient mitigation. As previously stated, during subsequent phase(s), models would be conducted to accurately determine the riverine impacts and required mitigation.

1. Construction requirements
Concrete sill will be replaced with rock chute to match the stable channel dimensions of this reach of the river.

2. Initial Success Criteria – 1-3 years after sill replacement

- a. River dimension, pattern, and profile at sill location are similar to a reference reach to be determined in subsequent phase(s).
- b. Positive increase in fish passage rates in the target species (Gulf Sturgeon, striped bass, paddlefish, AL shad, etc.) for three successive years as documented in BRFWCO, 2018.

3. Intermediate Success Criteria – 3-5 years after sill replacement

- a. Positive increase in fish passage rates in the target species (Gulf Sturgeon, striped bass, paddlefish, AL shad, etc.) for three successive years as documented in BRFWCO, 2018.
- b. Increased recruitment (e.g., > 10% more than baseline conditions) of target species 5 years after sill replacement.

4. Long-Term Success Criteria – 5-8 years after sill replacement
Species assemblage above and below the sill similar to reference conditions to be determined in subsequent phase(s) (e.g., aquatic invertebrates, fish, etc.).

10.7 Preliminary Lacustrine Mitigation Success Criteria

These preliminary success criteria were developed based on the creation of oxbow lakes and/or ponds (similar to borrow pits) within the newly excavated floodplain.

1. Construction requirements
    - a. Oxbow lake or pond will be excavated at dimensions and location(s) to be determined during the development of the project specific mitigation plan.
2. Initial, Intermediate, and Long-Term Success Criteria
    - a. Oxbow lake/pond dimension, pattern, and profile are similar to a reference resource to be determined in subsequent phase(s).
    - b. Hydrologic connection to river is at a similar frequency as impacted aquatic resources and water can both enter and exit the oxbow/pond.
    - c. Adequate water storage (i.e., oxbow/pond has ability to retain flood waters and precipitation).
    - d. Positive native aquatic species usage (i.e., waterfowl, herpetofauna, fish, invertebrates, and wetland plants present).

10.8 Monitoring and Adaptive Management

The following general plans for monitoring were developed to determine the success of the mitigation work. Tables 10 through 13 include the preliminary schedules for monitoring work and identifies the entity that will be responsible for the monitoring activity. The responsible party is the agency that is ultimately responsible for conducting the action and ensuring an acceptable outcome. The IMT will continue to be included throughout and are welcome to accompany and/or assist in any monitoring activity. The entire IMT is expected to play a role in reviewing monitoring reports and discussions of mitigation success. Periodic meetings will be conducted to coordinate with and inform the IMT. Coordination with resource agencies will happen on a case-by-case basis if needed.

The elements of the monitoring plans are designed to measure the attainment of ecological success criteria at key points over the course of the mitigation construction and operation periods. The costs of monitoring activities prior to and during construction are generally shared. Most post-construction monitoring costs are part of OMRR&R and are the responsibility of the non-Federal sponsor. Parametric monitoring costs were developed for planning purposes and can be found in Tables 6, 7, and 8. The project specific monitoring costs will be developed once the lands are identified and the acres for each habitat type are determined.

Monitoring work also offers an opportunity to build upon partnerships with local interests, non-governmental organizations, universities, and the public. The USACE and the non-

Federal sponsor are interested in these partnership opportunities. Parties interested in participating in monitoring efforts are encouraged to discuss potential work with the sponsors.

Table10 BLH Monitoring Activities

Target Year	Work Item	Work Item Description	Responsible Party
0	Begin Construction	Start of mitigation construction activities	USACE
1	Complete Construction	Finish clearing, grubbing, grading (excavation; ditch & berm removal), drainage alterations, etc.	USACE
1	Topographic/As-Built Survey	Perform as-built topographic survey of areas in enhancement features requiring significant grading. Includes survey of any structures installed plus cross-sections of significant ditches or berms removed, and for any new drainage features. Results documented in mitigation monitoring report.	USACE
2	Plantings	Install canopy and midstory species	USACE
2	Monitoring & Report	Perform field mitigation monitoring for contract success. Submit report by Dec. 31.	USACE
3	Analysis for Notice of Construction Complete	Review As-Builts and O&M manual. Review monitoring report and other data as compared to contract. Coordination with Interagency Team as needed.	USACE
3/4	NCC	Notice of Construction Complete to NFS The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met	USACE/NFS
3/4	Monitoring & Report	Perform field mitigation monitoring for Initial Success. Submit report by Dec. 31.	USACE
3/4	Analysis for Success Criteria	Review monitoring report and other data to make initial success criteria determination and to turn over monitoring to Non-Federal Sponsor.	IMT
4/5	All Responsibilities transferred to NFS	Transfer (turn-over) project monitoring to Non-Federal Sponsor. Note: transfer occurs this year unless additional plantings needed or canopy/midstory densities not achieved per success criteria.	USACE/NFS
	Monitoring & Report	Perform field mitigation monitoring for Intermediate Success. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
	Aerial Photography	Obtain rectified aerial photo of restoration features. Provide as part of mitigation monitoring report.	NFS
9/10	Monitoring & Report	Perform field mitigation monitoring for long term success criteria. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
14/15	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
19/20	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS

	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
24/25	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
29/30	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
34/35	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
39/40	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
44/45	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
49/50	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT

Table 11 Swamp Monitoring Activities

Target Year	Work Item	Work Item Description	Responsible Party
0	Begin Construction	Start of mitigation construction activities.	USACE
1	Complete Construction	Finish clearing, grubbing, grading (excavation; ditch & berm removal), drainage alterations, etc.	USACE
	Topographic/As-Built Survey	Perform as-built topographic survey of areas in enhancement. Includes survey of any structures installed plus cross-sections of significant ditches or berms removed, and for any new drainage features. Results documented in mitigation monitoring report.	USACE
	Review and Coordination	Review ongoing activities, coordination with Interagency Team as needed.	USACE
2	Plantings	Install canopy and midstory species	USACE
	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	USACE
	Review and Coordination	Review ongoing activities, coordination with Interagency Team as needed.	USACE
3	Topographic/As-Built Survey	Perform topographic survey. Includes survey of any structures installed plus cross-sections of significant ditches or berms removed, and for any new drainage features. Results documented in mitigation monitoring report.	USACE
	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	USACE
	Analysis for Notice of Construction Complete	Review As-Builts and O&M manual. Review ongoing activities, review monitoring report from prior year and other data as compared to success criteria. Coordination with Interagency Team as needed.	USACE
	NCC	Transfer (turn-over) project to the Non-Federal Sponsor. The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met.	USACE/NFS
	Review and Coordination	Review ongoing activities, review monitoring report from prior year and other data as compared to success criteria. Coordination with Interagency Team as needed.	USACE
5	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31. Report also accomplished added monitoring needed due to re-planting.	USACE

	Review and Coordination	Review ongoing activities, review monitoring report from prior year and other data as compared to success criteria. Coordination with Interagency Team as needed.	USACE
6	Analysis for Success Criteria	Review monitoring report from prior year and other data to make initial success criteria determination and to turn over monitoring to Non-Federal Sponsor.	IMT
	Transfer to NFS	Transfer (turn-over) project to Non-Federal Sponsor for all OMRR&R. Note: transfer occurs early this year unless topographic corrections and/or plantings required.	USACE, NFS
12	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
17	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
22	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
27	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
32	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
37	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria.	IMT

		Coordination with Interagency Team as needed.	
42	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
47	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review ongoing activities, review monitoring report from prior year and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT

Table 12 Upland Forest Monitoring Activities

Target year	Work Item	Work Item Description	Responsible Party
0	Begin Construction	Start of mitigation construction activities	USACE
1	Complete Construction	Finish clearing, grubbing, grading (excavation; ditch & berm removal), drainage alterations, etc.	USACE
	Topographic/As-Built Survey	Perform as-built topographic survey of areas in enhancement features requiring significant grading. Includes survey of any structures installed plus cross-sections of significant ditches or berms removed, and for any new drainage features. Results documented in mitigation monitoring report.	USACE
2	Plantings	Install canopy and midstory species	USACE
	Monitoring & Report	Perform field mitigation monitoring for contract success. Submit report by Dec. 31.	USACE
3	Analysis for Notice of Construction Complete	Review As-Builts and O&M manual. Review monitoring report and other data as compared to contract. Coordination with Interagency Team as needed.	USACE
3/4	NCC	Notice of Construction Complete to NFS The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met	USACE/NFS
3/4	Monitoring & Report	Perform field mitigation monitoring for Initial Success. Submit report by Dec. 31.	USACE
3/4	Analysis for Success Criteria	Review monitoring report and other data to make initial success criteria determination and to turn over monitoring to Non-Federal Sponsor.	IMT
4/5	All Responsibilities transferred to NFS	Transfer (turn-over) project monitoring to Non-Federal Sponsor. Note: transfer occurs this year unless additional plantings needed or canopy/midstory densities not achieved per success criteria.	USACE, NFS
	Monitoring & Report	Perform field mitigation monitoring for Intermediate Success. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
	Aerial Photography	Obtain rectified aerial photo of restoration features. Provide as part of mitigation monitoring report.	NFS
9/10	Monitoring & Report	Perform field mitigation monitoring for long term success criteria. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
14/15	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
19/20	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
24/25	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT

29/30	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
34/35	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
39/40	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
44/45	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT
49/50	Monitoring & Report	Perform field mitigation monitoring. Submit report by Dec. 31.	NFS
	Review and Coordination	Review monitoring report and other data as compared to success criteria. Coordination with Interagency Team as needed.	IMT

10.9 Riverine Monitoring Activities

Photographic documentation of project activities will occur during construction. Qualitative and quantitative monitoring will be conducted annually for a period not to exceed 10 years post-construction. The purpose of monitoring will be to ensure achievement of success criteria and to inform future adaptive management needs. Stabilization metrics include the formation of stable channel morphology upstream and downstream (distances to be determined in subsequent phase(s) and agreed upon by the IMT) of the sill that consists of riffles, pools, bars, benches, banks vegetated above ordinary highwater mark (OHWM), deposition, instream habitat, mobilization of sediment, and fish passage. A detailed monitoring plan with methodology will be developed to include permanent surveyed channel cross sections, pebble counts, photography stations, sediment monitoring, and instream habitat quality assessments.

Table 13 Riverine Monitoring Activities

Target Year	Work Item	Work Item Description	Responsible Party
0	Begin Construction	Start of mitigation construction activities	USACE
	During construction monitoring	Photographic documentation of project activities	USACE
1	Complete Construction		USACE
1	Analysis for Notice of Construction Complete	Review As-Builts and O&M manual. Review monitoring report and other data as compared to contract.	USACE
1/2	NCC	Notice of Construction Complete to NFS The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met	USACE/NFS
2	Monitoring	Perform field mitigation monitoring for Initial Success.	USACE
3	Monitoring	Perform field mitigation monitoring for Initial Success.	USACE
4	Monitoring & Report	Perform field mitigation monitoring for Initial Success. Submit report for IMT review.	USACE
4	Analysis for Success Criteria	Review monitoring report and other data to make initial success criteria determination	IMT
4/5	All Responsibilities transferred to NFS	Transfer (turn-over) project monitoring to Non-Federal Sponsor.	USACE/NFS
5	Monitoring	Perform field mitigation monitoring for intermediate Success.	NFS
6	Monitoring	Perform field mitigation monitoring for Intermediate Success.	NFS
7	Monitoring & Report	Perform field mitigation monitoring for Intermediate Success. Submit report for IMT review	NFS
7	Analysis for Success Criteria	Review monitoring report and other data to make intermediate success criteria determination	IMT
8	Monitoring	Perform field mitigation monitoring for long-term Success.	NFS
9	Monitoring	Perform field mitigation monitoring for long-term Success.	NFS
10	Monitoring & Report	Perform field mitigation monitoring for long-erm Success. Submit report for IMT review	NFS
10	Analysis for Success Criteria	Review monitoring report and other data to make long-term success criteria determination	IMT

10.10 Lacustrine Monitoring Activities

Qualitative and quantitative monitoring will be conducted annually for a period not to exceed 10 years post-construction. The purpose of monitoring will be to ensure achievement of success criteria and to inform future adaptive management needs.

Table 14 Lacustrine Monitoring Activities

Target Year	Work Item	Work Item Description	Responsible Party
0	Begin Construction	Start of mitigation construction activities	USACE
	During construction monitoring	Photographic documentation of project activities	USACE
1	Complete Construction		USACE
1	Analysis for Notice of Construction Complete	Review As-Builts and O&M manual. Review monitoring report and other data as compared to contract.	USACE
1/2	NCC	Notice of Construction Complete to NFS The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met	USACE/NFS
2	Monitoring	Perform field mitigation monitoring for Initial Success.	USACE
3	Monitoring	Perform field mitigation monitoring for Initial Success.	USACE
4	Monitoring & Report	Perform field mitigation monitoring for Initial Success. Submit report for IMT review.	USACE
4	Analysis for Success Criteria	Review monitoring report and other data to make initial success criteria determination	IMT
4/5	All Responsibilities transferred to NFS	Transfer (turn-over) project monitoring to Non-Federal Sponsor.	USACE/NFS
5	Monitoring	Perform field mitigation monitoring for intermediate Success.	NFS
6	Monitoring	Perform field mitigation monitoring for Intermediate Success.	NFS
7	Monitoring & Report	Perform field mitigation monitoring for Intermediate Success. Submit report for IMT review	NFS
7	Analysis for Success Criteria	Review monitoring report and other data to make intermediate success criteria determination	IMT
8	Monitoring	Perform field mitigation monitoring for long-term Success.	NFS
9	Monitoring	Perform field mitigation monitoring for long-term Success.	NFS
10	Monitoring & Report	Perform field mitigation monitoring for long-erm Success. Submit report for IMT review	NFS
10	Analysis for Success Criteria	Review monitoring report and other data to make long-term success criteria determination	IMT

10.11 Adaptive Management

This General Adaptive Management Plan (AMP) is for PR FRM mitigation measures which are designed to mitigate for bottomland hardwood, forested uplands, swamp, and riverine impacts. In subsequent phase(s) and when a project specific mitigation plan is developed, this general AMP would be refined to be project specific It should be noted that even though the preliminary mitigation measures include the potential purchase of credits from mitigation banks, this General AMP only details the adaptive management planning for the Corps constructed projects. In the event that mitigation bank credits are purchased, the mitigation management and maintenance activities for the mitigation bank credits will be set forth in the Mitigation Banking Instrument (MBI) for each particular bank. The bank sponsor (bank permittee) will be responsible for these activities rather than the USACE and/or the local Sponsor. USACE Regulatory staff reviews mitigation bank monitoring reports and conducts periodic inspections of mitigation banks to ensure compliance with mitigation success criteria stated in the MBI.

Adaptive management planning elements include: 1) development of a Conceptual Ecological Model (CEM), 2) identification of key project uncertainties and associated risks, 3) evaluation of the mitigation projects as a candidate for adaptive management and 4) the identification of potential adaptive management actions (contingency plan) to better ensure the mitigation project meets identified success criteria. This adaptive management plan is a living document and will be refined as necessary as new mitigation project information becomes available.

A CEM was developed to identify the major stressors and drivers affecting the potential mitigation measures (see Table 15). The CEM does not attempt to explain all possible relationships of potential factors influencing the mitigation sites; rather, the CEM presents only those relationships and factors deemed most relevant to obtaining the required acres/AAHUs. Furthermore, this CEM represents the current understanding of these factors and will be updated and modified, as necessary, as new information becomes available.

Table 15 Conceptual Ecological Model

Stressors/Drivers	BLH	Forested Uplands	Swamp	Riverine	Lacustrine
Sedimentation				-	-
Bank erosion				-	-
Channel incision				-	
Runoff	-		-	-	-
Invasive Aquatic Species				-	-
Vegetative Invasive Species	-	-	-	-	-
Herbivory	-	-	-		
Hydrology	+/-		+/-		
Topography (elevation)	+/-		+/-		

key to Cell Codes: *- = Negative Impact/Decrease*
+ = Positive Impact/Increase
+/- = Duration Dependent

A fundamental tenet underlying adaptive management is decision making and achieving desired project outcomes in the face of uncertainties. There are many uncertainties associated with the restoration of riverine systems. The IMT identified the following uncertainties during the planning process.

A. Uncertainty Relative to Achieving Ecological Success:
   1) Water, sediment, and nutrient requirements/limitations for BLH, Swamp, riverine, and lacustrine
   2) Magnitude and duration of wet/dry cycles for BLH and Swamp
   3) Growth curves based on hydroperiod and nutrient application for BLH and Swamp
   4) Tree litter production based on nutrient and water levels for BLH and Swamp
   5) Tree propagation in relation to management/regulation of hydroperiod for BLH and Swamp
   6) Bank erosion affecting oxbow lakes and river dimension, pattern, and profile
   7) Bank erosion contributing to poor water quality by increased turbidity
   8) Channel incision affecting hydrology and water quality
   9) Competition due to invasive/nuisance aquatic species
   10) Poor water quality due to vegetative invasive species

B. Loss rate of vegetative plantings due to herbivory

The items listed below would be developed to minimize risks.

- • Specified success criteria

- • Detailed planting guidelines for BLH, forested uplands, and Swamp
- • Invasive vegetative species control
- • Supplementary plantings as necessary
- Robust monitoring plans

Subsequently, as part of the adaptive management planning effort, the mitigation project features were re-evaluated against the CEM, and sources of uncertainty and risk were identified to determine if there was any need for additional actions and costs under the adaptive management plan to ensure that the project meets the required success criteria. Based on the uncertainties and risks associated with the project implementation the following contingency actions have been identified to be implemented if needed to ensure the required AAHUs are met.

1) Potential Action #1. Water control structures to ensure appropriate hydrology for BLH and swamp habitats
    - Uncertainties addressed: A1, A2, and A6

2) Potential Action #2 Nutrient application for BLH and swamp habitats
    - Uncertainties addressed: A1

3) Potential Action #3. Establish and maintain a riparian buffer to reduce storm-water, pollution, and nutrient run-off
    - Uncertainties addressed: A1

4) Potential Action #4, Establish and maintain a riparian buffer to capture sediments before they reach the river or oxbow lake(s).
    - Uncertainties addressed: A1

5) Potential Action #5. Maintain or implement vegetated streamside management zones in agricultural areas to stabilize banks and protect water quality
    - Uncertainties addressed: A7 and A8

6) Potential Action #6. Construction of in-stream structures to address impacts due to channel incision
    - Uncertainties addressed: A9

7) Potential Action #7. Implement invasive/nuisance aquatic species control
    - Uncertainties addressed: A10 and A11

8) Potential Action #8. Implement animal abatement measures (i.e. electric fences, trapping and relocating, etc.)
    - Uncertainties addressed: B

9) Potential Action #9. Install predator guards on planted saplings
    - Uncertainties addressed: B

The USACE would be responsible for the proposed mitigation construction and monitoring until the initial success criteria are met. Initial construction and monitoring would be funded in accordance with all applicable cost-share agreements with the NFS. The USACE would monitor (on a cost-shared basis) the completed mitigation to determine whether additional construction or management actions are necessary to achieve initial mitigation success criteria. Once the USACE determines that the mitigation has met the initial success criteria, monitoring would be performed by the NFS as part of its OMRR&R obligations. If after meeting initial success criteria, the mitigation fails to meet its intermediate and/or long- term ecological success criteria, the IMT would consult to determine the appropriate management or remedial actions required to achieve ecological success.

Section 11 References

Rankin-Hinds Pearl River Flood and Drainage Control District. 2014. Habitat Evaluation Procedures (HEP) Report Rankin-Hinds County Mississippi Flood Damage Reduction Project.

U.S. Army Engineer Research and Development Center. Pearl River Watershed Feasibility Study Two Lakes Flood Control Plan Aquatic Evaluation.

U.S. Army Corps of Engineers. 2019. Engineer Regulation 1105-2-100 Planning Guidance Notebook, Appendix C.

U.S. Army Corps of Engineers. 2020. Environmental Assessment #576, Appendix H.

U.S. Army Corps of Engineers 2023. West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study St. John the Baptist, St. James, Ascension, Livingston, St. Tammany, and St. Charles Parishes, Louisiana - Mitigation Plan Update, Appendices G and H.

U.S. Fish and Wildlife Service Baton Rouge Fish and Wildlife Conservation Office (BRFWCO). 2018. Barriers to Migration for Gulf Sturgeon in the Pearl River Watershed.

U.S. Fish and Wildlife Service 2020. Fish and Wildlife Coordination Act Report, Pearl River Basin, Mississippi, Federal Flood Risk Management Project, Hinds and Rankin.

U.S. Army Corps of Engineers. 2019. Accessed 2023. Regulatory In-lieu fee and Bank Information Tracking System (RIBITS). https://ribits.ops.usace.army.mil.

Mississippi Valley Division,
Regional Planning and Environment Division South

Pearl River Basin, Mississippi, Federal Flood Risk Management Project

Annex F1 - Habitat Evaluation Procedures (HEP) Report

July 2025

Habitat Evaluation Procedures (HEP) Report

Rankin-Hinds Pearl River Flood and Drainage Control District

Rankin-Hinds County Mississippi Flood Damage Reduction Project

October 2014

HEADWATERS INC.
NATURAL RESOURCES CONSULTING

RANKIN-HINDS COUNTY, MISSISSIPPI FLOOD DAMAGE REDUCTION PROJECT

DRAFT EVALUATION OF IMPACTS TO TERRESTRIAL AND AQUATIC HABITATS RESULTING FROM ALTERNATIVES FOR THE RANKIN-HINDS COUNTY, MISSISSIPPI FLOOD DAMAGE REDUCTION STUDY

INTRODUCTION

BACKGROUND AND OBJECTIVES

The Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service (FWS), 1980a, 1980b) were used to quantify the potential impacts of Rankin-Hinds County, Mississippi Flood Damage Reduction Study. The study area includes parts of both Hinds, and Rankin Counties, Mississippi. Major tributaries of the Pearl River within the study area include Eubanks Creek, Hanging Moss Creek, Lynch Creek, Purple Creek, Three-Mile Creek and Town Creek. The study area utilized is located within the Jackson Metropolitan Area and is primarily affected by headwater flooding caused by the Pearl River. Headwater flooding is caused by unusually heavy and intense rainfall events over the upper Pearl River Basin and above the Ross Barnett Reservoir located at the northern extreme of the study area. HEP was utilized to evaluate potential terrestrial and aquatic habitat impacts that could be anticipated from the construction of the proposed channel improvements plan and the proposed levee plan.

HEP is a habitat based evaluation system that allows one to estimate current habitat conditions, predict future conditions, compare project alternatives and devise mitigation strategies. HEP was developed as an assessment tool that focuses on habitat variables verses efforts to directly sample animal populations within a proposed project area. The HEP analysis completed for the Pearl River Flood Damage Reduction Study area was completed in a manner to provide a sufficient level of evaluation of the potential impacts to terrestrial habitats as a result of the proposed alternatives and provide an assessment tool to facilitate comparisons with the Channel Improvement Plan and the Levee Plan. For the purposes of the overall National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS), these proposed flood damage reduction alternatives are referred to as Alternative C and Alternative B, respectively.

The basic objectives of the HEP analysis prepared for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Project study area were to

determine the pre-project or baseline habitat suitability for the selected wildlife species as "target species" for each habitat found within the study area and to provide an estimation of potential impacts to each of the "target species" as a result of the construction of the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Plan. It is also the objective of this analysis to develop potential mitigation measures or design modifications that will help offset unavoidable habitat losses if possible. Only the direct impacts associated with the two proposed structural alternatives for the Rankin-Hinds County, Mississippi Flood Damage Reduction Plan were evaluated. These direct impacts included land clearing, channel dredging and/or excavation, weir and levee construction and long-term maintenance needs. The direct impacts also include areas that have been identified as disposal/fill areas for the dredge and/or excavation material. Impacts associated with the construction of interior collector ditches, gated drainage structures within the proposed levee segments and pumping plants along the levee segments were not included in this assessment except to the extent that these features could result in potential impacts to the Pearl River tributary streams with the exception of Richland Creek.

OVERVIEW OF HEP

HEP is a method which can be used to document the quality and quantity of available habitat for selected wildlife species. The evaluation process provides basic information for use in two (2) general types of wildlife habitat comparisons, the relative value of different areas at the same point in time; and the relative value of the same area at future points in time. By combining the two (2) types of comparisons, the impact of the proposed or anticipated land and water use changes on wildlife habitat can be quantified. For this project, the assessment was completed for both aquatic and terrestrial target species covering the full extent of the affected habitat types associated with the proposed structural alternatives.

HEP is in essence an accounting system for quantifying and displaying habitat availability for aquatic and terrestrial wildlife. HEP is based on habitat suitability index (HSI) models that quantitatively describe the habitat requirements of a species or group of species. HSI models use measurements of appropriate variables to rate the habitat on a scale of zero (0) which is defined as unsuitable to one (1.0) which is optimal. In a typical HEP study, a number of evaluation species or "target species" are chosen for each cover or habitat type (aquatic and terrestrial) identified within the study area. Species may be chosen because of their ecological, recreational or economic value. The evaluation species may also be chosen to represent groups of species; i.e., guilds, which have similar habitat needs (Roberts and O'Neal, 1985).

Once cover types or habitat units have been mapped and the evaluation or "target" species chosen for the study area, habitat variables contained in the HSI models for each species are measured from maps and aerial photographs and supplemented or proofed by on-site sampling. For this HEP Analysis, the most current LIDAR data was also utilized for mapping and habitat unit area calculations. HSI values are then calculated and the initial or baseline number of habitat units (HU) is determined for each species. One (1) HU equates to one (1) acre of optimal habitat for the chosen species. The number of HU's for a species is calculated as the number of acres of available habitat times its suitability for that species (HU = HSI x acres).

The habitat units (HU) available to each species are estimated for each of several target years (TY) over the life of the proposed project (generally 50 to 100 years). Estimates of future habitat conditions are made for the "without project" alternative and for each "with project" alternative. Impacts on each species are then determined by calculating the difference in average annual habitat units (AAHU's) between with and without project alternatives. Development of mitigation plans involving tradeoffs of one sort of habitat for another may involve the use of relative value indices that express the relative priority or importance of the evaluation species or their habitats (Wakeley and O'Neal, 1988).

STUDY AREA AND METHODS

STUDY AREA

Definition of the study area should consider the purposes of the study, significant changes that may occur in existing habitat and the interrelationships of species within the biological community that presently exist or could exist there in the future. The study area should include those areas where biological changes related to the land or water use proposal under study are expected to occur. The study area should include areas that will be affected, either directly or indirectly by the proposed use. As noted, the study area for this HEP analysis is defined as the two (2) project areas for the two (2) structural alternatives under evaluation.

PROJECT ALTERNATIVES

The final array of alternatives carried forward for consideration included the No Action Alterative, Alternative A (non-Structural), Alternative B (Plan 13 as defined by the initial array of alternatives), referred to as the Levee Plan and Alternative C (Plan 15 also under the original array of alternatives) and referred to as the Channel Improvements Plan. Details of each alternative are included in this section. In addition, Appendix A contains the mapping reflecting the extent of the two (2) structural alternatives included in this analysis.

No Action Alternative (Future Without-Project Condition)

Under the No Action Alternative, no flood damage reduction project would occur. The area would continue to experience flooding caused by the headwaters of the Pearl River as well as more localized events. As already presented in the Integrated Draft Feasibility and Environmental Impact Statement documentation, impacts would continue to be substantial and could possibly increase due to ongoing urban development and would continue to impact structures, infrastructure, transportation, and public facilities within the Jackson Metropolitan Area.

Alternative A (Non-Structural)

The measure of relocating structures (buy out) allows for moving structures as part of the project and buying the land upon which the structures were located. The total number of structures to be relocated in this alternative would be in excess of 3,100 including residential, commercial, schools, and hospitals. This

does not include structures behind existing levees although some probability of damage and risk in these areas will still exist. Under this alternative, risk reduction would not be provided to existing structures, including the City of Jackson Wastewater Treatment Plant Site.

Alternative B (Levee Plan)

Under this alternative, new levees would be constructed on both the east and west side of the Pearl River and the expansion of portions of the existing approximately 13.5 miles of levee that are currently in place. In addition, some areas would include newly constructed floodwalls due to right-of-way restrictions. Additionally, significant conveyance improvements would be constructed from RM 292 to RM 302 on the west bank of the river to reduce induced flooding from the new levees and reduce any impacts to the outlet structure of the Ross Barnett Reservoir.

Alternative C (Channel Improvements Plan)

This alternative consists of significant channel modification from RM 284 to RM 293.5. Levees exist within much of this reach and would be relocated in some areas to reduce flood levels. This alternative would consist of excavating the overbanks of the channel. Excavation would be placed adjacent to existing levees or adjacent to relocated levees. The large amount of excavation needed would create substantial land mass or expanded levee widths providing additional protection and additional risk reduction. The weir currently located at RM 290.7 would be removed and a new weir with a gate for low flows would be constructed near RM 284.3. This modification to a higher elevation and expanded width would provide a larger body of water for recreation while reducing channel maintenance. Additional pumps would not be needed to provide protection behind levees except where pumps already exist and would be modified as needed. A small levee segment would be constructed on the west bank approximately from RM 297 to RM 298 to mitigate flood risk in this area.

COVER TYPES

The completion of the HEP analysis requires the delineation of all cover types found within the defined study area. Cover types serve three main functions in a HEP analysis. The cover types facilitate the selection of the evaluation or "target" species. In addition, extrapolation of data from field sampled areas verses non-sampled areas can be done with a higher level of confidence if the study area is divided into relatively homogeneous areas. Additionally, separation of the study area into cover types facilitates treatment of the HEP data

and allows the models to develop more accurate habitat units used in the evaluation of the target species.

Specifically, the study area defined for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study is located within the confines of the Jackson Metropolitan Area. The study area consists largely of bottomland hardwood forests interspersed with oxbow lakes and supporting cypress-tupelo associations. In addition, upland habitats are present on the higher elevations that contain both pine and mixed pine and hardwood timber stands. There are several areas located throughout the study area that have been converted to more early successional scrub-shrub habitat types as a result of timber harvesting activities. In addition, a fairly substantial floodway management area located in the southern portion of the project area is also maintained in a general scrub-shrub habitat type. Though the Jackson Metropolitan Area has become highly urbanized, the preponderance of the study area remains largely undeveloped and remains in a primarily forestland habitat type.

Development of the cover types utilized in this HEP analysis was initially based upon cover type delineations of aerial photography coverage of the study area. Delineations of cover types was completed utilizing the 2012 National Agricultural Imagery Program (NAIP) color photography and the 1996 USGS NAPP color infrared photography covering the study area. The delineation of cover types was completed utilizing ESRI Geographic Information Systems (ArcGIS). Acreage estimates for each cover and/or land use type delineated in the original mapping efforts were also developed utilizing ArcGIS.

The ArcGIS mapping and cover type delineations were supplemented and refined by utilizing the Light Detection and Ranging (LiDAR) data that was available for the study area. The available elevation data in a Digital Earth Model (DEM) grid format was utilized to help facilitate the determination of observed elevation changes associated with the different cover types observed during the field assessments within the study area. LiDAR was utilized to capture the DEM data within ArcGIS to help in the determination of the extent of each cover type for the analysis. The elevation data utilized was obtained from the Mississippi Department of Environmental Quality (MDEQ) and the USGS Hinds County, Mississippi 2006 data collection and the MDEQ and USGS Rankin County, Mississippi 2013 DEM datasets. The data sets for both collection efforts consists of DEMs created from high resolution, airborne collected LiDAR elevation data.

The original cover types and/or land use types were first classified as specific descriptive habitat types that best fit the observed characteristics from the aerial photography coverage. A detailed ground truthing process was employed

wherein specific data points were established within the delineated cover or land use types to clarify the types identified in the photo interpretation and delineation process. Global Positioning System (GPS) points were taken at each sampling point to help justify the ground truthing to the cover or land use type delineations and to provide base data for the HEP analysis. It should be noted that the HEP analysis ground truthing was conducted at the same time that the wetlands field delineation and determination was conducted.

The study area was classified into the following cover types: emergent wetland, lacustrine, mixed forested wetlands, mixed scrub-shrub wetland, palustrine, riverine, upland evergreen forest, upland grassland, upland mixed forest, upland pasture, upland shrub lands and upland urban. The area included within each cover type was estimated utilizing the ArcGIS technology from the aerial photographs and justified through ground truthing and GPS technology as previously discussed herein. The acres and hectares determined to be in each cover type for each alternative, as well as, the percent coverage of each cover type, is shown in the following tables.

Cover types and acreages present for the Levee Plan model for the Rankin-Hinds Flood Damage Reduction Project			
Cover Types	**Levee (acres)**	**Levee (hectares)**	**Percent**
Emergent wetland	5.88	2.38	0.75
Lacustrine	28.24	11.43	3.59
Mixed Forested Wetland	291.49	117.96	37.10
Mixed Scrub-Shrub Wetland	30.12	12.19	3.83
Palustrine	18.54	7.50	2.36
Riverine	9.42	3.81	1.2
Upland Evergreen Forest	16.26	6.58	2.07
Upland Grassland	37.68	15.25	4.8
Upland Mixed Forest	326.88	132.28	41.6
Upland Pasture	-0-	-0-	-0-
Upland Scrub-Shrub	8.89	3.60	1.13
Upland Urban	12.39	5.01	1.58
	785.80	**317.99**	**100**

Cover types and acreages present for the Channel Improvements Plan model for the Rankin-Hinds Flood Damage Reduction Project			
Cover Types	**Channel Improvements (acres)**	**Channel Improvements (hectares)**	**Percent**
Emergent wetland	59.19	23.95	2.07
Lacustrine	200.09	80.97	7.00
Mixed Forested Wetland	911.58	368.90	31.91
Mixed Scrub-Shrub Wetland	256.04	103.62	8.96
Palustrine	147.20	59.57	5.15
Riverine	287.16	116.21	10.05
Upland Evergreen Forest	14.44	5.84	0.51
Upland Grassland	151.79	61.43	5.31
Upland Mixed Forest	536.47	217.10	18.70
Upland Pasture	54.41	22.02	1.9
Upland Scrub-Shrub	208.68	84.45	7.31
Upland Urban	29.60	11.98	1.04
Total	**2,856.62**	**1,156.04**	**100**

EVALUATION SPECIES

The evaluation species form the basis for the HEP analysis. An evaluation species can be a single species, a group of species, species life stage or a species life requisite. The evaluation species are used in HEP to quantify habitat suitability and determine changes in the number of available habitat units (HU's). As a result, the HEP analysis is directly applicable only to the evaluation species selected. The degree to which predicted impacts for these species can be extrapolated to a larger segment of the wildlife community depends on careful species selection.

Sixteen (16) evaluation species were selected for the HEP analysis completed for the Rankin-Hinds County, Mississippi Flood Damage Reduction Plan. Based upon the assessments completed relative to the available habitat and/or cover types, the combined habitat requirements of these species were believed to best reflect the important wildlife values of the various habitats or cover types in the study area. In addition, the specific species selected are also relative to the available HEP models.

Several selected evaluation species are known to inhabit the upland pine, mixed pine-hardwood and bottomland hardwood forestland areas that make up the majority of the project study area. These species include the barred owl (*Strix varia*), the gray squirrel (*Sciurus carolinensis*), the swamp rabbit (*Sylvilagus*

aquaticus), great blue heron (*Ardea Herodias*), the great egret (*Casmerodius albus*) and the wood duck (*Aix sponsa*).

The barred owl typically requires more expansive forestland habitats that contain large mature and decadent trees that provide cavities suitable for security and reproduction. Small mammals are the primary component of the barred owl's diet. From a cover standpoint, the barred owl appears to prefer older more mature stands of timber but they are known to inhabit earlier stage successional areas if there are a sufficient number of large diameter trees or snags present. Although the barred owl may occasionally inhabit small woodlot type areas, they are much more common in larger and more extensive forestland areas. Adequate nesting habitat is often the limiting factor for the successful habitation of a forestland area by the barred owl. The typical barred owl nest tree is tall, decadent, and has a suitable cavity or nest site in the upper portion of the tree bole. Most of the nest sites observed in Mississippi are in cavities in living trees. Based upon available literature, the most critical component of barred owl habitat appears to be availability of trees of sufficient size to provide cavities that are required for nesting.

The gray squirrel also tends to prefer a more mature forestland habitat type with an abundance of mast bearing trees such as oaks and hickories. The gray squirrel typically inhabits both bottomland and upland hardwood and mixed pine and hardwood forestland areas. Although they may occur in a variety of forest types, they prefer larger, densely forested areas typical of more mature timber stands. Large, dominant trees with exposed sunlit crowns are generally the primary seed producers in the type closed canopy timber stands found within a more mature forestland type. Tree cavities found in more mature timber stands are the preferred nesting and wintering shelter for the gray squirrel even though they sometimes utilize leaf nests. A significant amount of preferred gray squirrel habitat is present throughout the proposed project study area.

Swamp rabbits occur primarily in wetland and wetland-associated habitats throughout much of the southeastern United States and, specifically within the wetland forestland habitats found within the project area. Sedges and grasses appear to be the primary food sources for the swamp rabbit. However, in general, the food habits of the rabbits are not highly restrictive. A wide variety of herbaceous vegetation is characteristically consumed during the spring, summer and early fall. Bark, buds and twigs of woody vegetation are consumed during the remainder of the year.

Suitable habitat for the swamp rabbit ranges from bottomland hardwood forestland areas to herbaceous dominated coastal marshes. The swamp rabbit is

rarely found far from water and wetland habitats. It is a very common species found within floodplain bottomland hardwood forests along tributaries of large rivers, streams and swamp areas such as those found within the proposed project study area. Typically, swamp rabbits utilize brushpiles, downfall and dense herbaceous vegetation for cover. Swamp rabbit nests are usually found on the ground and are constructed with stalks of herbaceous vegetation and are lined with fur. Nests are commonly found under brush, plant debris or in other dense vegetative cover. The swamp rabbit requires relatively large tracts of suitable habitat to maintain viable populations.

Suitable habitat for the great blue heron ranges from freshwater lakes and rivers to brackish marshes, lagoons, mangrove area and coastal wetlands. Great blue herons feed anywhere they can locate prey. They can be solitary or flock feeders. Their typical diet consists of fish, small reptiles, amphibians and other crustaceans. Cover for concealments does not appear to be a limiting factor for the great blue heron. They nest in trees or bushes near the water's edge, often on islands or partially isolated spots.

The great egret, a large white heron, is typically associated with streams, ponds, lakes, mud flats, swamps, and freshwater and salt marshes feeding on fishes, amphibians, reptiles, crustaceans and insects. Great egrets are versatile nesters utilizing trees, shrubs and ground sites in riparian forests, swamp and island habitats. Human disturbance and habitat alterations are two significant factors contributing to the decline of the great egret's range.

The wood duck is one of the most stunningly colored birds in North America. They inhabit creeks, rivers, floodplain lakes, swamps and beaver ponds. They are considered primarily herbivorous but will consume invertebrates. The wood duck may utilize cover from trees or shrubs overhanging water, flooded woody vegetation, or a combination of the two cover types. Wood ducks seem to thrive when open water alternates with 50-70% vegetative cover allowing the duck to hide and forage. Nests occur in tree cavities or man-made cavities varying in size since the wood duck cannot create its own cavity.

The brown thrasher (*Toxostoma rufum*) occupies a wide variety of cover types within their breeding range. The highest densities, however, are typically found within dense woody vegetation associated with scrub and shrub type habitats, thickets, hedgerows, forest edges or mid-successional forests like cutover forestland areas. Within the project study area, they are known to occur within the edges of the open field grassland areas but primarily within the scrub-shrub type early successional forestland areas. The brown thrasher is an omnivorous ground forager that occasionally ascends shrubs and trees to feed on berries and fruit. Invertebrates and plant seeds are the principal foods in the breeding range

during the spring with fruit and berries becoming a predominant food source during the summer months. During the winter, they shift to a predominantly invertebrate diet. Brown thrashers typically nest in shrubs and trees but have been known to nest on the ground. The male birds are territorial and both sexes share incubation and care of the young. Though they are a migrant species, their breeding and wintering ranges tend to overlap in Mississippi.

The eastern meadowlark (*Sturnella magna*) prefers open, grassy areas with nearby singing perches. The meadowlark is an omnivorous ground feeder that generally nests in open fields. Approximately 74 percent of the eastern meadowlark's annual diet consists of animal matter and includes mainly beetle, grasshoppers, caterpillars, and occasionally flies wasps and spiders. Cricket and grasshoppers comprise 26 percent of the annual diet and beetles make up 25 percent of the annual diet. The remainder of the diet consists of vegetable matter, mainly grain and weed seeds.

The eastern meadowlark is primarily found in grasslands, meadows and pastures or other open field habitats. The preferred nesting habitat is pasture areas followed by hayfields, soil bank fields, winter wheat fields, idle areas and fallow areas. Nests of the eastern meadowlark are built in shallow depressions and have a dome-shaped roof constructed of grass and frequently interwoven with clumps of grasses or weeds. Elevated singing and lookout perches such as telephone wires, electric power lines, mounds of earth, farm implements or fence posts are used by males. Domestic cats and dogs tend to prey on the eggs and young of the eastern meadowlark. Close proximity of nesting sites to human habitations is also undesirable. In addition, mowing and heavy grazing by livestock may destroy meadowlark nests.

The slider turtle (*Pseudemys scripta*) is a predominantly aquatic turtle that inhabits southern waters. This species occurs in virtually all types of water bodies (e.g., rivers, ditches, sloughs, lakes and ponds). The slider turtle prefers quiet water approximately one (1) to two (2) meters in depth with a soft bottom, abundant vegetation and suitable basking sites. The habitat requirements of the slider turtle are broad. It exists sympatrically with other freshwater turtles within its range. The slider is considered a diurnal turtle. It feeds mainly in the morning and frequently basks on shore, on logs, or while floating during the rest of the day. At night, it sleeps lying on the bottom or resting on the surface near brush piles and hummocks.

Sliders are omnivores. Juvenile sliders are primarily carnivorous whereas adults tend to be herbivorous. Preferred foods include crustaceans, mollusks, adult and larval insects, fish, tadpoles and frogs. Plants in the diet include filamentous algae, duckweed (*Leman spp.*) and a wide variety of emergent and submerged

aquatic plants. In addition, they are frequently observed eating carrion found in the water. Since the sliders have a generalist diet, their ability to migrate both aquatically and terrestrially enables sliders to thrive where resources have a patchy distribution.

Mating occurs in the water but some suitable terrestrial area is required for egg-laying by nesting females. The nesting season in most cases extends from April through July in the southeast and females may nest once or twice during this period. Nests are common in open sites close to water. The nests are usually placed in loose soil that remains above the water table.

Water is an essential requirement in the ecology of this semi-aquatic species. Dense surface vegetation provides cover from predators and supports high densities of aquatic invertebrates and small vertebrates which offer better foraging than open water. As such, the slider turtle is a common associate observed within the oxbow lake areas found throughout the project study area. Sliders tend to move between habitats by both overland and aquatic routes either as a necessity to find food or to escape desiccating aquatic habitats. However, except for nesting females, movement from an aquatic habitat is not necessary for maintaining a population since they have a tendency to remain in their natal habitats for years. Thus, if a habitat provides suitable resources, it can sustain a healthy population of these turtles.

Aquatic habitats (i.e. lakes, rivers and intermittent streams) were assessed utilizing HEP models for the black crappie (*Poximoxis nigromaculatus*), the bluegill (*Lepomis macrochirus*), the common carp (*Cyprinus carpio*), the channel catfish (*Ictalurus punctatus*), the large-mouth bass (*Micropterus salmoides*), the redear sunfish (*Lepomis microlophus*), and the white crappie (*Poximoxis annularis*).

The black crappie is large sunfish that can grow as large as 16 inches and weigh as much as 5 lbs. They typically live in warm ponds, lakes, streams and reservoirs and prefer to be in groups. They are abundant in low gradient streams with low turbidity and low velocity. They prefer lots of plants and underwater structure, such as logs, stumps and rocks. The black crappie is an opportunistic feeder eating small fish, insects and crayfish. They are also known to eat just about anything that will fit in their mouth.

The blue gill is a freshwater species of sunfish that lives in shallow waters of lakes and ponds along with the slow-moving areas of streams and small rivers. They prefer cover to hide such as aquatic plants and fallen logs. They are opportunistic feeders with a diet consisting of insect larvae and small fish and will eat vegetation if food is scarce.

The common carp is an opportunistic feeder able to utilize any available food source. The carp prefers enriched, shallow warm, sluggish, and well-vegetated waters with a mud or silt substrate. They are extremely tolerant of turbidity as long as food is not limited.

The channel catfish populates a broad range of environmental conditions. Optimum riverine habitat is characterized by warm temperatures and a diversity of velocities, depths and structural features for cover and food. Optimal lake habitat for proliferation includes a large surface area, warm temperature, high productivity with abundant cover and low to moderate turbidity.

The largemouth bass prefers a lacustrine environment with extensive shallow areas that support some level of aquatic vegetation. Optimal riverine habitat includes large slow moving rivers or pools of streams with soft bottoms, aquatic vegetation and relatively clear waters. Their diet typically consists of aquatic insects, crayfish and smaller fish. The bass prefers areas low in salinity, with dissolved oxygen levels above 8 mg/liter and are intolerant of suspended solids.

The redear sunfish, commonly referred to as the shellcracker, prefers lacustrine environments over riverine. They primarily feed on the bottom and seldom feed on the surface. They prefer warm large lakes, bayous, marshes and reservoirs with vegetated shallow areas and clear waters. In riverine systems, they prefer large, clear, low gradient streams and rivers with sluggish currents and some aquatic vegetation. Their diet consists of larvae, mayfly and dragonfly naiads and, they will also consume small clams and freshwater pawns.

The white crappie is abundant in reservoirs and lakes greater than 5 acres in size. They also can occupy pools and overflow areas of larger rivers. They typically congregate in loose aggregations around submerged trees, stumps, brush, aquatic vegetation and boulders. Food consists of algae and zooplankton for the young, while the juveniles prefer planktonic insects, large adults feed primarily on small fish.

HABITAT SUITABILITY INDEX MODELS

Published Habitat Suitability Index (HSI) models were available for the sixteen (16) evaluation species. These include published HSI models for the barred owl (Allen 1987a), gray squirrel (Allen, 1987b), swamp rabbit (Allen, 1985), brown thrasher (Cade, 1986), eastern meadowlark (Schroeder and Sousa, 1982) and slider turtle (Morreale and Gibbons, 1986), black crappie (Edwards, et. al, 1982), the bluegill (Stuber, Gebhart and Maughan, 1982), the channel catfish (U.S. Fish and Wildlife Service, 1981), the common carp (Edwards and Twomey, 1982), the great blue heron (Short and Cooper, 1985), the great egret (Chapman and

Howard, 1984), the largemouth bass (Stuber, Gebhart, and Maughan, 1982), the redear sunfish (Twomey et. al, 1984), the white crappie (Edwards et. al , 1982) and the wood duck (Sousa and Farmer, 1983).

SAMPLING SCHEME

Habitat variables contained in the HSI models were measured during the time period of April 2013 through June 2014. As previously noted, the sampling was conducted as an integral part of the wetlands field delineation and determination that was also conducted for the project areas for both Alternative B and Alternative C, the two (2) structural alternatives evaluated. The sampling scheme was designed to include all habitat types of concern within the designated Rankin-Hinds County, Mississippi Flood Damage Reduction Study area. The sampling scheme was also designed to provide field information that was used to justify the acreages determined to be present within each habitat type.

Habitat variables were measured within 0.10 acre (37.5 foot radius) circular plots randomly placed throughout a sampling of the different habitat or cover types. Sample points were randomly selected based upon GPS coordinates from the habitat type locations from the 1996 NASA NAPP color infrared photography and the 2012 USGS NAIP color aerial photography used in the cover type delineation process. The sample points are also associated with the data points collected during the aforementioned wetlands field delineation and determination.

PLOT SAMPLING

Habitat variables for the terrestrial evaluations were either estimated directly or calculated later from data collected in the field. All data were collected on a 0.10 acre plot (37.5 foot radius). The HEP analysis completed for the Levee Plan was completed for primarily linear projects and therefore utilized transects run along the proposed levee alignment centerlines and within the proposed floodway clearing areas. The Channel Improvements Plan project area includes a much more extensive construction area and that limits itself to the use of a point sampling scheme which was based upon sampling within cover types. Once again, the field sampling for the HEP analysis was taken in conjunction with and utilizing the same primary data points that were included in the wetlands field delineation and determination assessments.

Plots were first classified by cover type and then the tree layer was sampled. The tree layer consisted of all woody plants greater than 20 feet tall. Trees within the plot were classified visually as either overstory or understory trees and identified

by species. The DBH of each tree in the plot was measured to the nearest inch and the average height of all trees (VHTTR01) was estimated visually and checked occasionally with a clinometer. Tree counts and DBH measurements were later used to calculate the mean DBH of the overstory trees (VDBTR01), density of trees greater than 20 inches DBH (VDNTR04) and the number of hard mast species with canopy cover greater than one (1) percent (VSDHM01).

Visual estimates of percent cover were made at each plot location within the different cover types. In the forested areas, percent cover was estimated separately for all trees within the plot (VCVTR01) and for the hard mast species (VRCHM01) that were present. In the cypress-tupelo swamp cover types (CYP), cover of emergent herbaceous vegetation (VCVEM03) was estimated. In the grassland (GRS) and shrubland (SHR) cover types, herbaceous ground cover (VCVHE01), grass cover (VRCGR01), shrub cover (VCVLT03) including woody plants three (3) to twenty (20) feet tall, and percent of ground area with leaf litter greater than 0.5 inch deep (VCVLT03) were estimated. Density of woody stems greater than three (3) feet tall (VDNSH02) was determined by either counting all stems within the plot or by sub-sampling a portion of the plot and extrapolation.

The variable CAV+SNG was estimated by adding the number of trees, living or dead, with one or more cavities greater than one (1) inch in diameter, as well as with the number of snags greater than four (4) inches in diameter. The cavities must be present in the trunk or limbs greater than four (4) inches in diameter. Additionally, the snags must be greater than six (6) feet tall.

The slider turtle HSI model requires an estimate of mean water depth (WDP01), mean current velocity (WVE01), water temperature (X125V5) and inundation regime (WRE01). WDP01 was estimated by estimating depths at various points within the sample plots. Water temperatures were measured using a thermometer submersed for at least one (1) minute. WVE01 was estimated to be zero since all sample sites were natural impoundments with permanent water. WRE01 was required only for the slider turtle model. Since bottomland hardwood sites were either temporarily or intermittently flooded, the value was near optimal for swamp rabbits.

Some of the key variables used for HSI models for the aquatic species include the percent of vegetative cover, average water depth, average total dissolved solids, stream gradient, maximum salinity, the minimum dissolved oxygen, pH levels, substrate for food composition and average water level fluctuations.

In addition, The U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory completed the Pearl River Watershed Feasibility Study, Two Lakes Flood Control Plan Aquatic Evaluation in April 2006. The 2006 Aquatic Evaluation was for a significantly larger project area but it is also

inclusive of the current project area. As a result, the 2006 Aquatic Evaluation was utilized as a part of the current HEP analysis update for the existing project alternatives. As such, the habitat variables utilized in the 2006 Aquatic Evaluation were also utilized as a part of this HEP analysis process. A copy of the 2006 Aquatic Evaluation is included as Appendix C to this report.

All habitat variables utilized in the HEP analysis were defined by the HSI models for each evaluation species and in conformity to the habitat variables utilized in the previously conducted HEP analysis for the prior project alternatives. Some of the key HEP variable definitions utilized in the HEP analysis for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study area are listed in Appendix B.

ANALYSIS OF IMPACTS

HSI DETERMINATIONS AND HEP SOFTWARE

HSI models were programmed into a standard spreadsheet program and habitat data for each sample plot in each cover type were entered into models for each of the appropriate evaluation species. An HSI value for each species on each plot was determined. HSI values for each species were averaged across all plots of similar cover type. Average HSI values and cover type quantities were used as input to the HEP analysis for the project study area and to calculate the habitat units (HU's) for each species and for each cover type found within the study area.

As a part of the HEP analysis completed for this evaluation, the HSI values developed for the evaluation species for the previous study efforts were further evaluated for applicability to the existing cover types found within the current study area. Based upon the comparisons completed relative to the previously developed HSI values and the current cover types found within the study area, it was determined that the HSI values for each of the evaluation species and for each of the study efforts are relatively the same. In addition, HSI values were developed for each of the evaluation species used for the current study effort that were not utilized during the previous study efforts and for which models are now relatively available.

In addition to the HSI values assessment and comparisons, the cover types utilized for the previous study efforts were also analyzed relative to the current cover types found within the study area. It was also determined that the cover types found within the study area have also remained fairly constant relative to the previous study efforts with the major differences being in the area of coverage for specific cover types. Therefore, a consensus was reached that the HSI values for the evaluation species previously utilized in the previous study efforts would remain constant as well as the cover types utilized where possible.

As discussed, the HEP analysis completed for the Rankin-Hinds County, Mississippi Flood Damage Reduction study is intended to provide an assessment of the habitat losses associated with the construction of the two (2) structural alternatives, the Levee Plan (Alternative B) and the Channel Improvements Plan (Alternative C). The decision to utilize the same HSI values for both plans is predicated upon the ability to make comparisons between the two plans and to provide for continuity for evaluation of the flood control alternatives in general. The following table includes the HSI values for each evaluation and cover type assessed.

The Mean Habitat Suitability Index (HSI) Values for Evaluation Species

Species	Emergent	Lake	Mixed Forested Wetlands	Scrub-Shrub wetland	Palustrine	Riverine	Upland Mixed Forest	Upland grassland	Upland pasture	Upland scrub-shrub
Barred owl			0.57		0.55		0.59			
Black crappie		0.88				0.72				
Bluegill		0.79				0.8				
Brown thrasher								0.29	0.29	0.29
Channel catfish		0.61			0.78	0.78				
Common carp		0.75				0.8				
Eastern Meadowlark								0.62	0.62	
Gray squirrel			0.49				0.61			
Great blue heron	0.87		0.75	0.75	0.75	0.75				
Great Egret				0.3	0.3					
Largemouth bass		0.95				0.95				
Redear sunfish		0.78				0.78				
Slider turtle	0.6	0.6		0.2	0.2	0.33				
Swamp rabbit			0.8	0.52	0.52					
White crappie		0.82				0.91				
Wood duck	0.22		0.91	0.75	0.75	0.91				

PROJECT LIFE AND PERIOD OF ANALYSIS

HEP requires that habitat availability for each species be estimated, for each of several target years, over a period of analysis that may include the life of the project plus any additional pre-project impact period. For the Rankin-Hinds County, Mississippi Flood Damage Reduction study, the 100-year economic life of the project begins 2021 and ends in 2121.

Work is estimated to begin in 2021 and there would be continuous impacts occurring during the three (3) year construction period until 2024. It was assumed that one-fifth of all impacts would occur by TY-1 and that all impacts would have occurred by TY-3. An additional target year at year 30 (TY-30) was

used to account for management practices and timber stand diversity and changes during the project life. This approach tends to overestimate average annual impacts but not to a degree that is unrealistic.

CALCULATING AVERAGE ANNUAL HABITAT UNITS

Average annual habitat units (AAHU's) were determined by annualizing the total habitat units (HU's) available over the 100-year economic life of the project and the three (3) year construction period. Impacts of both the Levee Plan and the Channel Improvements Plan were determined by calculating the net change in AAHU's between the with-project and without project alternatives for each evaluation species. The HEP guidance requires that all identified cover types available to a species be combined and a weighted HSI on the basis of acreage be used in the HEP analysis.

ASSUMPTIONS

During the previous studies, several cutover forestland areas were identified and cataloged as shrubland cover types. Since that time, much of this area has been allowed to grow back naturally and the character of these timber stands has changed in the period since that study was completed. Conversely, other forested areas have been clearcut during the same period. One assumption included in this HEP analysis was that the landowners would allow natural succession to occur through time and that timber harvesting activities would not be as extreme as what had previously taken place. It appears, based upon field observations, that is the case and portions of these areas were included in either the bottomland hardwood (BLH) cover type or in the mixed pine and hardwood (MPH) cover type for the purposes of the HEP analysis for the Rankin-Hinds County, Mississippi Flood Damage Reduction study area. As was the case in the previous studies that were conducted, it was assumed that future harvest activities within the study area would be accomplished on a much smaller scale through the implementation of small area clearcuts and/or selective harvest which would not result in appreciable changes in the overall structure of the study area forests. It is also assumed that the timber harvest activities employed within these much smaller harvest areas would likely be offset by successional changes in other undisturbed portions of the study area.

The nature of the type construction that would be utilized for either of the two (2) structural alternatives included in the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction study is such that a significant change in the existing habitat types will take place within the study area. As previously noted, the study area for the Rankin-Hinds County, Mississippi Flood Damage Reduction study HEP analysis was defined as the overall footprint of the

proposed channel improvements excavation area, the proposed dredge disposal areas, the proposed new levee segments and the associated floodway clearing areas.

In the case of the Channel Improvements Plan alternative, much of the existing forestland and other identified cover types will be converted to an open water habitat that would continue to exhibit riverine functions, specifically those areas within the channel excavation area. The portion of the study area included within the proposed dredge disposal areas would be filled and converted from what is now primarily forestland habitat types to what would most likely become either upland grassland or a scrub-shrub habitat, particularly in the short term of the project life. There is also the possibility that the proposed dredge disposal areas would become urban development areas over time.

In the case of the proposed new levee segments, it can be assumed that the new alignments would be maintained in a grassland cover type once construction is completed. Additionally, it can be assumed that the proposed floodway clearing limits would be maintained as a scrub-shrub habitat type through time with ongoing maintenance activities.

It is obvious, based upon the proposed project design features for both structural alternatives, significant habitat changes will occur as a result of either of the alternatives and therefore the habitat suitability for each of the evaluated species will change. For all of the evaluation species but the slider turtle, HSI values will diminish through the life of the project and, for the most part, will be significantly less immediately following the completion of the construction period.

Based upon the habitat factors evaluated, assumptions for HSI values were developed for each evaluation species based upon the critical habitat factors included in each HSI Model for the individual species. The assumed HSI values were developed based upon the habitat conversions that would take place for each evaluation species based upon the proposed project design criteria.

For the with-project conditions for the proposed channel improvement excavation areas, it was assumed that all of the acreage contained within the proposed channel improvement excavation areas would convert from the predominant riparian forestland habitat that now exists to an open water habitat. It was also assumed that the proposed dredge disposal areas along the banks of the channel excavation areas would eventually become some type of urban development area. Therefore a transition in acreage is shown to reflect anticipated development post project construction.

However, it should be noted that a certain percentage of the existing forestland habitat within the channel excavation areas will remain in the existing forestland habitat and will create "island features" within the excavated channel areas. In addition, it is assumed that these areas would be maintained in the existing forestland habitat through the life of the project.

It was assumed that the acreage associated with the proposed levee alternative project, specifically the levee segment alignments, would become grassland while the floodway clearing limits would become and would be maintained as scrub-shrub habitat throughout the life of the project.

RANKIN-HINDS COUNTY, MISSISSIPPI FLOOD DAMAGE REDUCTION STUDY AREA
ACRES OF COVER TYPES WITHIN PROJECT IMPACT AREAS

Cover Type	Acres/Impact Area		Total
	Channel Improvements	Levee	
Emergent	59.19	5.88	65.07
Lacustrine	200.09	28.24	228.33
Mixed forested wetlands	911.58	291.49	1,203.07
Mixed scrub wetlands	256.04	30.12	286.15
Palustrine	147.20	18.54	165.73
Riverine	287.16	9.42	296.58
Upland evergreen forest	14.44	16.26	30.70
Upland grassland	151.79	37.68	189.47
Upland mixed forest	536.47	326.88	863.34
Upland pasture	54.41	0	54.41
Upland shrub-land	208.68	8.89	217.57
Upland urban	29.60	12.39	41.99
Total	**2,856.62**	**785.80**	**3,642.42**

The Average Annual Habitat Units (AAHU's) were developed for each of the evaluation species based upon the analysis of the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Plan structural alternatives. The AAHU's for each evaluation species are based upon the Habitat Suitability Index (HIS) values that were developed as a part of the habitat assessment and the anticipated changes that would take place within the study area/project area through time for both the alternatives "with project conditions" and the "without project conditions". The following table depicts the Average Annual Habitat Units (AAHU's) for each evaluation species

AVERAGE ANNUAL HABITAT UNITS (AAHU'S)
CHANNEL IMPROVEMENTS ALTERNATIVE

Evaluation Species	No Actions	Channel Improvements
Barred owl	2655.0	-
Black crappie	1,642.18	421.13
Bluegill	376.54	1,460.37
Brown thrasher	98.0	164.29
Channel catfish	295.51	1,487.1
Common carp	1,578.36	345.64
Eastern meadowlark	78.0	363.79
Gray squirrel	2733.0	-
Great blue heron	570.23	1,478.64
Great egret	182.53	-
Largemouth bass	449.41	1,715.97
Redear sunfish	373.9	1,454.74
Slider turtle	308.25	949.31
Swamp rabbit	3379.0	-
White crappie	412.98	1,661.19
Wood duck	1,251.34	1,661.19

The following table includes the net changes in AAHU's for each evaluation species for the proposed Channel Improvements Alternative.

CHANGE IN AVERAGE ANNUAL HABITAT UNITS
FOR THE CHANNEL IMPROVEMENTS ALTERNATIVE

Evaluation Species	**Channel Improvements**
Barred owl	-2655.0
Black crappie	-1,221.05
Bluegill	1,083.83
Brown thrasher	66.29
Channel catfish	1,191.59
Common carp	-1,232.72
Eastern meadowlark	-285.79
Gray squirrel	-2733
Great blue heron	908.41
Great egret	-182.53
Largemouth bass	1,266.56
Redear sunfish	1,080.84

Slider turtle	641.06
Swamp rabbit	-3379
White crappie	1,248.21
Wood duck	409.86

As shown, the barred owl, gray squirrel and swamp rabbit all will lose a significant number of AAHU's over the life of the project. This is due primarily to the amount of existing forestland habitat found within the study area (~65.2%) and the substantial amount of preferred cover types utilized by these species. Those cover types include the mixed forested wetlands, mixed scrub shrub wetlands, palustrine, upland evergreen forestland and the upland mixed forestland cover types preferred by these evaluation species. The significant losses in AAHU's for each of these evaluation species is also due, in part, to the nature of the proposed project construction activities. At present, the project area contains a primarily riparian forestland habitat which contains cover types prevalent to these evaluation species. The creation of the primary aquatic habitat associated with the Channel Improvements Plan will result in the removal of the preponderance of the available habitat that now exists for most all the terrestrial evaluation species.

The conversion of the forested components and riverine habitat within the existing river channel transition into a lacustrine system with flow will significantly reduce the amount of AAHU's for the black crappie and common carp. There are also habitat changes that would occur relative to the available cover types for the great egret that would also result in a reduction in the AAHU's for this evaluation species but not to the same degree as would affect other species evaluated. However, the evaluation completed also recognized that vast amount of aquatic habitat that would be created with the Channel Improvements Plan. Though there is a significant reduction in the available AAHU's for these aquatic evaluation species, the overall gain in aquatic habitat would offset much of the losses for these species.

The change in AAHU's for the eastern meadowlark and brown thrasher are much less severe for the proposed project area. The cover types utilized by these evaluation species will be more prevalent as edge habitat along the expanded channel areas, as cover habitat along the new levee segments and as early successional habitat associated with the project construction activities. The preferred cover types for these species would also be present at differing intervals and specifically following construction with the proposed dredge disposal areas along the channel improvements excavation area. It is also anticipated that these cover types would be present at intervals throughout the project life as a result of normal land management activities.

Conversely, the wood duck, white crappie, slider turtle, redear sunfish, largemouth bass, great blue heron, channel catfish and the bluegill actually reflects a gain in AAHU's. This is due primarily to the construction of the proposed channel improvements areas and the substantial increase in available aquatic habitat for the species versus what would be available with the existing habitat types and what habitat availability would be anticipated through time for the without project conditions.

The following table includes the net changes in AAHU's for each evaluation species for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Project Levee Plan Alternative.

AVERAGE ANNUAL HABITAT UNITS (AAHU'S)
LEVEE PLAN ALTERNATIVE

Evaluation Species	No Actions	Levee
Barred Owl	450.0	-
Black Crappie	30.91	-
Bluegill	28.97	-
Brown thrasher	19.0	95.88
Channel catfish	38.89	-
Common carp	28.15	-
Eastern meadowlark	24.95	232.09
Gray squirrel	447.31	-
Great blue heron	926.89	277.52
Great egret	28.47	276.65
Largemouth bass	34.74	-
Redear sunfish	28.6	-
Slider turtle	40.58	178.42
Swamp rabbit	274.85	197.95
White crappie	30.82	-
Wood duck	307.81	240.29

The following table illustrates the net changes in AAHU's for each evaluation species for the Levee Plan impact area.

CHANGE IN AVERAGE ANNUAL HABITAT UNITS (AAHU's)
FOR THE LEVEE PLAN ALTERNATIVE

Evaluation Species	Constructed Levee
Barred Owl	-450.0
Black Crappie	-30.91
Bluegill	-28.97
Brown thrasher	76.88
Channel catfish	-38.89
Common carp	-28.15
Eastern meadowlark	207.14
Gray squirrel	-447.31
Great blue heron	-649.37
Great egret	248.18
Largemouth bass	-34.74
Redear sunfish	-28.6
Slider turtle	137.84
Swamp rabbit	-352.05
White crappie	-30.82
Wood duck	-67.52

All but 4 of the 16 evaluation species exhibit losses in AAHU's over the life of the project. Once again, this is due, in part, by the type habitat that would be impacted and the relationships these evaluation species have with the preferred cover types. In addition, AAHU's are lost for these evaluation species due to the nature of the plan design features including the construction of new levee segments and the floodway clearing along the river channel.

It is anticipated that the brown thrasher, eastern meadowlark, great egret and slider turtle would actually gain AAHU's through the life of the project primarily related with the creation of additional habitat. The proposed levee segments would be grassed following construction and would provide a much more extensive amount of grassland cover type than what currently exists. In addition, areas proposed for clearing for floodways would be maintained as scrub-shrub habitat through time.

COMPENSATION ANALYSIS

The compensation study identifies available measures that would compensate for and offset unavoidable habitat unit (HU) losses related to the proposed action or actions. The compensation is achieved through the implementation of specific management measures to existing habitat that would result in the net increase in HU's. The existing habitat chosen for the implementation of the management criteria may or may not be in the project study area. However, compensation rates related to specific management schemes are typically higher for selected habitats within the project study area or, minimally, within the same drainage basin. To obtain compensation, the HU losses associated with the proposed action must be fully offset by the specified acquisition and/or management measures. The HEP procedures provide for compensation options that include management plans based upon existing conditions in a candidate compensation area or on hypothetical management areas.

The compensation analysis completed for the 2006 Pearl River Watershed Flood Control project study included three (3) different compensation scenarios developed to provide compensation for the project impacts, as did the previous study efforts within the project area. It was assumed that the compensation analysis completed for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study Plan would likewise evaluate similar compensation scenarios.

MANAGEMENT PLAN ALTERNATIVES

The compensation analysis was completed to identify measures that would offset unavoidable HU losses to evaluation species as a result of the two (2) proposed project alternatives. As mentioned earlier, the compensation analysis for the proposed Rankin-Hinds County, Mississippi Flood Damage Reduction Study Plan would likewise evaluate similar compensation scenarios that were utilized in previous studies. These scenarios included an evaluation of three (3) different management plan scenarios that represent the most likely compensation alternatives for the proposed actions. The selected management plan scenarios are also specific to the evaluation of the losses for the terrestrial evaluation species and do not include specific criteria that would address the aquatic habitat losses.

Each management plan scenario included specific management plan criteria to arrive at the desired goal of compensation for the target species. The management plan scenarios selected for the analysis included the acquisition of existing forest land which can be somewhat related to preservation of existing habitats and including a long-term management plan. This management plan

scenario was identified as the **Acquisition Alternative**. The management plan scenarios evaluated also included the restoration of all the existing habitats within the project area and is defined as the **Restoration Alternative**. Under this management plan scenario it is assumed that every existing habitat type found within the project area would be restored at some other location within the Pearl River Basin. The third management plan scenario utilized includes the regeneration of the dominant habitat type within the proposed project areas, the bottomland hardwood forestland habitat type and is referred to as the **Regeneration Alternative**. Under this management plan scenario it is assumed that the off-site restoration activities would focus primarily upon the replacement of the predominant bottomland hardwood forestland cover type and would not focus on the specific replacement of all the existing cover types found within the project areas.

The compensation analysis included the development of basic assumptions that would be included in each management plan alternative evaluated and was based upon the premise that the proposed alternatives would take place within the Pearl River Basin and within the same general geophysical area. Since the channel improvement alternative would impact the largest acreage, the HEP compensation analysis was completed using acreage as large as those anticipated impacts. To that end, an approximately 3,000 acre parcel located to the south of the proposed project area and owned by the City of Jackson was used as a baseline for this analysis. In essence, the City of Jackson property was selected to serve as a "target forest" relative to the implementation of the three (3) possible management plan scenarios that were utilized for the analysis.

A HEP analysis was completed on the approximately 3,000 acre parcel to determine its potential as suitable habitat for the seventeen (17) evaluation species that were utilized. As a result, the HEP analysis developed for the City of Jackson property served as the baseline data for all three (3) proposed management plan scenarios evaluated relative to the proposed project alternatives. In addition, once again, the compensation analysis was completed for terrestrial habitat only. Although a baseline HEP analysis was calculated for aquatic species as well, the management scenarios only yielded estimated improvements in terrestrial habitat. Aquatic species would ultimately benefit from project implementation with the Channel Improvements Plan and the associated increase in aquatic habitats within the project area.

Each management plan scenario utilized has specific habitat goals that increased the potential of the site to create suitable habitat or cover types for the various target species. It should be noted, that the target species utilized were driven by the types of habitat that would occur as a result of the proposed project alternatives. It should also be noted that each management plan scenario and the

related habitat goals are evaluated relative to the potential management functions that can be implemented for each management plan alternative.

In performing a HEP compensation analysis three (3) different compensation scenarios are possible: 1) In-kind (no trade-off) with the compensation goal to precisely offset the HU for each of the evaluation species; 2) Equal replacement (equal trade-off) with the compensation goal to precisely offset the HU losses through the gain of an equal number of HU's and 3) Relative replacement (relative trade-off) with the goal to gain one HU for a target species in order to offset the loss of one HU relative to the proposed project alternatives impacts. Therefore, proposed compensation acreages will vary as a result of the HU's required for the target species. The tables that follow in the discussions below indicate the required number of HU's for each evaluated species while the overall proposed final acreage associated with each management scenario was derived from calculating the "optimum habit" for the target species predicated proportionately upon anticipated "new habitat" that would be developed in the proposed project area.

The first proposed management plan alternative included an analysis of the habitat units provided through the long-term management of existing forestland within the general locale of the project area. This scenario included the assumption that existing forestland would be purchased and a management plan developed that would result in an increase in habitat for the identified evaluation species through the life of the proposed projects. For this reason, it is referred to as the **Acquisition Alternative**. It was assumed for the purpose of this analysis that the cover types within the proposed management plan area occur in the same proportions as those found within the proposed project area. More specifically and as noted previously, an approximately 3,000.0 acre parcel located to the south of the proposed project area owned by the City of Jackson was used as a baseline for this analysis. Additional properties with similar habitat types within the same general locale were also evaluated. It was further assumed that the primarily forested bottomland hardwood habitat found on this property and on similar forestland within the general area could be managed through time to provide an overall increase in habitat units for the evaluation species. Utilizing these properties as a baseline, a Management Plan was developed to use as the assumed forest management baseline for the development of the estimated compensation areas for the impacts associated with each of the two (2) alternatives.

Further assumptions were also made that the Habitat Suitability Index (HIS) values for this proposed management plan scenario are similar in nature to those found within the study area for the without project conditions. Based upon these assumptions, it was estimated that a total of approximately 17,190.0 acres of existing forestland would need to be purchased and a forest management plan developed to increase the habitat suitability through time for the targeted species for the Channel Improvements Alternative.

Based upon this analysis, the purchase and management of the approximately 17,190 acres of existing forestland would slightly over compensate for impacts to habitat suitable for the barred owl, wood duck and swamp rabbit. In addition, the Channel Improvement Alternative would create and/or maintain existing habitat for nine (9) of the seventeen (16) evaluation species. This alternative would, however, significantly under compensate for habitat losses associated with the gray squirrel. This acreage would also over-compensate for the barred owl and swamp rabbit. An increase in habitat units for the brown thrasher, eastern meadowlark, great egret and the slider turtle is anticipated as a result of project completion.

Habitat losses associated with the Levee Alternative were also evaluated and in relationship to losses associated with the Channel Improvement Alternative. Under the compensation analysis completed, a total of approximately 2,250 acres of existing forestland would need to be acquired and placed under a forest management plan to offset losses associated with the Levee Alternative. This proposed acreage would fully compensate for habitat losses for barred owl, swamp rabbit and wood duck and would nearly compensate for losses associated with the great blue heron. This acreage undercompensates for habitat loss associated with the gray squirrel. An increase in AAHU's would be seen for the brown thrasher, eastern meadowlark, great egret and the slider turtle. The following table depicts the actual habitat units gained and the acreage needed to compensate for the habitat losses associated with each of the two (2) proposed alternatives.

HABITAT UNITS AND COMPENSATION AREA DETERMINATION FOR THE ACQUISITION COMPENSATION ALTERNATIVE

Evaluation Species	Constructed Levee	Channel Improvements	Management plan	Compensation Area (Acres)	
				Channel	Levee
Barred Owl	-450.0	-844.72	663.0	12,013.57	2,036.20
Brown thrasher	76.88	35.45	-	-	-
Eastern meadowlark	207.14	231.44	-	-	-
Gray squirrel	-447.31	-753.91	262.0	31,293.89	5,121.87
Great blue heron	-649.37	908.41	665.0	-	2,929.49
Great egret	248.18	-182.53	250.0	-	-
Slider turtle	137.84	641.06	-	-	-
Swamp rabbit	-352.05	-782.12	962.0	10,537.42	1,097.87
Wood duck	-67.52	409.86	629.0	-	322.03

The second management plan scenario for the terrestrial habitats evaluated is referred to as the **Restoration Alternative**. This management plan alternative would include the restoration of existing agricultural land through the conversion to forestland that would include a cover type composition that would be proportionately similar to the cover type makeup found within the study area. This alternative could include the completion of the restoration activities through fee purchase of the property or could be accomplished through the use of perpetual conservation easements with the property remaining in private ownership. It was assumed that the Habitat Suitability Index (HIS) for the evaluation species for the without project conditions could be provided through the life of the project with the restoration activities and associated long-term forest management plan in place. It was also assumed that the restoration efforts could provide a significant increase in habitat suitability for most of the evaluation species throughout the life of the project. Based upon the assumptions used, it is estimated that a total of approximately 9,076.0 acres of restoration of existing agricultural lands to similar cover type proportions would be needed to offset habitat losses associated with the proposed Channel Improvements Alternative. Under this scenario, habitat losses for all terrestrial species would be fully compensated.

The analysis of the habitat losses associated with the implementation of the Levee Plan revealed that a total of approximately 1,836.0 acres of existing agricultural lands would need to be restored to offset impacts to the evaluation species. More specifically, this alternative would fully compensate for the habitat losses of all affected species. The following table depicts the actual habitat units gained and the acreage needed to compensate for the habitat losses associated with each of the two (2) proposed plans.

HABITAT UNITS AND COMPENSATION AREA DETERMINATIONS FOR THE RESTORATION COMPENSATION ALTERNATIVE

Evaluation Species	Constructed Levee	Channel Improvements	Management plan	Restoration Area (Acres)	
				Channel	Levee
Barred Owl	-450.0	-2655.0	2,535.0	1,755.41	532.54
Brown thrasher	76.88	66.29	-	-	-
Eastern meadowlark	207.14	285.79	-	-	-
Gray squirrel	-447.31	-2733.0	1,993.0	1,992.77	673.32
Great blue heron	-649.37	908.41	-	-	1,281.65
Great egret	248.18	-182.53	300.0	3,205.23	-
Slider turtle	137.84	641.06	-	-	-

Swamp rabbit	-352.05	-3379	1,697.0	2,427.95	622.36
Wood duck	-67.52	409.86	2,535.0	1,755.42	129.85

The third scenario evaluated for compensation for each of the two (2) proposed plans is referred to as the **Regeneration Alternative**. This alternative includes the reforestation or restoration of existing agricultural lands through the conversion to a bottomland hardwood forestland habitat type only. Under this scenario, there would be no attempt to develop cover types proportionate to the study area. The restoration would be specific to existing agricultural lands suitable for conversion to a predominantly bottomland hardwood forestland habitat type. As was the case with the proposed restoration scenario, the land utilized for restoration or regeneration to a predominantly bottomland hardwood habitat could either be purchased or placed under a perpetual conservation easement and maintained in private ownership. It was also assumed that the reforestation of a primarily bottomland hardwood forestland habitat type would provide near optimal habitat conditions for most of the evaluation species through the life of the project with the implementation of a balanced long-term forest management plan. It was also assumed that the reforestation to a predominantly bottomland hardwood habitat type would provide optimal opportunity for mitigation for the forested wetland habitat losses associated with both the proposed project plans.

Based upon the evaluation completed, it is estimated that a total of approximately 5,850.0 acres of reforestation of existing agricultural lands to a predominantly bottomland hardwood habitat type would be needed to adequately compensate for the habitat losses associated with the proposed Channel Improvements Alternative. An estimated total of 1,950.0 acres of existing agricultural lands would need to be reforested to predominately bottomland hardwood habitat to compensate for the habitat losses associated with the proposed Levee Alternative. This acreage however would provide adequate compensation for all terrestrial species.

The following table depicts the actual habitat units gained and the acreage needed to compensate for the habitat losses associated for each of the two (2) proposed plans.

HABITAT UNITS AND COMPENSATION AREA DETERMINATION FOR THE REGENERATION COMPENSATION ALTERNATIVE

Evaluation Species	Constructed Levee	Channel Improvements	Management plan	Regeneration Area (Acres)	
				Channel	Levee
Barred Owl	-450.0	-2655.0	3,162.0	1,125.76	426.94
Brown thrasher	76.88	66.29	-	-	-
Eastern meadowlark	207.14	285.79	-	-	-
Gray squirrel	-447.31	-2733.0	2,543.0	1,249.0	527.70
Great blue heron	-649.37	908.41	2,125.0		916.76
Great egret	248.18	-182.53	-	1,619.33	-
Slider turtle	137.84	641.06	-	-	-
Swamp rabbit	-352.05	-3379	3,352.0	983.25	315.08
Wood duck	-67.52	409.86	2,535.0	885.72	103.88

Based upon the evaluations completed, the acreages proposed for each of the management plan scenarios can be adjusted to fully compensate for the habitat losses that would be incurred for each of the evaluation species and associated with each of the two (2) plans. The following table includes the acreages determined through the HEP compensation analysis to provide compensation for the habitat losses associated with each plan.

COMPENSATION ACRES REQUIRED TO OFFSET LOSSES OF TERRESTRIAL HABITAT DUE TO THE CONSTRUCTION OF BOTH ALTERNATIVES AS PRESCRIBED BY THE HEP COMPENSATION ANALYSIS

	Channel Improvements Plan	Levee Plan
Acquisition Alternative	17,190.0 Acres	2,250.0 Acres
Restoration Alternative	9,076.0 Acres	1,836.0 Acres
Regeneration Alternative	5,850.0 Acres	1,950.0 Acres

The following table represents the compensation acreage that would be needed for each of the two (2) proposed plans under the assumption that the habitat losses for all the evaluation species would be fully compensated.

COMPENSATION ACRES REQUIRED TO OFFSET LOSSES OF TERRESTRIAL HABITAT ASSOCIATED WITH BOTH ALTERNATIVES TO FULLY OFFSET LOSSES TO ALL EVALUATION SPECIES

	Channel Improvements Plan	Levee Plan
Acquisition Alternative	31,293.9 Acres	5,122.0 Acres
Restoration Alternative	3,205.2 Acres	1,282.0 Acres
Regeneration Alternative	1,619.33 Acres	916.0 Acres

Under the Channel Improvements Alternative, the limiting evaluation species for the **Acquisition Alternative** would be the gray squirrel. Based upon the analysis, a total of approximately 31,293.9 acres of existing forestland would need to be purchased and placed under a long-term forest management plan and other management plan activities to insure that all habitat losses for all the evaluation species are compensated. Under the proposed Levee Alternative, a total of approximately 5,122.0 acres would need to be purchased and placed under management to compensate for habitat losses for all the evaluation species. Under this scenario, the gray squirrel is the limiting evaluation species.

Under the **Restoration Alternative**, the great egret is the limiting evaluation species for the proposed Channel Improvements Plan requiring approximately 3,205.2 acres of restoration of forested habitat. In comparison, a total of approximately 1,282.0 acres would need to be restored to fully compensate for terrestrial habitat losses for all the evaluation species for the proposed Levee Plan Alternative.

The third compensation management plan alternative, the **Regeneration Alternative**, would include the reforestation of bottomland hardwood forestland. This management plan alternative provides the most balanced approach to accomplishing full compensation for all the evaluation species based upon the recommended compensation areas as developed under the HEP compensation analysis format. For the proposed Channel Improvements Plan, a total of approximately 1,619.33 acres would need to be reforested to provide full compensation for habitat losses associated with all the terrestrial evaluation species. In the case of the proposed Levee Plan, a total of approximately 916.0 acres would need to be reforested to accomplish full compensation for habitat losses for all terrestrial species.

Based upon the analysis completed, it appears that the reforestation of existing agricultural lands to a bottomland hardwood forestland habitat type represents

the most balanced approach for compensation for the associated habitat losses for both the proposed structural alternatives. Under the HEP analysis guidelines, this alternative provides the most balanced approach and would appear to provide adequate compensation for terrestrial habitat losses associated with each of the two (2) proposed plans.

Aquatic Compensation Analysis

As previously noted, the 2006 Aquatic Evaluation completed by the ERDC Environmental Laboratory staff was utilized as a part of the updated HEP analysis for the current proposed structural alternatives. Though completed for the previous alternative, the Two Lakes Flood Control Plan, the information and findings of the 2006 evaluation are still pertinent for the current alternatives that are being evaluated. As such, an additional field assessment on the Pearl River through the proposed project area was not completed. Rather, the existing data was utilized and the 2006 Aquatic Evaluation was made an integral part of this HEP analysis process (Appendix C).

To remain consistent with the 2006 Aquatic Evaluation, the same HSI values were utilized to evaluate the post-construction aquatic habitat conditions.

Evaluation Species	Existing Conditions (Lacustrine, Riverine and Palustrine)			Post-Project Conditions (Lacustrine)			Percent Change in HUs
	Acres	HSI	HU	Acres	HSI	HU	
Black Crappie	634.44	0.80	507.55	1,904.52	0.88	1,675.98	2.30
Bluegill	634.44	0.80	507.55	1,904.52	0.79	1,504.57	1.96
Channel Catfish*	634.44	0.72	456.80	1,904.52	0.35	666.58	0.46
Common Carp	634.44	0.79	501.21	1,904.52	0.35	666.58	0.33
Largemouth Bass	634.44	0.95	602.72	1,904.52	0.95	1,809.29	2.00
Redear Sunfish	634.44	0.78	494.86	1,904.52	0.78	1,485.53	2.00
White Crappie	634.44	0.87	548.79	1,904.52	0.82	1,561.71	1.85

* The channel catfish is the only species that inhabits all three (3) assessed aquatic habitats.

As noted, the Channel Improvements Plan alternative would result in the more significant modifications to the existing aquatic habitats present within the project area in comparison with the Levee Plan alternative, which would not significantly modify or alter the current aquatic environments. Therefore, HUs were determined for the existing habitats using the published HEP Models for

each of the seven (7) fish species commonly found within the project area. It was assumed that all species utilized all of the aquatic environments within the project area during their life cycle. Based upon that assumption, an average HIS was calculated for each species across all the habitats.

As previously discussed, a total of approximately 634.44 acres of palustrine, lacustrine and riverine habitats would be impacted by the proposed Channel Improvements Plan. As a part of the project implementation, approximately 1,904.52 acres of lacustrine habitat would be created. As a final determination, the percent change in habitat units for each evaluation species was calculated by comparing the available HUs for the existing conditions relative to the available HUs with the post-construction conditions. As a result, the post-construction conditions would provide a percent increase in available HUs for each of the evaluation species utilized. These conditions would be provided due to the creation of a larger aquatic environment post-construction.

Based upon the analysis, the predominately lacustrine habitat species such as the black crappie had the largest percent increase in available habitat post-construction while the largemouth bass and redear sunfish would both have a similar increase in potential available habitat. At the same time, the common carp and the channel catfish both saw a decrease in the percent of available habitat post-construction which is primarily due to the transition from what are strictly riverine and palustrine environments to what would be a more lacustrine environment post-construction from an overall perspective. Given the fact that no net loss of HUs would be anticipated as a result of the project construction, it can be assumed that all the existing species would be present within the project area post-construction.

REFERENCES

Allen, A.W., 1985. "Habitat Suitability Index Models: Swamp Rabbit," Biological Report 82(10.107), U.S. Fish and Wildlife Service, Washington, DC.

Allen, A.W., 1987a. "Habitat Suitability Index Models: Barred Owl," Biological Report 82(10.143), U.S. Fish and Wildlife Service, Washington, DC.

Allen, A.W., 1987b. "Habitat Suitability Index Models: Gray Squirrel (Revised)," Biological Report 82(10.135), U.S. Fish and Wildlife Service, Washington, DC.

Cade, B.S., 1986. "Habitat Suitability Index Models: Brown Thrasher," Biological Report 82(10.118), U.S. Fish and Wildlife Service, Washington, DC.

Chapman, B.R., and R.J. Howard. 1984. "Habitat Suitability Index Models: Great Egret", Biological Report 82(10.78), U.S. Fish Wildlife Service, Washington, DC.

Edwards, E.A., D. A. Krieger, M. Bacteller, and O.E. Maughan. 1982. "Habitat Suitability Index Models: Black Crappie. ", Biological Report 82(10.6), U.S. Fish and Wildlife Service, Washington, DC.

Edwards, EA, DA Krieger, G Gebhart, and OE Maughan. 1982. "Habitat Suitability Index Models: White Crappie." Biological Report 82(10.7) U.S. Fish and Wildlife Service, Washington, DC.

Edwards, E.A., and K.A. Twomey. 1982. "Habitat Suitability Index Models: Common Carp. " Biological Report 82(10.12), U.S. Fish and Wildlife Service, Washington, DC.

Morreale, S.J. and Gibbons, J.W., 1986. "Habitat Suitability Index Models: Slider Turtle," Biological Report 82(10.125), U.S. Fish and Wildlife Service, Washington, DC.

Roberts, T.H. and O'Neal, L.J., 1985. "Species Selection for Habitat Assessments," Miscellaneous Paper EL-85-8, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Schroeder, R.L. and Sousa, P.J., 1982. "Habitat Suitability Index Models: Eastern Meadowlark," Biological Report 82(10.29), U.S. Fish and Wildlife Service, Washington, DC.

Short, H.L., and R.J. Cooper. 1985. "Habitat Suitability Index Models: Great Blue Heron", Biological Report 82(10.99), U.S. Fish and Wildlife Service, Washington, DC.

Sousa, P.J., and A.H. Farmer. 1983. "Habitat Suitability Index Models: Wood Duck", Biological Report 82(10.43). U.S. Fish and Wildlife Service, Washington, DC.

Stuber, RJ, G Gebhart and OE Maughan. 1982. "Habitat Suitability Index Models: Bluegill", Biological Report 82(10.8), U.S. Fish and Wildlife Service, Washington, DC.

Stuber, RJ, G Gebhart, and OE Maughan. 1982. Habitat Suitability Index Models: Largemouth bass, Biological Report 82 (10.16), U.S. Fish and Wildlife Service, Washington, DC.

Twomey, KA, G Gebhart, OE Maughan, and PC Nelson. 1984. "Habitat Suitability Index Models and Instream Flow Suitability Curves: Redear Sunfish", Biological Report 82(10.79), U.S. Fish and Wildlife Service, Washington, DC.

U.S. Fish and Wildlife Service, 1980a. "Habitat as a Basis for Environmental Assessment," 101 ESM, U.S. Fish and Wildlife Service, Washington, DC.

U.S. Fish and Wildlife Service, 1980b. "Habitat Evaluation Procedures (HEP)," 102 ESM, U.S. Fish and Wildlife Service, Washington, DC.

U.S. Fish and Wildlife Service. 1981. "Standards for the Development of Habitat Suitability Index Models", Biological Report (103), U.S. Fish and Wildlife Service, Division of Ecological Services. Washington D.C.

Wakeley, J.S. and O'Neil, L.J., 1988. "Techniques to Increase Efficiency and Reduce Effort in Applications of the Habitat Evaluation Procedures (HEP), "Technical Report EL-88-12, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Killgore, K. Jack, Hoover, Jan J., Murphy, Catherine E. and George, Stephen G., 2006. "Pearl River Watershed Feasibility Study, Two Lakes Flood Control Plan, Aquatic Evaluation". U.S. Army Engineer Research and Development Center, Environmental Laboratory, Waterways Experiment Station, Vicksburg, Mississippi.

Mississippi Valley Division,
Regional Planning and Environment Division South

Pearl River Basin, Mississippi, Federal Flood Risk Management Project

Annex F2- Relevant Laws and Regulations Specific to Compensatory Habitat Mitigation Planning for Corps of Engineers Civil Works Projects

July 2025

Compensatory Habitat Mitigation Laws, Guidance, Policies and Regulations

Laws

- Clean Water Act
- Fish and Wildlife Coordination Act
- Magnuson – Stevens Fishery Conservation and Management Act
- National Environmental Policy Act
- Water Resources Development Acts of 1986, 1990, 2000, 2007, 2014, and 2016.
- 33 U.S.C. 2283

Implementation Guidance

- Section 2036(a) of the Water Resources Development Act of 2007 - Mitigation for Fish and Wildlife and Wetlands Losses. Issued by ASA(CW) 31 August 2009.
- Section 1162 of the Water Resources Development Act of 2016 (WRDA 2016), Wetlands Mitigation. Issued by ASA(CW) 01 February 2018.
- Section 1162 of the Water Resources Development Act of 2016 and Section 1040 of the Water Resources Reform and Development Act of 2014, Fish and Wildlife Mitigation (Section 906 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 2283) (WRDA 2016). Issued by ASA(CW) 08 March 2019.
- Section 1163 of the water Resources Development Act of 2016 (WRDA 2016, Wetlands Mitigation. Issued by ASA(CW) 08 March 2019.

Policy

- Cost Sharing for Lands Associated with Fish and Wildlife Mitigation. Issued by USACE Director of Civil Works 19 September 2006.

Regulations

- 40 CFR 230.92, definition of mitigation bank.
- 40 CFR 1500.3(b)(2), include alternatives input from State, Tribal and local governments.
- 40 CFR 1503.3(e), cooperating agencies must cite statutory authority to specify mitigation.
- 40 CFR 1508.5, definition of cooperating agency.
- 40 CFR 1508.20, definition of mitigation.
- Engineer Circular 1105-2-412 Assuring Quality of Planning Models.
- Engineer Regulation 1105-2-100 Planning Guidance Notebook, Appendix C.
- Engineer Regulation 200-1-5 Policy for Implementation and Integrated Application of the U.S. Army Corps of Engineers (USACE) Environmental Operating Principles (EOP) and Doctrine.
- Engineer Regulation 200-2-2 Procedures for Implementing NEPA.