

2021

West Bank & Vicinity, Louisiana General Re-Evaluation Report with Integrated Environmental Impact Statement



**US Army Corps
of Engineers®**
New Orleans District

U.S. Army Corps of Engineers, New Orleans
District

Non-Federal Sponsor: Coastal Protection and
Restoration Authority Board of Louisiana

July 2021

Cover Sheet

Project Title: West Bank and Vicinity, Louisiana General Re-Evaluation Report with Integrated Environmental Impact Statement

Proposed Action: The New Orleans District of the U.S. Army Corps of Engineers is re-evaluating the performance of the West Bank and Vicinity system given the combined effects of consolidation, settlement, subsidence, and sea level rise over time and new datum to determine if additional actions are recommended to address the economic and life safety risks associated with flooding due to hurricanes and coastal storms.

Location: St. Charles, Jefferson, Orleans, and Plaquemines Parishes, Louisiana

Type of Statement: Final Environmental Impact Statement

Lead Agency: U.S. Army Corps of Engineers

Cooperating Agencies: U.S. Fish and Wildlife Service
National Oceanic and Atmospheric Administration

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Abstract: This General Re-Evaluation Report with integrated Environmental Impact Statement presents the results of a U.S. Army Corps of Engineers (USACE) coastal storm risk management study for the West Bank and Vicinity project located in the greater New Orleans area, Louisiana. USACE is undertaking the study in partnership with the Coastal Protection and Restoration Authority Board of Louisiana, the study's non-federal sponsor. Southeast Louisiana is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause levees to require future lifts to sustain or improve performance. The Recommended Plan consists of 49 miles of levee lifts, 1 mile of new floodwall, and 268 feet of floodwall replacements to be constructed as needed before the combined effects of consolidation, settlement, subsidence, and sea level rise reduce elevations below the required design elevations. In addition, approximately 5.6 acres of foreshore protection would be constructed to support implementation of the Recommended Plan.

WEST BANK & VICINITY, LOUISIANA GENERAL RE-EVALUATION REPORT WITH INTEGRATED ENVIRONMENTAL IMPACT STATEMENT

EXECUTIVE SUMMARY

This General Re-Evaluation Report (GRR) with integrated Environmental Impact Statement presents the results of a U.S. Army Corps of Engineers (USACE) coastal storm risk management study for the West Bank and Vicinity (WBV) project located in New Orleans, Louisiana. This study is authorized by Section 3017 of the Water Resources Reform and Development Act of 2014. USACE is undertaking the study in partnership with the Coastal Protection and Restoration Authority Board of Louisiana, the study's non-federal sponsor. This report provides documentation of the plan formulation process to identify a recommended coastal storm risk management plan, along with environmental, engineering, and cost details of the Recommended Plan.

The existing WBV project includes features in four parishes (St. Charles, Jefferson, Orleans, and Plaquemines) on the west bank of the Mississippi River in the greater New Orleans area. Currently, the WBV project includes a total of 89 miles of levees and 21 miles of floodwalls, floodgates, water control structures, and other risk reduction features. This includes primary perimeter storm surge risk reduction features, MRL co-located features, and detention basin features along the Harvey and Algiers canals. The existing project reduces the risk of flooding associated with a coastal storm surge and wave event with a 1% chance of being exceeded in any given year.

Southeast Louisiana, including the greater New Orleans area, is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause levees to require future lifts (raises) to sustain the current performance of the project. This GRR re-evaluates the performance of the WBV system given the combined effects of consolidation, settlement, subsidence, and sea level rise over time and the availability of new elevation data (vertical datums), and determines if additional actions are recommended to address the economic and life safety risks associated with overtopping of the levee systems due to hurricanes and coastal storms.

A Semi-Quantitative Risk Assessment (SQRA) was performed to identify the magnitude of the risk associated with levee system overtopping. Due to the limited time and funding available to conduct the study, a full SQRA that examines all potential failure modes was not able to be conducted. Given the authorizing language to “address consolidation, settlement, subsidence, sea level rise, and new datum to restore Federally authorized hurricane and storm damage reduction projects”, the risk assessment performed for this study focused on risks related to overtopping of the levee system. This decision is supported by examination of the available Screening Level Risk Assessments, which identified overtopping of levees as the major risk driver and was fully coordinated with the USACE Levee Safety Program team. The system may have other potential modes of failure prior to overtopping but the risk assessment did not seek to identify or quantify any risks not related to overtopping. An additional semi-quantitative risk assessment is planned in the future to support the FEMA levee certification purposes and that effort will take a comprehensive look at system risks.

The study utilized a 50-year period of analysis and estimated future conditions at the end of that period if no action is taken to address the identified problems. These projections include over \$84 million in expected annual economic damages. The future estimated average annual incremental life loss related to overtopping of the system is 1E-01 (0.1) lives per year. Additionally, for the climate change analysis, the study considered potential relative sea level change impacts on system performance and adaptability during a 100-year performance horizon.

USACE identified several structural and non-structural measures to reduce coastal storm risk in the study area. An initial array of five action alternatives was formulated, evaluated, and compared primarily (but not exclusively) based on cost, economic damage reduction, life safety risk reduction related to overtopping of the system, and environmental and cultural resources impacts.

The National Economic Development (NED) Plan is the alternative that reasonably maximizes net economic benefits while remaining consistent with the federal objective of protecting the environment. Alternative 2 was identified as the NED Plan and the Recommended Plan. The Recommended Plan includes system-wide levee lifts and raising floodwalls to address the projected 1% annual exceedance probability (AEP) flooding event through the year 2078. The general features included in the Recommended Plan can be seen in Figure ES-1. The plan consists of 49 miles of levee lifts to be constructed before the combined effects of consolidation, settlement, subsidence, and sea level rise reduce the levee elevations in each levee reach below the required design elevation. Additionally, the Recommended Plan includes 268 feet of floodwall replacements and 1 mile of new floodwall to be constructed prior to the combined effects causing the design requirements to be exceeded for each structure. In addition, approximately 5.6 acres of foreshore protection would be constructed to support implementation of the Recommended Plan. The Recommended Plan has a total project first cost of approximately \$602 million and a Benefit-to-Cost Ratio (BCR) of 4.7. It reduces the estimated annual economic damages to approximately \$8 million and reduces life loss due to overtopping risk.

The Recommended Plan has many other impacts (both positive and negative) in addition to NED benefits. Regional Economic Development (RED) benefits support approximately 158 average annual, full-time equivalent jobs, \$609 million in labor income, \$702 million in the gross regional product, and \$1.1 billion in economic output in the local impact area. Other Social Effects (OSE) benefits include a reduction to life safety risks associated with overtopping of the levee system to tolerable levels, a reduction in the risk of overtopping that could result in contamination of farmland and drinking water and could negatively impact community cohesion, and reduced overtopping flood risk to four structures listed on the National Register of Historic Places. The plan has negative Environmental Quality (EQ) effects including impacts to bottomland hardwoods along the Mississippi River, as well as soil and wildlife impacts in borrow sites.

Implementation of the Recommended Plan would result in potential impacts to Bottomland Hardwood-Wet (BLH-Wet) habitat. These impacts would be avoided to the maximum extent practicable but would be unavoidable in some locations due to existing infrastructure on the protected side of the levees. The proposed mitigation plan assumes the 37.21 Average Annual Habitat Units (AAHUs) of BLH-Wet impacted (approximately 60 acres) by the Recommended Plan would be offset through the purchase of equivalent mitigation bank credits.

The public had the opportunity to review and comment on the draft report during the 55-day public review period which began in December 2019. Public meetings were held in January 2020 to present the TSP and allow the public to respond and ask questions prior to finalizing the recommendation. Comments received and responses can be found in Appendix L. Numerous environmental commitments are listed within the EIS to ensure environmental compliance, including development of a Programmatic Agreement with the State Historic Preservation Officers, Tribes, and the Advisory Council on Historic Preservation. Additional NEPA documentation and associated public review would be conducted, as necessary, to address any changes not evaluated within the scope of the impact assessment.



Figure ES-1. WBV Recommended Plan – General Features

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ACROYNMS AND ABBREVIATIONS

AAHUs: Average Annual Habitat Units
AALL: Average Annualized Life Loss
ACHP: Advisory Council on Historic Preservation
ACS: American Community Survey
ADCIRC: Advanced Circulation
AEP: Annual Exceedance Probability
APE: Area of Potential Effects
APF: Annual Probability of Failure
ASTM: American Society for Testing and Materials
ATR: Agency Technical Review
BCR: Benefit-to-Cost Ratio
BLH: Bottomland Hardwood habitat
BMP: Best Management Practice
CDP: Census Designated Place
CED: Comprehensive Environmental Document
CEQ: Council of Environmental Quality
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act
cfs: cubic feet per second
CFR: Code of Federal Regulations
CO: Carbon Monoxide
COTP: Captain of the Port
CPRAB: Coastal Protection and Restoration Authority Board of Louisiana
CSVR: Content-to-Structure Value Ratio
CWA: Clean Water Act
dB: decibel
dBA: A-Weighted Decibel
DNL: Day-Night Average Sound Level
DO: Dissolved Oxygen
DoD: Department of Defense
DQC: District Quality Control
DWS: Drinking Water Supply
EAD: Equivalent Annual Damage
ECB: Engineering and Construction Bulletin
EFH: Essential Fish Habitat
EIS: Environmental Impact Statement
EJ: Environmental Justice
EO: Executive Order
EOP: Environmental Operating Principles
EQ: Environmental Quality
ER: Engineer Regulation
ESA: Environmental Site Assessment
FEMA: Federal Emergency Management Agency
FMP: Fishery Management Plan

FPPA: Farmland Protection Policy Act
FWAC: Future Without Action Condition
FWOP: Future Without Project
FWP: Fish and Wildlife Propagation
FY: Fiscal Year
GIWW: Gulf Intracoastal Waterway
GMFMC: Gulf of Mexico Fisheries Management Council
GRR: General Re-evaluation Report
HEC: Hydrologic Engineering Center
HEC-FDA: Hydrologic Engineering Center Flood Damage Analysis
H&H: Hydrology and Hydraulics
HSDRRS: Hurricane Storm Damage and Risk Reduction System
HTRW: Hazardous, Toxic, and Radioactive Waste
HUD: Housing and Urban Development
IEPR: Independent External Peer Review
IER: Individual Environmental Report
IHNC: Inner Harbor Navigation Canal
IPET: Interagency Performance Evaluation Task Force
JLNHPP: Jean Lafitte National Historic Park and Preserve
JPM-OS: Joint Probability Method-Optimal Sampling
LDEQ: Louisiana Department of Environmental Quality
LDNR: Louisiana Department of Natural Resources
LDWF: Louisiana Department of Wildlife and Fisheries
LERRD: Lands, Easements, Rights-of-way, Relocations, and Disposal areas
LNHP: Louisiana Natural Heritage Program
LORR: Level of Risk Reduction
LPV: Lake Pontchartrain and Vicinity, Louisiana
MBTA: Migratory Bird Treaty Act
MM: Mile Marker
MR&T: Mississippi River and Tributaries
MRL: Mississippi River Levee
NAAQS: National Ambient Air Quality Standards
NAVD88: North American Vertical Datum of 1988
NED: National Economic Development
NEPA: National Environmental Policy Act

NFIP: National Flood Insurance Program
NMFS: National Marine Fisheries Service
NOAA: National Oceanic and Atmospheric Administration
NO_x: Nitrogen Oxides
NRCS: Natural Resources Conservation Service
NRHP: National Register of Historic Places
NSI: National Structure Inventory
O₃: Ozone
O&M: Operations and Maintenance
OMRR&R: Operations, Maintenance, Rehabilitation, and Replacement
OSE: Other Social Effects
PCR: Primary Contact Recreation
PED: Preconstruction Engineering and Design
PFM: Probable Failure Mode
PM: Particulate Matter
PPA: Project Partnership Agreement
RAS: River Analysis System
REC: Recognized Environmental Conditions
RED: Regional Economic Development
RM: River Mile
RNA: Regulated Navigation Areas
ROW: Right-of-Way
RSLC: Relative Sea-Level Change
RSLR: Relative Sea-Level Rise

SAV: Submerged Aquatic Vegetation
SCR: Secondary Contact Recreation
SELA: Southeast Louisiana Urban Flood Control Project
SHPO: State Historic Preservation Officer
SO_x: Sulfur Oxides
SQRA: Semi-Quantitative Risk Assessment
SWPPP: Stormwater Pollution Prevention Plan
TDS: Total Dissolved Solids
T&E: Threatened and Endangered
THPO: Tribal Historic Preservation Officer
TRG: Tolerable Risk Guidelines
TSP: Tentatively Selected Plan
USACE: U.S. Army Corps of Engineers
USCG: United States Coast Guard
USDA: U.S. Department of Agriculture
USEPA: United States Environmental Protection Agency
USFWS: U.S. Fish and Wildlife Service
USGS: United States Geological Survey
VOC: Volatile Organic Compound
VRAP: Visual Resources Assessment Procedure
WBV: West Bank and Vicinity, Louisiana
WRDA: Water Resources Development Act
WRRDA: Water Resources Reform and Development Act

WEST BANK & VICINITY, LOUISIANA GENERAL RE-EVALUATION REPORT WITH INTEGRATED ENVIRONMENTAL IMPACT STATEMENT

1 INTRODUCTION

1.1 STUDY SCOPE

This General Re-Evaluation Report (GRR) with integrated Environmental Impact Statement (EIS) presents the results of a U.S. Army Corps of Engineers (USACE) coastal storm risk management study for the West Bank and Vicinity project located within the greater New Orleans area, Louisiana. This study is authorized by Section 3017 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Public Law 113-121).

Following the storm damage that occurred as a result of Hurricane Katrina in 2005, the Congress and Administration provided authorization and appropriations through supplemental acts, "...to raise levee heights where necessary and otherwise enhance the existing West Bank and Vicinity (WBV) project to provide the levels of protection necessary to achieve the certification required for participation in the National Flood Insurance Program (NFIP) under the base flood elevations current at the time of this construction;..." This level has sometimes referred to in the past as the "100-year" "1% Level of Risk Reduction ("LORR"), or 1% annual exceedance probability (AEP) event. Throughout this report, flooding within the WBV system caused by coastal storm events will be referred to by its AEP, which is the probability that a given amount of flooding may be realized or exceeded in any given year. For example, a flood event with a 1% AEP would have a 1% probability of occurring every year. For more information on this terminology, see Section 2.0 (Problems and Opportunities).

There are multiple projects adjacent to the existing WBV project. Although not a hurricane and storm damage risk reduction project, the Mississippi River and Tributaries Project (MR&T) is a riverine flood risk reduction project which, between River Miles (RM) 70 and 119 on the West Bank, includes the Mississippi River Levees (MRL) that tie into the WBV hurricane alignment to form the comprehensive system perimeter. There are also several Gulf Intracoastal Waterway (GIWW) locks which provide navigation connections to the Mississippi River and as such provide the MR&T riverine flood risk reduction at those points. The nearby Lake Pontchartrain and Vicinity (LPV) project provides an equivalent level of hurricane and storm damage risk reduction for a portion of the New Orleans metropolitan area located on the east bank of the Mississippi River.

There are numerous complex structures, levees lining interior navigable and drainage retention areas, and interior drainage infrastructure situated within the WBV and MRL perimeter alignments. The interior drainage infrastructure includes local pump stations and drainage canals, the federal flood risk reduction Southeast Louisiana Urban Flood Control Project ("SELA"), and the post-Hurricane Katrina authorized storm-proofing of interior pump stations to ensure the operability of the stations during hurricanes, storms, and high water events. WBV was designed and constructed so as not to adversely impact internal drainage.

The authorization found in Section 3017 of WRRDA 2014 is only applicable to the LPV and WBV projects. Thus, while these GRRs, being conducted under Section 3017 of WRRDA 2014, are for LPV and WBV, when used in this report the term Hurricane and Storm Damage Risk

Reduction System (HSDRRS) will refer to the LPV and WBV projects, as well as other projects which contribute, as an incidental benefit, to providing risk reduction for the 1% AEP event. The other projects that contribute to the provision of 1% hurricane and storm damage risk reduction associated with the HSDRRS system are the Mississippi River Levees (MRL), the Southeast Louisiana (SELA) project, and the Storm Proofing Pump Stations project. The scope of this study will focus on the WBV project and components of adjacent projects if applicable and necessary for WBV to provide coastal storm risk management.

This GRR will re-evaluate the performance of the WBV project given the combined effects of consolidation, settlement, subsidence, and sea level rise over time and the availability of new elevation data (vertical datums), to determine if additional actions are recommended to sustain the current level of risk reduction for hurricanes and tropical storms. To be recommended, these actions must be determined to be technically feasible, environmentally acceptable, and economically justified. The evaluation will utilize a specified future timeframe, termed the “period of analysis”, in order to consider future conditions and evaluate the effects of alternatives over time (see Section 5 for more information about how the period of analysis is identified).

Alternatives will consider increasing, maintaining, or decreasing this level of risk reduction in order to ensure all reasonable alternatives have been evaluated. However, as described in Section 1.3, Section 3017 of WRRDA 2014 only authorizes measures to restore WBV to the 100-year LORR (the authorized level of risk reduction). This limitation to the study authorization guided the team as alternatives were formulated and evaluated in order to identify the National Economic Development (NED) plan.

1.2 PURPOSE OF REPORT

The general purpose of this study with integrated Environmental Impact Statement (EIS) is to analyze alternatives to reduce hurricane and storm risk within the WBV study area. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative. The study will identify whether an economically justified plan exists to reduce economic damages and life risk due to the combined effects of subsidence, consolidation, settlement, sea level rise, and datum changes on the WBV system. This report also satisfies the requirement of the National Environmental Policy Act (NEPA) to evaluate the proposed federal action.

Risks to human life are a fundamental component of all facets of flood and coastal storm risk management and must receive explicit consideration throughout the study process. As described in Section 3.4, a risk assessment was performed to identify the magnitude of the risk associated with levee system overtopping. This assessment, including an evaluation of tolerable risk guidelines, informed the formulation and evaluation of alternatives for the study.

1.3 PROJECT AUTHORITY

Following Hurricanes Katrina and Rita in August and September 2005, several supplemental acts provided authority and appropriated funds to repair, accelerate to complete, and improve the hurricane and storm damage risk reduction features in the WBV study area.

The DoD (Department of Defense) Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and the Pandemic Influenza Act of 2006 (Public Law 109-148, Chapter 3, Construction, and Flood Control and Coastal Emergencies) or “3rd Supplemental,”

appropriated funds to accelerate the completion of the previously authorized project and to restore and repair the project at full federal expense.

The WBV project was authorized by the WRDA of 1986, and work was still being performed in 2005 when Hurricane Katrina made landfall.

In June 2006, the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and the Hurricane Recovery of 2006 (Public Law 109-234, Title II, Chapter 3, Construction, and Flood Control and Coastal Emergencies) or “4th Supplemental,” appropriated funds and added the authority to raise levee heights where necessary, reinforce and replace floodwalls, armor critical elements, and otherwise enhance the project to provide the levels of protection necessary to achieve the certification required for participation in the NFIP under the base flood elevations current at the time of construction.

In May 2007, the U.S. Troop Readiness, Veterans’ Care, Hurricane Katrina Recovery, and Iraq Accountability Appropriations Act, 2007 (Public Law 110-28, Title IV, Chapter 3, Flood Control and Coastal Emergencies and Sec. 4302) or “5th Supplemental,” provided \$1,300,000,000 to carry out projects and measures for the WBV and LPV projects as described in Public Law 109-148, and provided flexibility to the Secretary to reallocate un-obligated funds from the Public Law 109-234 projects funded under the Flood Control and Coastal Emergencies heading, subject to coordination with the House and Senate Committees on Appropriation.

The Water Resources Development Act (WRDA) of 2007 (Public Law 110-114 at Section 7012), authorized the raising of levee heights where necessary and otherwise enhancing the WBV and LPV projects to provide the level of protection necessary to achieve the certification required for participation in the NFIP under the base flood elevation current at the time of construction.

The 6th Supplemental, “Supplemental Appropriations Act, 2008,” (Public Law 110-252, Title III, Chapter. 3, Construction) provided WBV \$920 million dollars (funds that became available October 1, 2008) subject to a federal 65% and 35% non-federal cost share “to modify authorized projects in southeast Louisiana to provide hurricane, storm and flood damage reduction in the greater New Orleans and surrounding areas to the level of protection necessary to achieve the certification required for participation in the NFIP under the base flood elevations current at the time of enactment of this Act”. This Act became law on 30 June 2008.

The 7th Supplemental, “Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009,” (Construction heading, Division B, Title I, Chapter 3 of Public Law 110-329) provides that the Secretary of the Army is directed to use \$350,000,000 of the \$1,500,000,000 appropriated under that heading to fund the estimated amount of non-federal cash contributions to be financed in accordance with Section 103(k) of the WRDA of 1986, over a period of 30 years from the date of completion of the work undertaken pursuant to the WBV PPA, or separable element thereof.

1.4 STUDY AUTHORITY

Section 3017 of the Water Resources Reform and Development Act (WRRDA) 2014 (Public Law 113-121) authorizes the Secretary of the Army to carry out measures that address consolidation, settlement, subsidence, sea level rise, and new datum to restore certain federally authorized hurricane and storm damage reduction projects to their authorized levels of protection, if the Secretary determines the necessary work is technically feasible, environmentally acceptable, and economically justified. In addition, the authority of Section 3017

to study and construct measures terminates 10 years after the date of enactment of WRRDA 2014 on 10 June 2024.

WRRDA 2014 stipulates:

SEC. 3017. REHABILITATION OF EXISTING LEVEES.

(a) IN GENERAL – The Secretary shall carry out measures that address consolidation, settlement, subsidence, sea level rise, and new datum to restore Federally authorized hurricane and storm damage reduction projects that were constructed as of the date of enactment of this Act to the authorized levels of protection of the projects if the Secretary determines the necessary work is technically feasible, environmentally acceptable, and economically justified.

(b) LIMITATION. – This section shall only apply to those projects for which the executed project partnership agreement provides that the non-Federal interest is not required to perform future measures to restore the project to the authorized level of protection of the project to account for subsidence and sea-level rise as part of the operation, maintenance, repair, replacement, and rehabilitation responsibilities.

(e) TERMINATION OF AUTHORITY – The authority of the Secretary under this subsection terminates on the date that is 10 years after the date of enactment of this Act.

1.5 NON-FEDERAL SPONSOR

The non-federal sponsor for this study is the Coastal Protection and Restoration Authority Board of Louisiana (CPRAB) and the feasibility cost-share agreement was executed on October 09, 2018.

The CPRAB is established as the single state entity with authority to articulate a clear statement of priorities and to focus development and implementation efforts to achieve comprehensive coastal protection for Louisiana. The CPRAB's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration Master Plan. Working with federal, state, and local political subdivisions, including levee districts, the CPRAB is working to establish a safe and sustainable coast that will protect communities, the nation's critical energy infrastructure, and natural resources into the future.

The CPRAB has stated that it intended or intends to enter into cooperation endeavor agreements or other sub-agreements, in accordance with the Constitution and laws of the state of Louisiana, for performance of CPRAB's obligations under a PPA. Some of the state entities which CPRAB may enter into cooperation endeavor agreements or other sub-agreements with include, but are not limited to:

- The Southeast Louisiana Flood Protection Authority – West Bank
- Plaquemines Parish Government
- St. Charles Parish
- Jefferson Parish
- Orleans Parish
- New Orleans Sewerage and Water Board

1.6 STUDY AREA AND MAPS

1.6.1 GENERAL STUDY AREA

The general study area (Figure 1-1 and Figure 1-2) includes the areas within the hurricane and storm damage risk reduction systems that include the LPV and WBV projects and adjacent areas. It includes the parishes of Jefferson, St. Bernard, Orleans, Plaquemines, and St. Charles. It is in southeast Louisiana and is bounded by Lake Pontchartrain to the north, Lake Borgne and Breton Sound to the east, and Bayou Trepagnier and Cross Bayou to the west. The study area is also bisected by the Mississippi River, with LPV to the north and WBV to the south. To the south there are numerous lakes, bayous, fragmented marsh, and wetlands that ultimately terminate in the Gulf of Mexico.

The City of New Orleans and the surrounding metropolitan area is a mixture of highly urbanized and industrial areas abutting wooded lands, wetlands, numerous man-made canals, bayous, and other watercourses, which serve as a rich landscape for wildlife. The study area occupies a portion of one of the oldest delta complexes in the Mississippi River Deltaic Plain. The study area is part of the Barataria Basin. Lake Salvador and Lake Cataouatche are estuary areas to the south that connect to the Gulf of Mexico through Barataria Bay.

The study area is dissected by numerous canals and waterways. Numerous sensitive environmental resources are located near the study area. In general, these environmental resources are largely comprised of bottomland hardwood forests, cypress-tupelo swamps, and various freshwater, brackish and saline marsh, and scrub-shrub habitats.

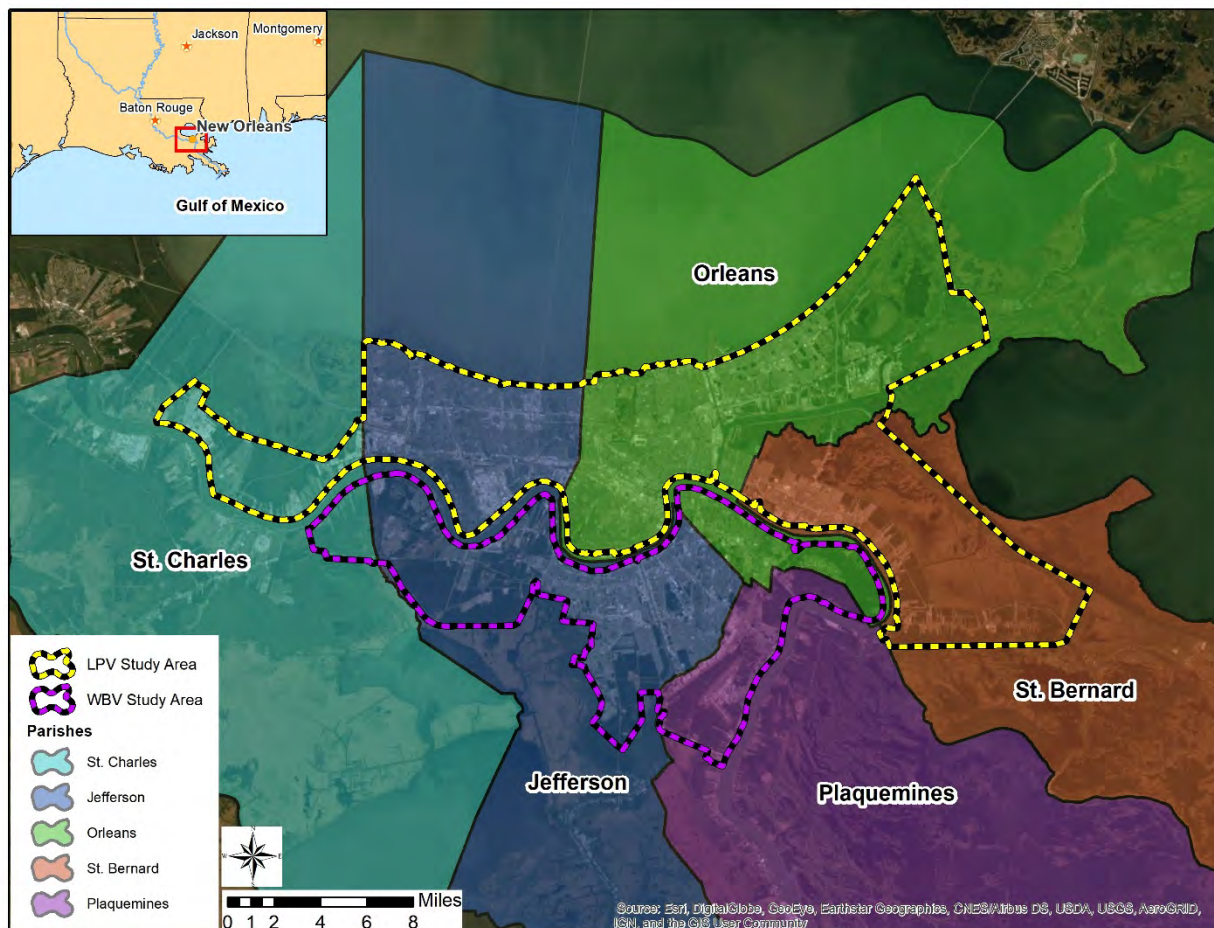


Figure 1-1. General Study Area Including Parishes

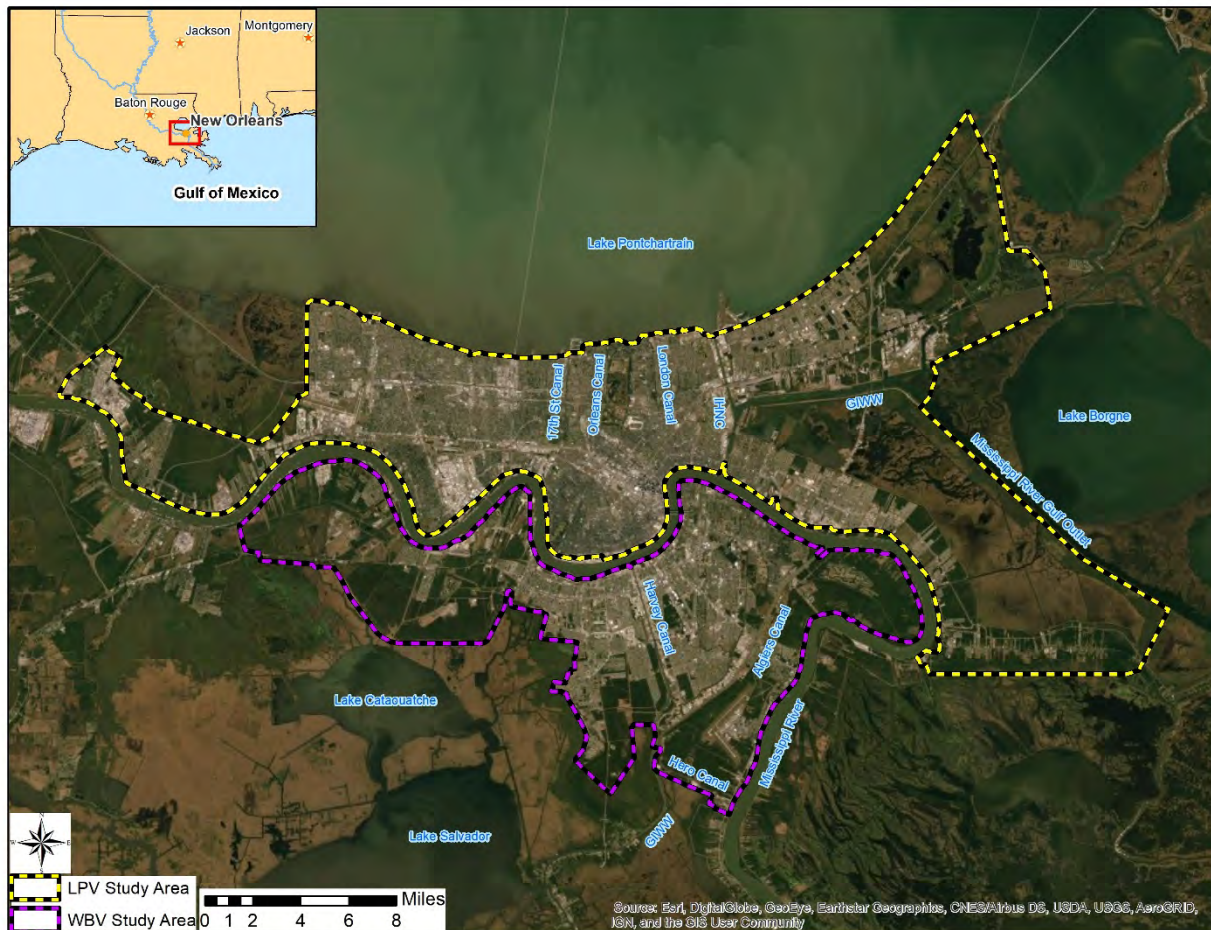


Figure 1-2. General Study Area Including Water Bodies

1.6.2 WBV PROJECT AND STUDY AREA

The WBV project is defined as the risk reduction features on the west bank of the Mississippi River in St. Charles, Jefferson, Orleans, and Plaquemines parishes. Construction of the WBV project starts at the MRL in Ama in St. Charles Parish and ends at the MRL in Oakville in Plaquemines Parish. The project is in a high-density residential and commercial area.

Currently, the WBV project includes a total of 89 miles of levees and 21 miles of floodwalls, floodgates, water control structures, and other risk reduction features. This includes primary perimeter storm surge risk reduction features, MRL co-located features, and detention basin features along the Harvey and Algiers canals.

The Mississippi River and Tributaries' levee (MR&T levees or MRL) provides risk reduction from riverine flow flood risks. The WBV project connects to the MRL at both the west and east end of the system.

Typical operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) activities include mowing levees and ensuring sufficient turf growth, maintaining High Performance Turf Reinforcement Mats (armoring), and maintaining and repairing spalls in floodwalls and concrete levee transition armoring.



Figure 1-3. WBV Levees and Floodwalls

1.7 INTERAGENCY STUDY TEAM & COOPERATING AGENCIES

The CPRAB was part of the interagency study team. The interagency study team provided data and subject matter expertise to identify problems, characterize existing and future conditions, develop measures, and formulate and evaluate alternatives.

Cooperating agencies include the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA).

1.8 PRIOR REPORTS, EXISTING WATER PROJECTS, & ONGOING PROGRPRIOR REPORTS

The following is a list of recent or ongoing programs and studies in the study area relevant to the WBV:

- 1988-1996. USACE. Chief's Reports for West Bank and Vicinity, LA. There were several Chief's Reports authorizing work for WBV. These include one in 1988 for West Bank Hurricane Protection Levee; one in 1995 for West Bank of the Mississippi River, New Orleans (East of Harvey Canal); and one in 1996 for Westwego to Harvey Canal, Louisiana, West Bank Hurricane Protection (Lake Cataouatche Area), Jefferson Parish.

- USACE. 1994. Southeast Louisiana Hurricane Preparedness Study. This study established evacuation zones for each parish and provided estimated “clearance times” to evacuate each zone based on hurricanes of different sizes, strengths, and forward speeds.
- USACE. 2006. Hurricane and Storm Damage Risk Reduction System Design Report. This report was prepared post-Katrina and updated the H&H modeling and 100-year design elevations for LPV and WBV. The analysis utilized for this report utilized the latest models available, including ADCIRC, and was the first update to design heights since the 1984 study.
- USACE. 2007. Elevations for Design of Hurricane Protection Levees and Structures Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project and West Bank and Vicinity, Hurricane Protection Project. This report provides a detailed documentation of the coastal and hydraulic engineering analysis performed to determine the 1% AEP project design elevations for these two hurricane protection projects. The report has been prepared to provide levee and structure elevations so that USACE can initiate detailed design and construction as described in the 4th Supplemental Appropriation, Public Law 109-234 of the One Hundred Ninth Congress. Available at: <https://www.mvn.usace.army.mil/Portals/56/docs/engineering/HurrGuide/ElevationsforDesignofHurricaneProtectionLeveesandStructures.pdf>
- Interagency Performance Evaluation Task Force (IPET). 2009. Interagency Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System. Final Report of the Interagency Performance Evaluation Task Force. This report is the result of an intense performance evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System during Hurricane Katrina.
- USACE. 2009. Louisiana Coastal Protection and Restoration Final Technical Report, Hydraulics and Hydrology Appendix – Volume 1. New Orleans District, New Orleans, LA. The Technical Report informs decision makers, stakeholders, and the public of the tradeoffs that should be considered in future decisions in order to maintain existing risk levels and/or reduce risk along the Louisiana coast.
- USACE. 2012. Hurricane Isaac With and Without 2012 100-year HSDRRS Evaluation. Preliminary Report. February 2012. New Orleans District, New Orleans, LA. This report evaluated whether construction of HSDRRS had a measurable effect on areas outside the system inundated by Hurricane Isaac and provides insight into possible project impacts.
- USACE. 2013. Comprehensive Environmental Documents - Phase I, Greater New Orleans Hurricane and Storm Damage Risk Reduction System, Volumes 1-3. This document describes and evaluates the cumulative impacts of the 217 miles of the HSDRRS described by the Individual Environmental Reports. Available at: <https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/Comprehensive-Environmental-Document/>
- USACE 2013. Greater New Orleans Hurricane and Storm Damage Risk Reduction System, Levee Armoring Research Document Report. This report provides the background and summary of Task Force Hope funded research and development for wave overtopping armoring of the landside levees and transitions within HSDRRS.
- USACE 2013. Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) National Flood Insurance Program (NFIP) Levee System Evaluation

Report. The report documents the technical levee system evaluation, associated assumptions, and analyses conducted to demonstrate NFIP requirements for a FEMA accredited levee system.

- USACE. 2014. Greater New Orleans Hurricane and Storm Damage Risk Reduction System, Levee Armoring, Engineering Alternatives Report. This report presents alternatives analyzed to provide resiliency to the landside of earthen levees and the final recommended armoring solution that meets the Congressional authorization for resiliency.
- USACE. 2014. Elevations for Design of Hurricane Protection Levees and Structures Report, Version 2.0, provides a detailed documentation of the coastal and hydraulic engineering analysis performed to determine the project design elevations for three projects within the Greater New Orleans HSDRRS; Lake Pontchartrain and Vicinity, West Bank and Vicinity, and New Orleans to Venice Projects, including the portions of the Mississippi River levees coincident with these projects. Available at: <https://www.mvn.usace.army.mil/Portals/56/docs/PAO/Matt/%281%29-FINAL-MAIN-REPORT-2014-DER.pdf>
- Coastal Protection and Restoration Authority (CPRA). 2017. Louisiana's Comprehensive Master Plan for a Sustainable Coast. The 2017 Coastal Master Plan sets an ambitious path to respond to the loss of coastal land and the threats from storm surge events. Available at: http://coastal.la.gov/wp-content/uploads/2017/04/2017-Coastal-Master-Plan_Web-Single-Page_CFinal-with-Effective-Date-06092017.pdf
- Long Distance Sediment Pipeline (LDSP), Bayou Dupont Marsh and Ridge Creation (p36 CPRA MP). The LDSP has borrowed and transferred nearly 10 million cubic yards of Mississippi River sediment to support Bayou Dupont Marsh and Ridge creation projects.

Some of the above reports were referenced in support of this study. Table 1-1 summarizes which reports that were referenced and identifies the type of data or information that was utilized from each.

Table 1-11-2. Relevant Data Sources

		Relevance to WBV			
		Data Source	Structural	Non-Structural	Future Without Project
1994	Southeast Coastal LA Hurricane Preparedness Study	X	X	X	X
2006	HSDRRS Design Report	X	X	X	X
2009	Louisiana Coastal Protection and Restoration Final Technical Report	X	X	X	X
2013	NFIP Levee System Evaluation Report	X	X	X	X

		Relevance to WBV			
		Data Source	Structural	Non-Structural	Future Without Project
2017	CPRA 2017 Coastal Master Plan	X	X	X	X

1.8.1 EXISTING WATER PROJECTS & ONGOING PROGRAMS

Mississippi River Levee (MRL)

The Mississippi River and Tributaries Project (MR&T) was authorized by Congress and constructed to reduce the risk of flood damage from high river flows. The WBV hurricane design grade on the reach from Oakville to English Turn, Mississippi RM 70 to 85.5, is higher than the required MRL riverine design grade. Construction contracts were completed to construct WBV features on top of and over the MRL from RM 70 to 85.5 to the WBV elevation and design guidelines. If the MR&T levees were deficient in elevation for MR&T's riverine design grade, MR&T authorities and appropriations were used to restore the MR&T to the MR&T riverine design grade and WBV funding was utilized to achieve the remaining required design height. Operation and maintenance of the reaches of the MR&T where the MRL design grade is equal to or higher than the WBV design grade are funded and guided by the separate MR&T authorities and guidance.

The Southeast Louisiana Urban Flood Control Project (SELA)

SELA is a flood control project, authorized by Congress to improve the rainfall drainage systems in Orleans, Jefferson, and St. Tammany Parishes. On the West Bank, SELA focuses on improving existing and constructing new drainage channels and stormwater pump stations. These features convey stormwater via pump stations across the WBV risk reduction perimeter and impact the interior drainage flow that WBV gates and pump stations need to handle. CPRAB has been the non-federal sponsor of SELA projects since 2009.

Algiers and Harvey Locks

USACE maintains and operates the navigation locks where the Harvey and Algiers Canals meet the Mississippi River. Although these locks provide the incidental benefit (i.e. a benefit outside of the project's authorized purposes) of closure of the WBV perimeter, their purpose and function is navigation. The lock gates will remain closed whenever Mississippi River water levels exceed the design high water levels in the Harvey and Algiers Canals.

GIWW (Gulf Intercoastal Water Way)

The GIWW exits the perimeter protection at the West Closure Complex. The West Closure Complex is a major feature of the HSDRRS which reduces risk for residences and businesses in three parishes on the west bank of the Mississippi River: Orleans, Jefferson and Plaquemines parishes. This risk reduction feature is located approximately one half mile south of the confluence of the Harvey and Algiers canals on the Gulf Intracoastal Waterway. Constructing the complex at this location eliminates 26 miles of levees and floodwalls parallel to the canals from the west bank's perimeter risk reduction system and allows the Harvey and Algiers canals

to serve as a detention basin for rainwater draining from the three parishes. The structural features of the project reduce the risk associated with a storm surge event that has a one percent chance of occurring in any given year, or a 100-year storm surge.

Davis Pond Freshwater Diversion

The levee on the east bank of the Davis Pond Freshwater Diversion channel provides the western edge of the WBV. This channel was constructed in 1997-2002 under a cooperation agreement between the state of Louisiana and USACE. It is authorized to divert Mississippi River water into the Barataria Bay estuary, as part of the program to reverse the loss of coastal wetlands.

The diversion structure on the bank of the Mississippi River has four 14-foot square reinforced concrete box culverts with sluice gates. The gates can be operated to pass up to 10,650 cfs into the 9,300-acre ponding area. The Davis Pond Diversion Structure lies outside the boundaries of the WBV, and no special operation is required in response to storm surge other than the normal monitoring of water levels in the channel and controlling the gates to prevent flooding. CPRA has the operations, maintenance, rehabilitation, and replacement (OMRR&R) responsibilities of the Davis Pond Diversion eastern levee, which provides the incidental benefit of risk reduction to the WBV.

2 PROBLEMS & OPPORTUNITIES

This section focuses on the purpose and need for the study, including discussion of the problems to be addressed by the study, potential opportunities to be considered, study goals and objectives, as well as study constraints. Scoping and coordination with the public, state agencies, and federal agencies was also conducted during the process of identifying the problems and opportunities. These activities are also described.

Throughout this section and all subsequent sections, flood and coastal storm events and their resultant inundation will be referred to by AEP, which is the probability that this storm or level of flooding may be realized or exceeded in any given year. For example, a flood event with a 1% AEP would have a 1% probability of occurring every year. This is a change in terminology from the recent commonly used term “annual chance of exceedance” (ACE). Additionally, in the past, flood events have often been described by their “return period” – or the estimated average length of time between flood events of a particular magnitude. A 1% AEP event would have been referred to as having a 100-year return period or being a 100-year event. This terminology is no longer used because it falsely conveys a sense of time and lowers public risk perceptions. Table 2-1 provides a list of AEP flooding events that were considered during the study, with their equivalent “return period.” It is important to note that all AEP references in this report are for expected water levels inside and outside the system, not the AEP of meteorological events (i.e. a 1% flood event is not the same as, nor does it necessarily occur as a result of, a 1% storm event).

Table 2-1. Comparison of AEP, ACE, and Return Period Terminology

AEP/ACE	Return Period*
20%	5-year
10%	10-year
4%	25-year
2%	50-year
1%	100-year
0.5%	200-year
0.2%	500-year
0.1%	1000-year
*Note: Return Period is a term that can be misleading, is often misunderstood, and is no longer used by USACE (see ER 1110-2-1450).	

2.1 PURPOSE & NEED*

The federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation’s environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. The purpose of the study with integrated EIS is to analyze alternatives to reduce overtopping flood risk due to coastal storms within the WBV study area. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative. The study will identify whether a NED plan exists to reduce life risk and

economic damages due to the combined effects of subsidence, settlement, consolidation, sea level rise, and the availability of new vertical datums on the WBV system. The study will identify and analyze benefits across a full array of benefit categories and will also consider if life risks warrant additional action above and beyond the NED plan. The integrated report includes assessment of the environmental effects of a reasonable range of potential alternatives or actions designed by USACE, including the No Action Alternative, prior to decision making.

2.2 PROBLEM IDENTIFICATION

2.2.1 PROJECT HISTORY

Since 1852, 39 hurricanes have made landfall within 65 nautical miles of metropolitan New Orleans. Storm surge flooding threatens lives, damages homes, businesses and infrastructure, and disrupts the nationally significant energy industry. According to the Department of Health and Hospitals (DHH), approximately 1,400 deaths were reported following Hurricane Katrina and approximately 1.3 million residents were displaced immediately following the storm. Estimated property damages were in excess of \$28 billion in the New Orleans area and as much as \$125 billion along the Gulf Coast (NOAA 2018, USACE 2006).

After the devastation of the 2005 hurricane season, the U.S. embarked on one of the largest civil works projects ever undertaken, at an estimated cost of \$14.6 billion, with restoration, accelerated construction, improvements, and enhancements of various risk reduction projects and environmental mitigation within southeastern Louisiana, including the Lake Pontchartrain and Vicinity, Louisiana Project (LPV) and the West Bank and Vicinity, Louisiana Project (WBV). P.L. 109-234 authorized the construction of a system to provide the levels of protection necessary to achieve the certification required for participation in the NFIP under the base flood elevations current at the time of construction. The total budgeted cost for the WBV project, under the post-Hurricane Katrina supplemental acts, is approximately \$3.9 billion. The completion of the levees, floodwalls, gates, and pumps that together form the HSDRRS provided risk reduction for a 1% AEP hurricane and storm damage event to the areas within LPV and WBV.

The Greater New Orleans HSDRRS is designed to reduce the flood risk associated with a 1% AEP storm surge and wave event. Levees in WBV were constructed on a limited footprint with the understanding that additional height would need to be added (termed “levee lifts”) in the future to counteract soil consolidation, settlement, subsidence, and sea level rise and maintain the designed level of risk reduction. Floodwall heights were designed to account for an estimated one foot of future sea level rise by the year 2057.

Interior rainfall is conveyed by non-Federal pump stations and gravity flow outside of tropical events. When the river or storm surge events cause perimeter gates to be closed, pumping stations that are part of WBV are activated to work in series with non-Federal pump stations to remove rainfall from the project area. The WBV project is currently accredited by the Federal Emergency Management Agency (FEMA) for the 1% AEP level of risk reduction, utilizing specific HSDRRS guidelines. However, as with any hurricane and storm damage risk reduction project, there are remaining life safety and economic damage risks associated with the potential for project non-performance (some form of physical failure) or design exceedance. In an extreme case, non-performance can result in sudden localized high-velocity flows and rapid increases in flood depth on the interior of the system. Design exceedance occurs when conditions occur that are beyond what the system was designed to address (in this case, higher

surge levels and/or greater wave overtopping rates). Design exceedance impacts can range from increased interior flooding of the system to project non-performance.

2.2.2 PROBLEMS TO BE ADDRESSED BY THIS STUDY

Southeast Louisiana, including the greater New Orleans area, is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause existing levees to require future lifts to sustain performance of the WBV system. The post-Hurricane Katrina supplemental acts authorities did not provide for future lifts and by the terms of the PPA for construction of the “New Work”, the sponsor is not required to perform future measurements to restore the “New Work” to the authorized level of protection to account for subsidence or sea level rise as part of its federal OMRR&R responsibilities. Engineering analysis indicates that absent future levee lifts to offset consolidation, settlement, subsidence, and sea level rise, at some point in the future the project will not provide risk reduction for the 1% AEP event.

New Datums

The study authority included consideration of the effects of new vertical datums on future project performance. Following review of datum changes, changes to the existing or future performance of the WBV system based on new vertical datum values were identified as negligible and therefore, not a problem that needs to be directly addressed in this study. Survey and spatial data used in this study were collected utilizing the North American Vertical Datum of 1988, Epoch 2004.65 (NAVD88 (2004.65)) and the standards set forth in EM 1110-2-6065. Datum changes occur periodically resulting in an updated value for the base reference plane at any specific horizontal location. Vertical Control Monuments (benchmarks) located throughout the WBV system area are updated with datum changes which can be used to update the WBV system vertical measurements relative to the current datum at the time of measurement.

Settlement and Consolidation

Consolidation is the change in soil volume over time due to applied load leading to dissipation of porewater pressure. Settlement is a result of consolidation and other factors. Levee settlement considers changes to the levee itself and that of the foundation soils under the levee. Settlement of the levee consists of shrinkage (reduction in soil volume) and lateral spread. Settlement of the foundation consists of immediate and primary consolidation settlement. Immediate settlement is caused by the elastic deformation of dry, moist and saturated soils without any change in the moisture content, as the pore water initially resists the applied load. Primary consolidation settlement is the result of a volume change in saturated cohesive soils because of expulsion of the water that occupies the void spaces. The volume change is caused by a stress increase which in turn is caused by the applied levee load.

The amount and rate of settlement will vary based on the levee soil properties and geometry, foundation stratigraphy, and pre-consolidation pressure.

Settlement below the 1% AEP design elevation increases the risk of overtopping by reducing the crown elevation of the levee over time. Settlement amounts and rates vary across the systems and decrease over time.

Subsidence

In general, subsidence is the sinking of the ground because of underground material movement. It is caused by naturally occurring geologic and human-caused processes, which may include faults in rock formations; human withdrawal of water, oil, and gas; and compaction of shallow sediments. In the study area, subsidence is primarily caused by groundwater pumping and surface water pumping (known as dewatering). Other factors include the natural consolidation of alluvial deposits, as well as groundwater and sea level fluctuations over geologic time.

In the study area, subsidence contributes to the lowering of the levee top elevations by lowering the ground that the levee sits on.

Sea Level Change

Sea level change can be an increase or decrease in water levels and varies regionally around the globe. Sea level rise increases risk by increasing the initial water elevation (stillwater) that hurricanes influence, thereby increasing storm surge and wave elevations. Relative sea-level change (RSLC) is a combination of eustatic (global or widespread) sea-level rise and local subsidence. Figure 2-1 below graphically depicts the combined effects of subsidence and sea level rise.

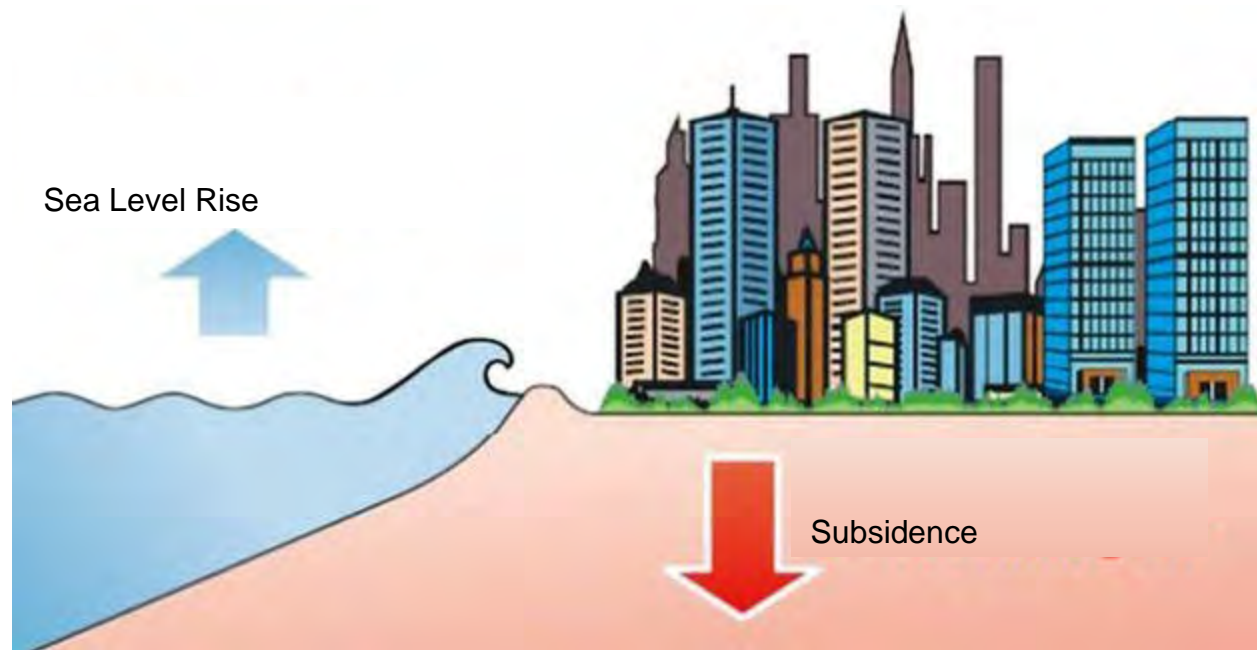


Figure 2-1. Graphical depiction of subsidence and sea level rise effects. (Erkens, Bucx, Dam, de Lange, & Lambert, 2015)

Combined Effects

Figure 2-2 demonstrates how sea level rise (dashed blue line), changes in the levee top elevation due to settlement (dotted black line) and changes in ground elevation due to regional subsidence (dashed black line) combine to reduce the ability of the levee system to provide the designed 1% AEP risk reduction in the future, absent future levee lifts.

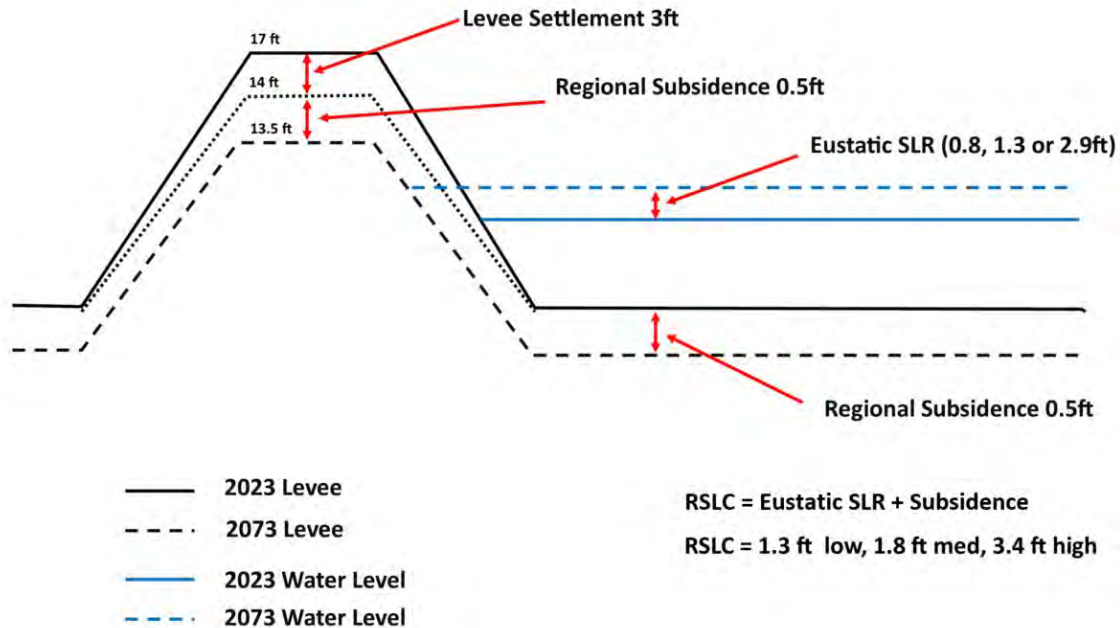


Figure 2-2. Illustrative Example of the Combined Effects of Settlement, Subsidence and Sea Level Rise Over the 50-Year Period of Analysis

2.2.3 SCOPING & COORDINATION*

Scoping is an early and open process for determining the scope of alternatives to be considered and the range of issues to be addressed in an EIS and for identifying the significant concerns related to a proposed federal action. A public scoping meeting was held on April 30, 2019 after the Notice of Intent to Prepare an EIS was published in the Federal Register on April 2, 2019.

Additionally, USACE coordinated with the following state and federal agencies, Federally-recognized Tribes, and other interested parties:

- Louisiana Coastal Protection and Restoration Authority Board (CPRAB)
- Louisiana Coastal Protection and Restoration Authority (CPRA)
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service
- U.S. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)
- National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service
- Louisiana Department of Natural Resources (LDNR)
- Louisiana Department of Environmental Quality (LDEQ)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- Louisiana State Historic Preservation Office (SHPO)
- Alabama-Coushatta Tribe of Texas
- Chitimacha Tribe of Louisiana
- Choctaw Nation of Oklahoma
- Coushatta Tribe of Louisiana
- Jena Band of Choctaw Indians

- Mississippi Band of Choctaw Indians
- Muscogee (Creek) Nation
- Seminole Nation of Oklahoma
- Seminole Tribe of Florida
- Tunica-Biloxi Tribe of Louisiana
- The Southeast Louisiana Flood Protection Authority – West Bank
- Plaquemines Parish
- St. Charles Parish
- Orleans Parish
- Jefferson Parish

Please see Appendix L, *Coordination*, for related documents.

2.2.4 COORDINATION MEETINGS

Study collaborators discussed problems, opportunities, and potential measures through numerous coordination meetings. While not comprehensive, the following meetings are examples of ongoing coordination:

- Plan Formulation coordination meeting (1st iteration): September 10, 2018
- Plan Formulation coordination meeting (2nd iteration): November 6, 2018
- Stakeholder and sponsor: November 5, 2018
- Federal coordination: November 6, 2018
- State coordination: November 7, 2018
- Levee District Strategic Partnership Meeting: March 29, 2019

The intent of the 1st and 2nd iteration Plan Formulation meetings was to complete early rounds of the USACE six-step planning process to inform the development of potential alternatives for the study. Subsequent coordination meetings were focused on agency and stakeholder collaboration during early stages of the study process.

2.2.5 PUBLIC REVIEW AND COMMENTS

Public input occurred at multiple points during the planning study. The general public could learn about the study through information posted to the New Orleans District's public website. As noted above, a public scoping meeting was held in April 2019. The Draft EIS was released for a 55-day public comment period, beginning when the Notice of Availability was published in the Federal Register on December 13, 2019. USACE conducted one public meeting on January 21, 2020 to encourage the public to provide comments on the Draft EIS and the proposed action. For additional information, see Appendix L, *Coordination*.

2.2.6 PROBLEM SUMMARY AND STATEMENT

The combined effect of subsidence, settlement, and sea level rise will continue and increase risk of overtopping of levees during hurricane storm events, as time progresses. This in turn increases:

- Risk of catastrophic failure from overtopping
- Risk to life safety
- Risk of damage to property & infrastructure
- Regional economic impacts

- Risk to cultural heritage and population, and other social effects
- Risk of environmental damages and human health safety impacts from industrial flooding

PROBLEM STATEMENT: Due to subsidence, settlement, and potential sea level rise there is an increased risk of overtopping of WBV levees during hurricane storm events over the period of analysis, resulting in increased risk to life safety and storm damages within the WBV area.

2.3 OPPORTUNITIES

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

- Maintain the coastal storm risk reduction benefits associated with the initial (\$3.9B) federal investment in the WBV system
- Protect environmental resources
- Evaluate a level of risk reduction above the 1% AEP event
- Reduce the costs associated with hurricane and storm damages to the environment and human health.

2.4 FEDERAL INTEREST

As originally established by the Flood Control Act of 1965, and further exemplified in the \$3.9 billion dollars invested in the WBV system after Hurricane Katrina, there is a federal interest in hurricane and storm risk reduction projects for the WBV area. As described in section 2.2.1, hurricanes and coastal storm events continue to threaten lives, damage property and infrastructure, and disrupt the nationally significant energy industry. A federal interest exists in further reducing the coastal storm and life safety risk of the WBV system to offset the long-term effects of consolidation, settlement, subsidence, and sea level rise.

2.5 GOALS & OBJECTIVES*

The federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative, including identification and analysis of benefits across a full array of benefit categories.

The goal of the study is to reduce the risk of life loss and economic damages due to hurricane storm surge in the greater New Orleans metropolitan area. Specific study objectives were developed to identify measures and alternatives which can address the study area's problems while taking advantage of the identified opportunities and avoiding the constraints. The following study objectives were developed based on the study area problems, opportunities, and goals, as well as the federal objective and regulations. Per the study's authorizing language, the following objectives will include, at a minimum, consideration of an alternative to restore the authorized level of risk reduction (the 1% AEP flood event).

Objectives:

1. Reduce the risk of life loss due to hurricane and storm damage in WBV over the 50-year period of analysis associated with consolidation, settlement, subsidence, sea level rise,

and new datum. This includes identifying at least one alternative which reduces life safety risk associated with system overtopping below tolerable levels (see Section 3.4.1). This will be primarily measured by life safety risk reduction estimates.

2. Reduce economic damages due to hurricane and storm damage in WBV over the 50-year period of analysis associated with consolidation, settlement, subsidence, sea level rise, and new datum. This will be primarily measured by economic benefits estimates.

2.6 CONSTRAINTS

A planning constraint limits the extent of the plan formulation process. Plans should be formulated to meet study objectives and avoid violating the constraints. All USACE studies have a set of “universal” constraints and study-specific constraints. These are outlined below, along with a list of additional considerations that, while not constraints, may influence the study process.

The criteria below are considered constraints when formulating management measures.

Universal Study Constraints Applicable to this Study

- Avoid or minimize environmental and cultural resources impacts, including but not limited to Clean Water Act Section 404 wetlands, endangered species, and critical habitat.
- Avoid or minimize locating project features on lands known to have Hazardous, Toxic and Radioactive Waste (HTRW) concerns.
- Resource constraints – time, money, knowledge
- Adhere to applicable laws and policies

Study-Specific Constraints

- Avoid impacts to the functions of other federal projects in the vicinity. These projects include but are not limited to the GIWW, MR&T, IHNC, etc.
- Per the study authority, selection of a recommended plan is limited to the 1% AEP level of risk reduction. Therefore, plan formulation will be primarily focused on this LORR.
- Per the authority, Section 3017 only applies to projects for which executed PPAs provide that the non-federal interest is not required to perform future measures to restore the project to the authorized level of protection of the project to account for subsidence and sea-level rise as part of OMRR&R responsibilities .

Additional Study Considerations

- *Real Estate*. Due to urbanization, many areas have very little open land adjacent to the existing levee features. Increases to the project footprint may be difficult without buying out structures.
- *Wetland mitigation*. Mitigation areas may be hard to find. Mitigation bank credit availability varies with time, and potentially impacted habitat types may have limited suitable land nearby for identification of potential mitigation sites.
- *Environmental Justice*. An Environmental Justice (EJ) analysis focuses on the potential for disproportionately high and adverse impacts to minority and low-income populations during the construction and normal operation of a federal action. The study must strive to avoid or minimize this potential impact.

- *Transfer of risk.* The study must identify and address any potential transfer of risk to other entities. Increases to economic, life safety, or environmental risk should be avoided or minimized.

3 EXISTING CONDITIONS LEVEE PERFORMANCE

One of the first steps in the USACE planning process is to assess the existing conditions in the study area. This generally includes describing all the factors that are relevant to the study, as they exist during the study period. This section discusses the current condition of the levee, the hydrology and hydraulic conditions that affect the levee's performance, the potential economic damages if the levee's current elevations were to be exceeded by storm surge and/or waves (known as overtopping), and the potential life safety consequences if levees were overtopped or failed (breached) due to overtopping (breach prior to overtopping was not evaluated – see Section 3.5 for more information). Section 4 discusses the potentially affected existing environment. Section 5 will consider potential changes in the future which may affect the levee's performance and estimates corresponding changes to economic damages, levee performance risk, and life safety consequences.

3.1 EXISTING LEVEE SYSTEM CONDITION

Currently, the WBV project includes a total of 89 miles of levees and 21 miles of floodwalls, floodgates, water control structures, and other risk reduction features. This includes primary perimeter storm surge risk reduction features, MRL co-located features, and detention basin features along the Harvey and Algiers canals. The WBV project construction began in 1961 but was incomplete at the time Hurricane Katrina made landfall in 2005.

The floodwall design elevations resulting from the post-Hurricane Katrina Supplemental Acts were intended to reduce estimated tropical storm flood risk in the year 2057 (sometimes referred to as the “2057 design”), while the levees were designed with the understanding that lifts would be required in the future to maintain design heights. However, those authorities did not provide for future lifts to maintain the levee design elevations as levee soils consolidated over time. The construction resulting from the post-Katrina Supplemental Acts was essentially completed in 2018.

The Greater New Orleans HSDRRS is designed to reduce the flood risk associated with a 1% AEP storm surge and waves event. Design elevations of levees and floodwalls are set to limit the expected wave overtopping rate to 0.1cfs/ft at 90% confidence and 0.01 to 0.03 cfs/ft at 50% confidence for the 1% AEP storm surge and wave event at each design segment. Probabilistic overtopping estimates at each design segment assume simultaneous occurrence of 1% AEP surge level and 1% AEP wave characteristics. Additionally, the design elevations are checked for resiliency by comparing top of levee/structure elevations to the 0.2% AEP still-water elevations.

Levee top elevation, top width, and side slopes vary throughout the system. In some areas there are landside stability berms and there are some reaches with wave berms. All WBV levees and WBV/MRL co-located levees are armored with either high performance turf reinforcement mat, concrete aprons, rip-rap, or articulated concrete blocks. The WBV/MRL co-located project area is defined as the area in which the WBV design elevations are higher than the MR&T design elevations. However, since the MR&T is established and maintained by previous authority that is not superseded by the WBV authority, the projects are said to co-exist or coincide, meaning the WBV levee or feature is built on top of, and over, the MR&T levee.

The levees have settled over time. Settlement begins to occur as soon as stresses are increased on the soil, which can begin when levee construction fill is placed, but can be due to

other factors. Because the system was constructed over time, the amount of settlement varies throughout the system. Some reaches have been “lifted” (height added) by CPRAB and either Southeast Louisiana Flood Protection Authority - West or Plaquemines Parish Government, as USACE Section 408 (Alteration to a Project) effort, prior to armoring being added, to compensate for settlement. However, the current PPA does not require the non-federal sponsor to maintain the authorized level of risk reduction of the “New Work” to account for subsidence or sea level rise as part of its Operations, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) responsibilities. In order to assess the current levee elevations, a top-of-levee survey was completed in the fall of 2018. This survey was used to assess the accuracy of previous settlement projections and support projected future settlement (see Section 5). The survey also confirmed that the levees are currently providing the intended level of risk reduction.

Generally, armoring is intended to provide resiliency to the system when subject to events greater than the design event. The WBV was designed for the 1% AEP stillwater and wave overtopping then checked for resiliency for the 0.2% AEP stillwater elevation. The purposes of armoring are to reduce the risk of catastrophic failure during these less-frequent, more severe events, and to ensure that the system remains in place and functional for subsequent storm events. To this end, armoring is essential and is included as part of the system on all perimeter levees and in critical areas to include transition points where levees and floodwalls abut; pipeline crossings of levee alignments; and floodwalls where erosion could compromise wall stability. Although interior flooding due to wave overtopping could occur in larger events, the risk of catastrophic failure of the perimeter system is reduced with the installation of armoring.

Floodwalls including I-walls and T-walls are used throughout the WBV system. It is often not practical to add height to a completed hard structure. Therefore, the perimeter hard structures were constructed to the estimated 2057 required elevation based on projections for subsidence, sea level rise, and other variables at the time of design and construction. In some instances, structures were built with up to two feet of “structural superiority” for features that were deemed particularly difficult to modify in the future. Concrete T-walls are typically located at points along the levee where there is a high potential for erosion or insufficient space for an earthen levee. T-walls are located on either side of every river, railroad, and interstate, and state highway crossings. Wall thickness varies by wall height and ranged between 1.5 and 4.5 feet. Base width and thickness varies by location and wall height. Base width ranged from 6 to 22.5 feet and base thickness ranged from 2 to 4.25 feet.

On the interior of the WBV system, drainage pump stations remove water that falls inside (rain) or overtops the system. These pumps remove water to the exterior of the system or to interior canals for storage and/or removal by other pumps.

The ability to withstand impacts from boats and barges that may become unmoored during a storm is an important consideration in parts of the interior of the system that are used for navigation but also function as temporary ponding areas during a storm event. Structural features located adjacent to major navigation routes are further protected by dolphins, berms, or Regulated Navigation Areas (RNA) to reduce the risk of contact from tows or loose vessels. Within the WBV system, these areas include the Harvey and Algiers Canals and a portion of the Gulf Intracoastal Waterway (GIWW).

The United States Coast Guard (USCG), with support from USACE, has implemented RNA where there are floodwalls with high probability of catastrophic failure should an unmoored, unimpeded barge strike them with any substantial force. Most of the existing floodwalls in

subject areas were constructed Pre-Hurricane Katrina and were not designed for barge impact loads. Risk reduction is maximized through evacuation of these areas prior to an event. If evacuation is not attainable, it is imperative that the USCG ensure that the requirements contained within 33 CFR 165.838 “Regulated Navigation Area; New Orleans Area of Responsibility, New Orleans, LA” are effective in keeping vessels under control and away from the floodwalls during tropical events. A supplemental notice for revisions to the RNA was filed in June 2013. Details of the RNA and revisions can be found in Chapter 33 of the Code of Federal Regulations: 33 CFR Part 165, [Docket No. USCG-2009-0139].

As of September 2013, this RNA is defined within the following areas of the WBV project: The GIWW from Mile Marker (MM) 22 East of Harvey Locks; The Harvey Canal, between the Lapalco Boulevard Bridge and the confluence of the Harvey Canal and Algiers Canal; the Algiers Canal, from Algiers Lock to the confluence of the Algiers Canal and the Harvey Canal; and the GIWW from the confluence of Harvey Canal and Algiers Canal to MM 7.5 West of Harvey Locks.

3.2 EMERGENCY PREPAREDNESS AND ACTION PLANS

Each Parish, as well as the State of Louisiana, has an emergency action plan for a hurricane event. These plans include timing of evacuation orders, as well as procedures to be followed. The information presented in this section was gathered from existing emergency action plans and interviews with officials from the Parishes and the State of Louisiana.

Due to the extreme nature of the events which would result in a breach of the New Orleans levee systems, evacuation order timings are tied to the arrival of a storm rather than any imminent danger of system failure. Each Parish has its own mandatory evacuation timeline which is based on the arrival of a storm. These evacuation timelines are displayed in Table 3-1 below. Because the mandatory evacuation orders are issued well in advance of a storm's arrival, individuals who choose to evacuate are likely to have enough time to do so.

Table 3-1. Issuance of Mandatory Evacuation Orders, by Parish

Parish	Hours Before Storm Arrival
Orleans	72
Plaquemines	72
St. Charles	40
Jefferson	54
Source: http://www.lsp.org/pdf/hurricaneSE.pdf	

The Parishes' individual evacuation plans for major storms is supported by the State of Louisiana's plan to enact contraflow on the major interstates in the area, I-10 east and west and I-55 and I-59. During contraflow, all travel lanes are redirected to exit the area. Many of the parishes also have staging areas or registries for those that do not have their own vehicles or need other special assistance evacuating.

While severe tropical storms and hurricanes are well-forecasted and most people have the means to follow news coverage, the study area has a large population of homeless and citizens

living below the poverty line who may not have the technology necessary to receive warnings. These demographic groups may be hard to reach since there is not a loudspeaker or siren system in place for warning issuance. Additionally, some portion of the population will be unable to or choose not to evacuate. The percentage of each Parish that is anticipated to remain within the system despite a mandatory evacuation order (as estimated by Parish officials), is displayed in Table 3-2 below.

Table 3-2. Estimated Percentage of Population Not Likely to Evacuate, by Parish

Parish	Population Not Evacuating
Orleans	5%
Plaquemines	5%
St. Charles	20%
Jefferson	Not estimated
Source: https://www.sdmi.lsu.edu/sdmi/wp-content/uploads/2017/06/BehavioralAnalysisForSELAHurricaneEvents.pdf	

Additionally, the State of Louisiana and the Red Cross open shelters outside of the impacted areas for those with transportation, but no place to stay after evacuating.

The USACE New Orleans District emergency response includes sending embedded personnel to the Governor's Office of Homeland Security and Emergency Preparedness as well as liaisons to local parishes and levee districts in order to monitor system performance and provide engineering expertise and other assistance as required to minimize risks to the system.

3.3 HYDROLOGIC AND HYDRAULIC CONDITIONS

3.3.1 STORM MODELING

Storm effects for Future Without Project (FWOP) conditions were modeled in ADvanced CIRCulation (ADCIRC) using a suite of 152 synthetic storms. The storms cover a range of hypothetical tracks, forward speeds, intensities and sizes. The Joint Probability Method – Optimal Sampling (JPM-OS) synthetic storms are basically an extension of the limited observed record. The JPM-OS code combines the meteorological probability and the peak surge elevation of all 152 storm events to estimate the 5%, 2%, 1%, 0.5%, 0.2%, and 0.1% AEP surge elevations for the existing FWOP conditions. No rainfall time-series are available for the 152 synthetic storms, therefore, rainfall was not included in the RAS 2D polder interior simulations described in subsequent sections.

Although rainfall was not included in the simulations, a two-part sensitivity analysis was conducted to explore the potential effects of rainfall on the inundation modeling. A simulation of Hurricane Katrina was performed with and without rainfall. The results of that test show that the model of interior flooding is not very sensitive to rainfall. The large overtopping volume expected during a modeled Katrina event dominated water levels and rainfall had only a small effect. With the second sensitivity, the HEC-RAS modeling of synthetic storms was completed with rainfall by assuming a 10YR rain accompanies each of the 152 synthetic storms. The resulting inundation showed extensive street flooding throughout the city. However, the HEC-RAS model

does not include the extensive subsurface drainage network that is present in the city and this results in increased water levels when rainfall is applied. If the drainage network were modeled, it would have an effect of lowering water levels for the 10YR rain, and could possibly reduce the effect of the rainfall flooding component.

3.3.2 INUNDATION MODELING

Inundation of the system interior can result from wave action alone, or a combination of surge and wave action. The inundation estimates in this section assume that the levees and floodwalls do not fail prior to or as a result of overtopping by surge and waves (this is discussed further in Section 3.4).

To model interior flooding extent and depths, a River Analysis System 2-dimensional (RAS 2D) model was developed. The WBV includes RAS 2D meshes for four sub-basins: Lake Cataouatche, Harvey-Westwego, Gretna-Algiers, and Belle Chasse (Figure 3-1). All 2D meshes are connected using storage area connections with weir profiles assigned using the latest available surveys. The nominal mesh resolution is 700ft. This mesh resolution facilitates higher computational efficiency while producing realistic results. Manning's "n" (roughness) values were assigned using the 2011 National Land Cover Database.



Figure 3-1. WBV Sub-Basins

The perimeter levee and floodwall elevations are not incorporated into the Hydrologic Engineering Center (HEC) HEC-RAS 2D geometry but are used in overtopping calculations that are input as boundary conditions to the model. Rainfall was not included in the RAS 2D simulations described in this section. Pump information was extracted from the USACE pump database and the pumps in the model are modeled as 2D connections with outlet rating curves.

The rating curve approach ensures the peak capacity of each pump is utilized in the simulations.

Overtopping rates were calculated at all design segments. Each segment has unique levee or floodwall geometry and hydraulic boundary conditions including surge elevation, significant wave height and mean wave periods.

ADCIRC Hydrographs were extracted for all 152 synthetic storms at each segment. The ADCIRC dataset used was the “2017 CPRA master plan”. This surge hazard analysis is the only dataset available from the extensive post-Hurricane Katrina modeling of Southeast Louisiana that includes hydrographs, wave heights, and wave periods for all the locations needed for this study. Additional inputs into the overtopping calculations include levee geometry parameters including wave berm elevation, levee slope and crest elevations. Levee and floodwall surveyed elevations were mapped to each of the 415 segment profiles.

Eutotop overtopping formulae were used to determine the wave and free-flow overtopping time-series for each synthetic storm. If the surge level is less than the crest elevation, wave overtopping formulae are used. If the surge is greater than the crest elevation, the weir equation is combined with the wave overtopping formulae, accounting for wave and freeflow overtopping. Overtopping rates were calculated at each survey point along each of the 415 design segments. The resulting overtopping rates at each survey point were then summed to produce a total for each segment. The width between each survey point is factored into the calculations. The overtopping time-series at each segment was then summed to the corresponding RAS 2D flow boundary. In total, 81 flow boundary conditions were assigned to the RAS 2D geometry.

HEC-RAS simulations were computed for all 152 JPM-OS synthetic storms. Once all 152 synthetic storms were evaluated, surge statistics could be completed using the latest JPM-OS code. The code was supplied by Engineer Research and Development Center’s (ERDC’s) Coastal Hydraulics Lab. The code combines the meteorological probability and the peak surge elevation of all 152 storm events to estimate the 5%, 2%, 1%, 0.5%, 0.2% and 0.1% AEP surge elevation.

Modeled storm surge elevations were plotted against the levee and floodwall elevation data to determine potential locations for surge overtopping. Additionally, in areas where surge or waves were estimated to overtop the levees or floodwalls, overtopping rates were calculated. Figures 3-2, 3-3, and 3-4 display the 1%, 0.5%, and 0.2% AEP water depth for existing conditions. In these figures, the canals and navigation channels are apparent as relatively linear features with deep water.

Depth maps such as the figures below depict a coarse representation of high-resolution hydraulic model results. In HEC-RAS, a single peak water surface elevation is estimated for each 700ft cell. Depths within each cell will then vary by the underlying 3ft high resolution terrain dataset. The report figures show depth, measured from the minimum terrain elevation within each cell, mapped across the entire cell, so depths may appear coarser and more extensive than they are in the actual hydraulic modeling and subsequent economic analysis.

The high resolution water surface profile and depths for all return periods were provided to the economics team for evaluation of damages (refer to Section 3.4 for economic analysis).



Figure 3-2. 1% AEP Peak Depths (ft) for Existing Conditions

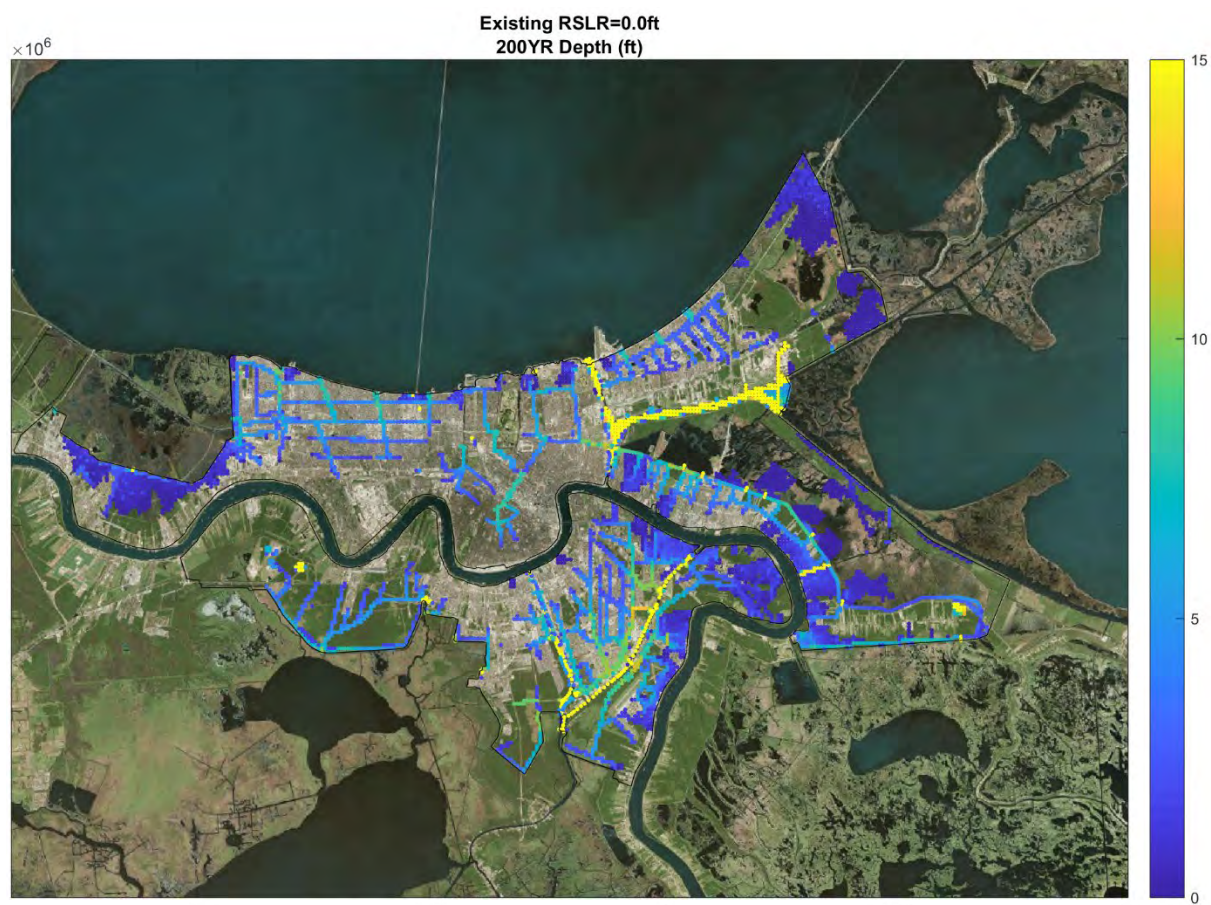


Figure 3-3. 0.5% AEP Peak Depths (ft) for Existing Conditions



Figure 3-4. 0.2% AEP Peak Depths (ft) for Existing Conditions

Estimations of inundation extent and depths varies by polder based primarily on interior topography and the interior drainage system. While the modeling assumes that all levee system pumps are functioning at 100% capacity, it does not take into account any local (sewer) drainage features.

3.4 EXISTING ECONOMIC DAMAGES

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) program version 1.4.2 was utilized to evaluate flood damages using risk-based methods. The key economic inputs for the analysis are the structure inventory, depth-damage functions, content-to-structure value ratios, and the associated quantified risk and uncertainty parameters associated with these inputs.

Structure Inventory

The structure inventory used for this study is the National Structure Inventory (NSI) version 2. This updated version of the inventory uses Zillow data, ESRI map layer data, and CoreLogic data to improve structure placement over the previous version of the NSI. RS Means was used to calculate the depreciated replacement value of structures. An extensive survey was conducted to estimate foundation heights for different sectors within the greater New Orleans area. Structure counts by occupancy types are shown in Table 3-3.

Table 3-3. Structure Counts by Occupancy Type

West Bank and Vicinity Structure Counts by Occupancy Type NSI 2019			
Residential		Non-Residential	
One-Story Slab	35,463	Eating and Recreation	745
One-Story Pier	21,379	Professional	2,366
Two-Story Slab	9,085	Public and Semi-Public	870
Two-Story Pier	5,561	Repair and Home Use	1,164
Mobile Home	921	Retail and Personal Services	1,840
		Warehouse	1,334
		Multi-Family Occupancy	4,236
Total Residential	72,409	Total Non-Residential	12,555

Depth-Damage Relationships and Content-to-Structure Value Ratio (CSVr)

Depth-damage relationships define the relationship between the depth of flooding and the percent of damage at varying depths that occurs to structures and contents. These mathematical functions are used to quantify the flood damages to a given structure. The content-to-structure value ratio (CSVr) is expressed as a ratio of two values: the depreciated replacement cost of contents and the depreciated replacement cost of the structure.

One method to derive these relationships is the "Expert Opinion" method described in the Handbook of Forecasting Techniques, IWR Contract Report 75-7, December 1975 and Handbook of Forecasting Techniques, Part II, Description of 31 Techniques, Supplement to IWR Contract Report 75-7, August 1977. A panel of experts was convened to develop site-specific depth-damage relationships and CSVrs for feasibility studies associated with Jefferson and Orleans Parishes. The results of this panel were published in the report Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-To-Structure Value Ratios (CSVrs) In Support Of the Jefferson and Orleans Flood Control Feasibility Studies, June 1996 Final Report. Table 3-4 displays the CSVrs and their respective standard deviations used for WBV.

Table 3-4. Content to Structure Ratios (CSVs) and Standard Deviations

Content-to-Structure Value Ratios (CSVs) and Standard Deviations (SDs)		
Structure Category		(CSV,SD)
Residential	One-story	(0.69, 0.37)
	Two-story	(0.67, 0.35)
	Mobile home	(1.14, 0.79)
Non-Residential	Eating and Recreation	(1.70, 2.93)
	Groceries and Gas Stations	(1.34, 0.78)
	Professional Buildings	(0.54, 0.54)
	Public and Semi-Public Buildings	(0.55, 0.80)
	Multi-Family Buildings	(0.28, 0.17)
	Repair and Home Use	(2.36, 2.95)
	Retail and Personal Services	(1.19, 1.05)
	Warehouses and Contractor Services	(2.07, 3.25)

Vehicle Inventory

Based on 2010 Census information for the New Orleans Metropolitan area, there are an average of 2.0 vehicles associated with each household (owner occupied housing or rental unit). According to the Southeast Louisiana Evacuation Behavioral Report published in 2006 following Hurricanes Katrina and Rita, approximately 70 percent of privately owned vehicles are used for evacuation during storm events. The remaining 30 percent of the privately owned vehicles remain parked at the residences and are subject to flood damages. Only vehicles associated with residential structures were included in the analysis. Vehicles associated with non-residential properties were not included in the evaluation.

First Floor Elevations

Topographical data based on NAVD88 vertical datum was used to assign ground elevations to structures and vehicles in the study area. The assignment of ground elevations and the placement of structures were based on a digital elevation model with a fifteen foot by fifteen foot grid resolution developed by the USGS. The ground elevation was added to the height of the foundation of the structure above the ground in order to obtain the first floor elevation of each structure in the study area. Vehicles were assigned to the ground elevation of the adjacent residential structures.

Levee Fragility

One possible input to the economic model is the inclusion of fragility curves. Fragility curves relate the levee loading (height of water on the levee) to the probability of failure and account for the possibility of damages occurring prior to levee overtopping. In addition, due to the complex nature of the storm modeling and the simplifying assumptions of the economic model (which, along with other factors specific to this study, limit its ability to reflect the complexity of hurricane-related flooding), there were no levee fragility curves utilized for this economic analysis. Therefore, the economic model assumes that the levees never fail and all damages

are caused by water flowing into the system over the top of the levee. This assumption effectively reduces the damage estimates because there is always some probability that the levee could fail prior to overtopping, which would introduce more water into the system and increase flood damages. While economic damages may be underestimated due to the lack of fragility curves, this underestimation applies to all study conditions (existing, future without project, and future with project). If future risk assessments find that prior-to-overtopping failure modes drive the risk for the system, then it is possible that the project benefits identified by this study will not be fully realized.

The rationale for omitting fragility curves and the related uncertainty is discussed further in Section 9.7.1. It should be noted that the life safety model (see Section 3.5) uses a semi-quantitative risk assessment methodology and is able to estimate life safety risk related to the potential for levee failure due to overtopping.

Existing Conditions Damages Due to Overtopping

The existing conditions damages due to overtopping by probability event are displayed in Table 3-5 and the expected annual damages by sub-basin are displayed in Table 3-6. Table 3-5 presents the damages estimated to occur at each AEP event of that AEP (i.e., these damages are not cumulative and are not annualized).

Table 3-5. Existing Conditions Expected Annual Damages Due to Overtopping by Probability Event

West Bank and Vicinity Expected Annual Damages by Probability Event 2023	
100%	\$0
10%	\$0
5%	\$0
2%	\$0
1%	\$20,861
0.5%	\$61,124
0.2%	\$2,013,192
0.1%	\$4,672,489

Table 3-6 presents the expected annual damages due to overtopping occurring for the 1% AEP event. Estimations of expected annual damages take into account the likelihood of damages for all AEP events.

Table 3-6. Existing Conditions Annualized Economic Damages Due to Overtopping by Sub-Basin (1% AEP Event)

West Bank and Vicinity Expected Annual Damages 2023 \$1,000s	
Sub-Basin	Expected Annual Damages, 2023
Belle Chasse	\$2,635
Gretna-Algiers	\$8,199
Harvey-Westwego	\$1,268
Lake Cataouatche	\$978
Total	\$13,080

3.5 EXISTING CONDITIONS LIFE RISK

There is a significant risk to human health, safety, and property associated with hurricane storms in the greater New Orleans area, demonstrated by documented impacts as early as the 1920s. During many of these hurricane storm events, residents are evacuated from their homes, occasionally for extended periods of time. Structures experience major damage and evacuation routes are shut down by floodwaters. In addition, access to critical infrastructure such as hospitals, fire departments, police department, and schools are limited or cut off. This section describes the current probability of levee overtopping (with and without breach) during hurricane storm events and the associated life safety consequences.

3.5.1 RISK IDENTIFICATION

A Semi-Quantitative Risk Assessment (SQRA) was performed to identify the magnitude of the life risk associated with levee system overtopping. Due to the limited time and funding available to conduct the study, a full SQRA that examines all potential failure modes was not able to be conducted. Given the authorizing language to “address consolidation, settlement, subsidence, sea level rise, and new datum to restore Federally authorized hurricane and storm damage reduction projects”, the risk assessment performed for this study focused on risks related to overtopping of the levee system. This decision is supported by examination of the available Screening Level Risk Assessments, which identified overtopping of levees as the major risk driver and was fully coordinated with the USACE Levee Safety Program team. The system may have other potential modes of failure prior to overtopping but the risk assessment did not seek to quantify any risks not related to overtopping. An additional semi-quantitative risk assessment is planned in the future to support the FEMA levee certification purposes and that effort will take a comprehensive look at system risks.

In this context, risk is defined as a measure of the probability (or likelihood) and consequences of uncertain future events. The SQRA considered the probability of overtopping (with and without breach) along with the economic and life safety consequences associated with overtopping. This section discusses the existing risk, while Section 5 (Future Without Project Condition) discusses the estimated risk in the future as a result of the combined effects of settlement, subsidence, and sea level rise over the period of analysis.

Tolerable risk guidelines (TRGs) are used in risk management to help inform the process of characterizing and judging the significance of estimated risks developed during the risk assessment process. TRGs are described in more detail in Section 6.4.2. Tolerable risks are those that society is willing to live with to achieve or obtain certain benefits. Within the USACE framework, risks that are above these tolerable limits are determined to warrant some form of management action to reduce the risk. USACE guidelines for tolerable risk limits are related to average incremental life loss. Incremental risk is the increased life risk associated with the presence of flood risk reduction features (such as a levee or dam).

Annualized life loss estimates are often very small numbers and are, therefore, commonly reported in scientific notation. Table 3-7 provides conversions from scientific notation to decimal and text equivalents.

Table 3-7. Example Number Equivalents

Scientific Notation	Decimal Equivalent	Text Equivalent
1E-01	0.1	1 person in 10 years
1E-02	0.01	1 person in 100 years
1E-03	0.001	1 person in 1,000 years
1E-04	0.0001	1 person in 10,000 years
1E-05	0.00001	1 person in 100,000 years

3.5.2 PROBABLE FAILURE MODES

A probable failure mode (PFM) is a mechanism that, once initiated, could potentially progress to breach of a levee system. A PFM analysis results in an estimate of the likelihood of failure (breach) in a given loading situation. This information is used in conjunction with consequences information to estimate life safety risk. This differs from the economic analysis described in Section 3.3 which, due to different modeling requirements, assumed that the levees do not breach under any loading scenario.

The risk assessment team identified three overtopping potential failure modes as critical to the study's purpose to address the effects of settlement, subsidence, and sea level rise.

- PFM 1 Overtopping with waves of Armored Levee leads to breach
- PFM 2 Overtopping with waves of Unarmored Levee leads to breach
- PFM 3 Overtopping with waves of Wall Levee Tie-in leads to breach

PFMs 1 and 2 are overtopping of the levees in armored and unarmored reaches. Armoring reduces the probability of failure due to overtopping. WBV levees are armored and MRL levees above the existing crossover point are unarmored.

PFM 3 is for overtopping near/at a floodwall/levee tie-in, which was an area that experienced problems during Hurricane Katrina. Modifications were made post-Hurricane Katrina, and this evaluates those modifications.

3.5.3 LEVEE RISKS

The term "levee risk", sometimes referred to as "incremental risk", is used to refer to the risk posed by the levee system itself. The 'levee risk' associated with this project is the risk

(probability of failure and associated consequences) to the landside area and floodplain occupants that can be attributed to the presence of the levee should the levee breach subsequent to overtopping, where the consequences considered are over and above those that would occur without levee breach.

In many levee systems, each risk-driving PFM would be evaluated for two scenarios: with and without intervention. Intervention is considered to be any human activity that takes place prior to or during a flood with the intent of increasing the probability that a levee system will successfully function during a given flood. The risk team determined that there were no intervention activities that could be taken during a hurricane event. Therefore, the only scenario considered is “without intervention.”

To model levee breach scenarios, the risk assessment team performed breach modeling evaluations at three locations on the WBV levees plus two more on the west bank of the Mississippi River: one on the co-located MRL levee and one upstream of the current crossover point to establish a PFM in an unarmored reach. These breach modeling locations were chosen as representative design and loading locations and were not reflective of any known or perceived deficiency in the system. Each breach evaluation location was loaded with the surge and wave outputs from the ADCIRC model for the 2%, 1%, 0.5%, and 0.2% AEP events in the existing condition. The model then estimated the hydraulic characteristics of depth, velocity, and associated arrival times of those flood water. Those were the inputs to the LifeSim model, which is a tool used to estimate life loss and direct damage during a flood or storm event.

3.5.4 NON-BREACH RISKS

Non-breach risks are risks associated with overtopping of the levee system that does not result in a failure (breach). These were also estimated by the LifeSim model using the surge overtopping estimates. The non-breach consequences are subtracted from the breach consequences to determine the incremental risk. It must be noted that the risk team did not run the non-breach scenario for the existing 1% or 0.2% AEP event, since the hydrology and hydraulics (H&H) modeling showed no stillwater overtopping of the levee in those cases. Appendix C, *Hydrology and Hydraulics*, contains information on special modeling performed to estimate non-breach wave overtopping inundation for all conditions of the study.

3.5.5 CONSEQUENCES

The LifeSim model estimated life safety risk for the existing conditions for the 1% AEP and 0.2% AEP events. The model used the hydraulic characteristics of depth, velocity, and associated arrival times of flood water from breach modeling as inputs to the LifeSim model. The LifeSim model used a structure database to distribute population within the model. A number of variables were entered into the LifeSim model based on information from the Parishes' emergency action plans and discussions with Parish officials, such as relative warning issuance, hazard communication delay, warning issuance delay, warning diffusion time, and protective action initiation. The LifeSim model then utilized Monte Carlo analysis and computed multiple iterations in order to obtain a range of possible life loss outcomes. Due to the long warning times for the area (any individuals choosing to evacuate should have ample time to do so), traffic simulation were not used for evacuations. However, it must be noted that the risk team did not run the non-breach scenario for the 1% AEP event consequences because H&H modeling indicated there was no free-flow overtopping and very little wave overtopping. Based on the modeling for WBV, the incremental life loss estimates ranged from low to high.

3.5.6 RISK CHARACTERIZATION

Given the limited scope of the SQRA, the risk characterization is limited to the incremental risk related to overtopping and, therefore, is not a full risk characterization for the project. The total incremental risk associated with overtopping, which combines the risks and consequences of all of the PFMs considered for the study, helps portray an overall levee overtopping risk picture. In the existing condition, all overtopping PFMs are below tolerable risk and the total is below the societal tolerable risk line. The estimated total annual probability of failure due to overtopping for WBV existing conditions is between $3E-07$ and $3E-06$ (0.0000003 and 0.000003) failures per year and the best estimate of the average annual incremental life loss is $3E-06$ (0.000003) lives per year, which is considered tolerable from a societal perspective.

4 AFFECTED ENVIRONMENT*

This section assesses the historic and existing conditions of relevant resources within the study area and is organized by resource topic. This section is not a comprehensive discussion of every resource within the study area, but rather focuses on those resources described as significant by laws, executive orders, regulations, and other standards of national, state, or regional agencies and organizations, technical or scientific agencies, groups, or individuals, and the general public. The relevant resources include the following: geology and soils, water resources, forest and wetland resources, upland resources, fisheries resources, wildlife resources, invasive species, federally-listed species, cultural and historical resources, ecological, scenic, and aesthetic resources, recreational resources, air quality, noise, transportation, socioeconomic resources and environmental justice, and HTRW.

4.1 ENVIRONMENTAL SETTING

4.1.1 STUDY AREA

The portion of the New Orleans Metropolitan Area known as the West Bank (from being on the West bank of the Mississippi River) extends from eastern St. Charles Parish to northern Plaquemines Parish along the right descending bank of the Mississippi River (Figure 1-3, above). It includes the communities of Algiers, Ama, Avondale, Belle Chasse, Bridge City, Gretna, Harvey, Marrero, Terrytown, Timberlane, Westwego, and Waggaman. The study area is part of the Barataria Basin. Lake Salvador and Lake Catouatche are estuary areas to the south that connect to the Gulf of Mexico through Barataria Bay. The study area is dissected by numerous canals and waterways. Numerous sensitive environmental resources are located near the study area including the Bayou aux Carpes Clean Water Act (CWA) Section 404(c) area, Barataria Bay, Gulf of Mexico, and Mississippi River (Figure 4-1). In general, these environmental resources are largely comprised of bottomland hardwood forests, cypress-tupelo swamps, and various freshwater, scrub-shrub, and forested wetland habitats.

The study team considered the affected environment to be the four sub-basins or polders. Refer to Table 4-1 and the location map (Figure 3-1).

Table 4-1. Study Area Overview

Sub-basin (Polder)	Parish	Sub-basin Area (acres)	Cities and Areas of Interest	Previous Improvement Efforts
Belle Chasse	Orleans, Jefferson, Plaquemines	17,855	Belle Chase	Hero Canal Levee and Eastern Terminus, Mississippi River Co- Located Levees
Gretna- Algiers	Orleans, Jefferson, Plaquemines	19,355	Algiers, Gretna, Harvey, Terrytown, Timberlane	GIWW, Harvey and Algiers Canal Levee and Floodwalls
Harvey- Westwego	Jefferson	15,353	Ama, Waggaman; Bridge City, Westwego, Marrero Bayou Aux Carpes CWA Section 404(c) Area	Westwego to Harvey Levee
Lake Cataouatche	Jefferson, St. Charles	24,883	Ama, Waggaman. Avondale	Lake Cataouatche Levee, Western Terminus Levee, Company Canal Floodwall
TOTAL		77,446		



Figure 4-1. Important Waterways and Bayou aux Carpes 404(c) Area

4.1.2 PHYSICAL GEOGRAPHY & LAND USE

4.1.2.1 PHYSICAL GEOGRAPHY

The study area is located on the Deltaic portion of the Mississippi River Alluvial Plain. Specifically, the area is located on the northern edge of the Barataria Basin on the western side of the Mississippi River between RM 82 to 127 above Head of Passes. The Barataria Basin is an intertributary basin dominated by features which include natural levee ridges, crevasse-splay deposits, marsh, lakes, and swamps. The eastern and northern edge of the basin is defined by the natural levee ridge of the Mississippi River and the western edge of the basin is defined by the Bayou Lafourche natural levee ridge. The Gulf of Mexico constitutes the southern boundary. Elevations within the study area vary from 31 feet NAVD88 on levees and floodwalls to near sea level in the back swamp and lake areas to below sea level in many of the urbanized areas which are under forced drainage.

4.1.2.2 LAND USE

The 2011 National Land Cover Database includes the most up-to-date data concerning the study area. Table 4-2 identifies various land uses within the study area. Figure 4-2 displays land use categories within the study area.

Table 4-2. Land Use in Study Area by Sub-Basin (Polder)

Land Use	Belle Chasse (acres)	Gretna-Algiers (acres)	Harvey Westwego (acres)	Lake Cataouatche (acres)	Total Acres in Study Area
Open Water	140	212	231	304	887 (1.15%)
Developed, Open Space	990	1,251	657	1,049	3,947 (5.10%)
Developed, Low Intensity	3,300	10,302	6,350	4,114	24,066 (31.07%)
Developed, Medium Intensity	814	3,514	2,254	689	7,271 (9.39%)
Developed, High Intensity	475	2,429	1,332	759	4,995 (6.45%)
Barren Land	64	2	71	1,367	1,504 (1.94%)
Deciduous Forest	181	9	12	81	283 (0.37%)
Evergreen Forest	36	1	8	14	59 (0.08%)
Mixed Forest	1,092	25	10	85	1,212 (1.56%)
Shrub/Scrub	166	19	7	49	241 (0.31%)
Herbaceous	76	19	17	89	201 (0.26%)
Hay/Pasture	546	170	280	1,473	2,469 (3.19%)
Cultivated Crops	859	5	181	1,610	2,655 (3.43%)
Woody Wetlands	8,304	1,379	3,469	11,121	24,273 (31.34%)
Emergent Herbaceous Wetlands	812	18	474	2,079	3,383 (4.37%)
Total Acres	17,855	19,355	15,353	24,883	77,446 (100.00%)

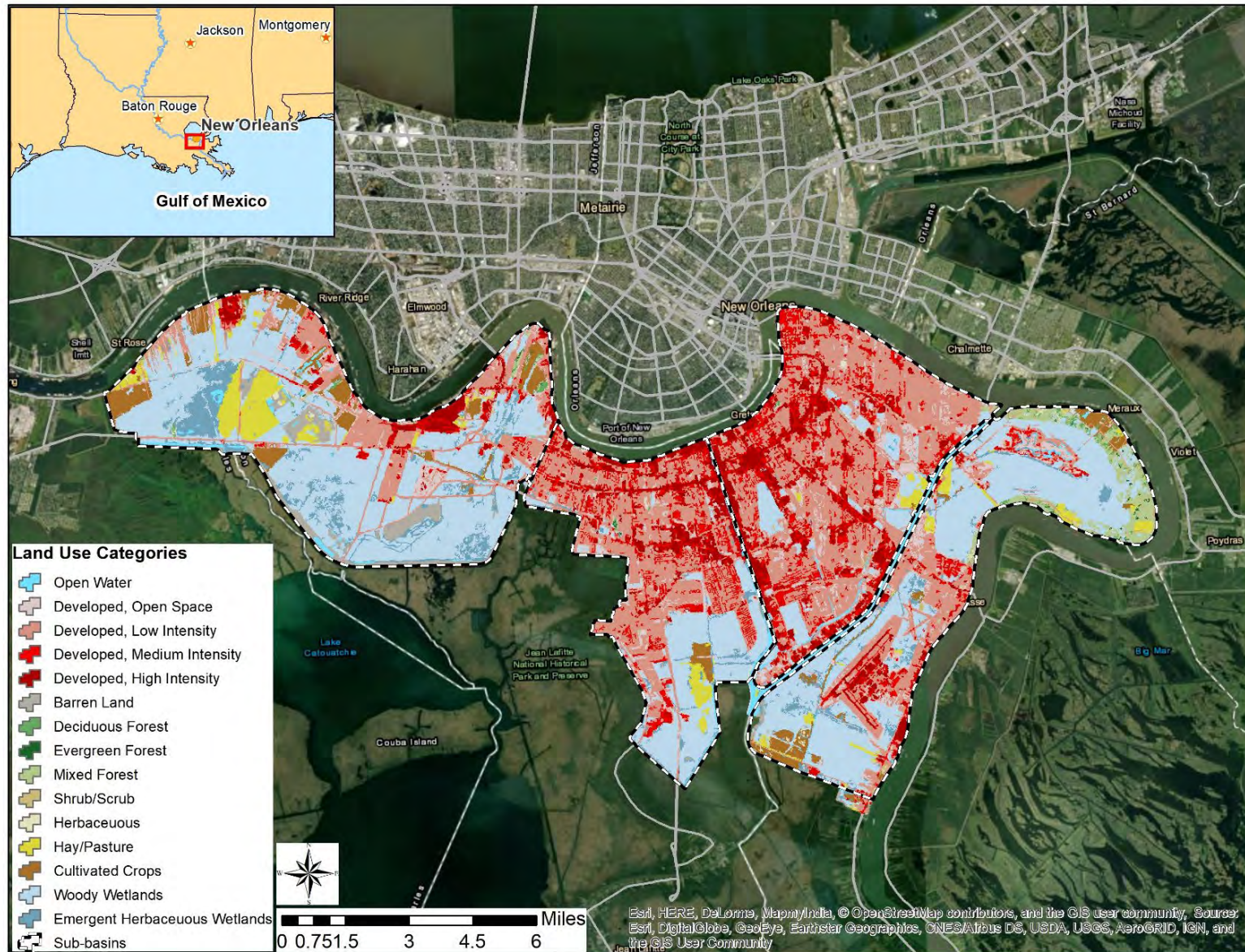


Figure 4-2. Land Use Categories Within the West Bank and Vicinity Study Area.

4.1.3 CLIMATE

Information on climate, climate change, relative sea level change and hydrology of the study area can be found in Section 5.2.

4.1.3.1 PRECIPITATION & TEMPERATURE

The study area has a subtropical climate, with tropical air masses dominating the weather during the spring and summer and cold continental frontal passages causing substantial temperature changes during the fall and winter. The climate is influenced by the many water surfaces of the lakes, streams, and the Gulf of Mexico. Precipitation generally is heavy in two fairly definite rainy periods. Summer showers last from mid-June to mid-September, and heavy winter rains generally occur from mid-December to mid-March. Table 4-3 provides a summary of weather averages (USclimatedata.com, 2019). For additional information on past climate see USACE (1994).

Table 4-3 Study Area Climate Averages at New Orleans

Weather Variable	Average
Annual High Temperature	77.1°F
Annual Low Temperature	62.3°F
Average Annual Temperature	69.7°F
Average Annual Precipitation – Rainfall	63.5 inches
Days Per Year with Precipitation - Rainfall	119 days

4.1.3.2 WINDS

Average wind speed and direction in New Orleans experience seasonal variation through the year. The windiest months occur between September and May with an average wind speed estimated at 8.9 miles per hour. Southerly winds often occur from February through July while Northerly winds are most common from November to February (weatherspark.com, 2019). For additional information on historic wind speeds see USACE (1994).

4.1.3.3 TROPICAL STORMS AND HURRICANES

Several tropical storms and hurricanes have passed through or near the study area. The frequency of hurricanes is greatest between August and October; however, hurricane season extends from June through November. Tropical storms and hurricanes typically produce the highest wind speeds and greatest rainfall events along the Gulf Coast. High winds are typically accompanied by massive storm surge, and in the case of the most powerful storms, these surges can be as high as 28 feet when they strike the Louisiana Coast (NOAA, National Oceanic and Atmospheric Administration (NOAA) Office of Science and Technology Fisheries Information Query, 2019a). Heavy rains, flooding, and wind are the primary problems associated with tropical storms and hurricanes. Table 4-4 provides a summary of recent hurricanes affecting the greater New Orleans area.

Table 4-4. Recent Hurricanes

Storm Name	Date	Landfall Location	Sustained Winds (mph)
Lili	3 Oct 2002	Vermilion Parish, LA	92
Katrina	29 Aug 2005	Buras-Triumph, LA	125
Rita	24 Sept 2005	TX/LA border	115
Gustav	01 Sept 2008	Cocodrie, LA	105
Ike	13 Sept 2008	Galveston, TX	110
Isaac	29 Aug 2012	Plaquemines Parish, LA	80
Nate	07 Oct 2017	LA/MS coast	85
Harvey	August 2017	TX/LA coast	130
Barry	10-14 Jul 2019	Marsh Island and Intracoastal City, LA	75
Laura	27 Aug 2020	Cameron, LA	150
Delta	9 Oct 2020	Creole, LA	100
Zeta	28 October 2020	Cocodrie, LA	110
Online Sources (Accessed 9 Jan 2019): https://coast.noaa.gov/hes/docs/postStorm/Lili_%20final.pdf ; https://pubs.usgs.gov/circ/1306/pdf/c1306_ch7_i.pdf ; http://www.hurricanesience.org/history/storms/2000s/ike/ ; http://www.hurricanesience.org/history/storms/2000s/rita/ ; http://www.hurricanesience.org/history/storms/2000s/gustav/ ; http://www.hurricanesience.org/history/studies/katrinacase/ ; https://www.wunderground.com/hurricane/Katrinassurge_contents.asp https://www.nhc.noaa.gov/archive/2012/al09/al092012.posest.08282356.shtml https://www.weather.gov/lch/2020Delta https://www.weather.gov/lch/2020Laura https://www.weather.gov/lch/2020Zeta			

4.2 GEOLOGY & SOILS

4.2.1 GEOLOGY

The geologic history since the end of the Pleistocene Epoch is pertinent to the study area. At the close of the Pleistocene, sea level was approximately 360 to 400 feet below the present sea level and the Mississippi River was entrenched into the older Pleistocene sediments. As sea level rose to its present stand, the entrenched valley was filled with sediment by the Mississippi River, resulting in an increase in meandering and channel migration. This meandering and channel migration resulted in a series of deltas extending into the Gulf of Mexico. Seven Holocene deltas are recognized in the lower Mississippi River Valley. For further details on the delta formation see USACE (1994). Overall, development of the deltas resulted in the gradual degradation of the study area through subsidence and shoreline retreat.

The deepest formations in the study area are Pleistocene deposits, consisting of somewhat hardened fluvial sands, silts, and mud at a depth of 40 to 60 feet below the ground surface to depths around 180 feet below the ground surface. These sediments were exposed and weathered during low sea-level stands as a result of Pleistocene glaciation, resulting in relatively higher cohesive strengths than would normally be expected. Holocene deposits found above the Pleistocene deposits are the results of gradual deposition of organic peat mixed with

fluvial silt and mud deposited as overbank deposits and inter-distributary deposits of the Mississippi River in cypress swamps around Lake Pontchartrain (Kolb, Smith, & Silvia, 1975)

As described in the previous IER (USACE, 2019), artificial levee material 10-24 feet thick comprise the surface. Beneath the artificial levee deposits lie swamp deposits composed of organic clays, fat clays, and peats with occasional sand and silt layers. Swamp deposits are generally between 10 to 20 feet thick. Natural levee deposits composed of clays and silts are adjacent to abandoned distributaries. Additional information on geological deposits can be found in IER #12 (USACE, 2009a), IER #13 (USACE, 2009b), IER #14 (USACE, 2009c), IER #15 (USACE, 2008), IER #16 (USACE, 2009d), and IER #17 (USACE, 2009e).

4.2.2 SOILS

Much of the study area was formerly wetlands (cypress swamps and marshes). As the greater New Orleans area grew and the constructed levees were built even higher, water was drained from swamps and marshes by canals, and pumped and dredged material, including peat and mud, were used to elevate the area for habitation. Resulting surface soils are classified as dredged material or muck. Land inside the levees is continually subsiding due to dewatering of peat deposits, often resulting in surface elevations below sea level. Water content in the soils is generally high and decreases with depth.

Soils within the study area were generally formed from Mississippi River sediments deposited as river floodwaters spread over the river banks during flood events. Soils in the study area are usually fine-grained sand, silt, and clay and contain abundant organic material.

The study area can be divided into three main soil categories (1) soils found on naturally occurring levees that are protected from flooding; (2) soils frequently ponded in marshes and swamps that experience frequent flooding; and (3) soils previously ponded, but have been drained and are protected from flood (Trahan, 1989; Mathews, 1983).

4.2.3 PRIME AND UNIQUE FARMLANDS

The U.S. Department of Agriculture (USDA) defines prime farmland as land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and which is available for these uses. Since the supply of high-quality farmland is limited, the USDA encourages responsible governments and individuals to use the nation's prime farmland wisely. The Farmland Protection Policy Act (FPPA) is intended to minimize the impact federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. USACE will prepare an AD-1006 application to evaluate the prime farmland in the study area during feasibility level design, which is included in Appendix G, *Environmental Compliance*. The assessment is completed on form AD-1006, Farmland Conversion Impact Rating, to establish a farmland conversion impact rating score which can be used as an indicator of the potential to convert farmland to non-farm use. Prior to final report approval and final public review, this evaluation will be included for the proposed construction footprint and updated during the Pre-construction, Engineering, and Design phase upon identification of borrow sites. Farmlands subject to FPPA requirements do not have to be currently in use for crop production. The land can be in use as pasture or cropland, forest land, or other wildlife habitat. Areas of water, wetlands, or urbanized land are not considered subject to FPPA requirements. Farmlands previously impacted by development or other hard structures, such that they are no longer viable for crop production, are not regulated under FPPA.

Cancienne silt loam, Cancienne silty clay loam, Shriever clay, Schriever silty clay loam, and Harahan clay are designated prime and unique farmland soils (USACE, 2009a). Areas of prime and unique farmland soils are shown in Figure 4-3. Many designated prime and unique farmland soils within the study area near the proposed action have been previously developed or contain existing levees and right-of-ways; however, some potentially impacted areas fall under the jurisdiction of the FPPA. Table 4-5 provides acres of prime and unique farmland soils by sub-basin and acres previously potentially impacted by HSDRRS

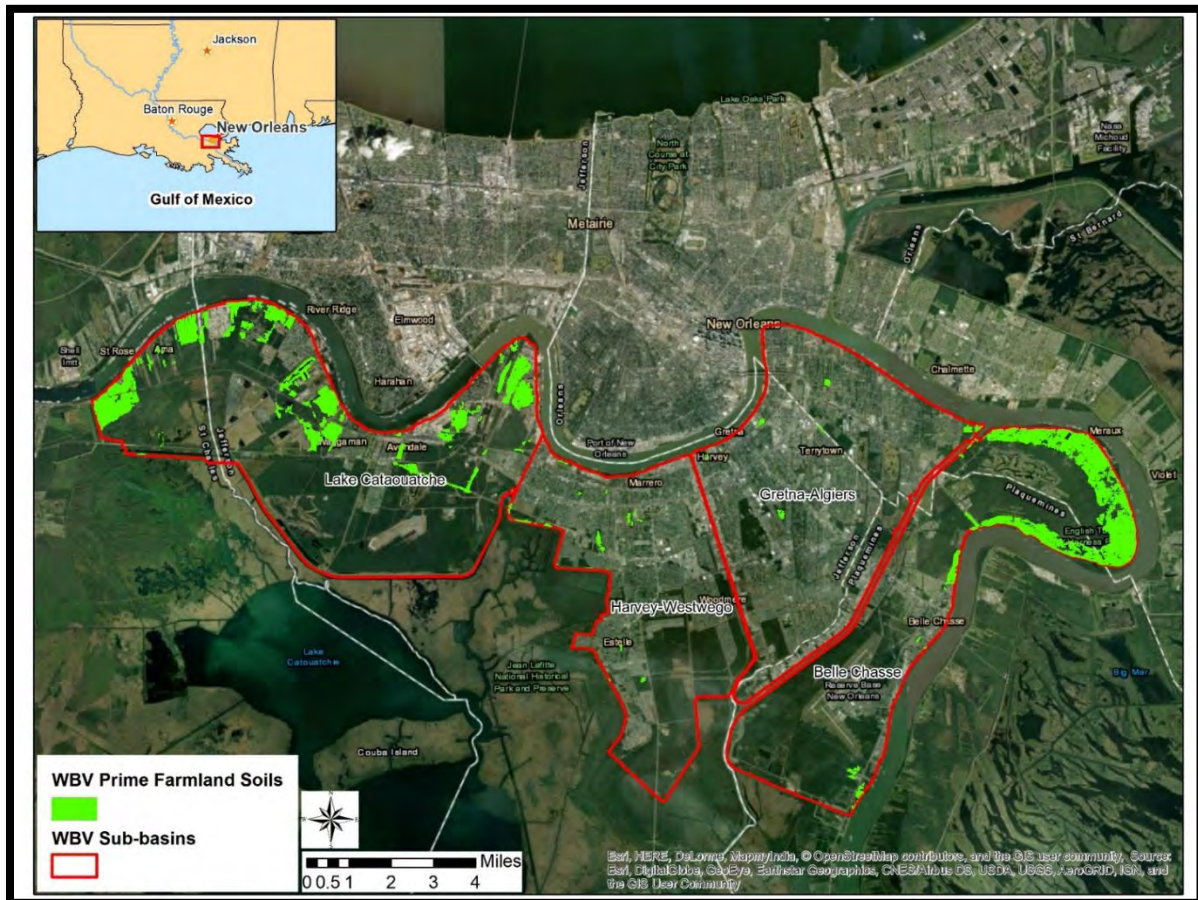


Figure 4-3 Location of Prime and Unique Farmland Soil Locations within the Study Area

Table 4-5. Acres of Prime and Unique Farmland Soils within the Study Area Sub-Basins

Sub-Basin	Total Prime Farmland (acres)	Total potentially impacted Prime Farmland Soils from previous HSDRRS projects (acres) (USACE, 2013)
Belle Chasse	1,845	6
Gretna-Algiers	51	0.0
Harvey-Westwego	57	0.0
Lake Cataouatche	1,948	594
Total	3,901	600

4.3 WATER RESOURCES

4.3.1 GROUNDWATER & SURFACE WATER QUANTITY

Groundwater and surface water quantities have not been identified as resources of issue in southeast Louisiana. The primary groundwater resources within the study area include Norco and Gonzales-New Orleans aquifers (Prakken & Lovelace, 2014). The Mississippi River is the primary source of fresh surface water in the study area. There is adequate surface water quantity available for all uses in the majority of the region, primarily because surface water for drinking, commercial, and industrial uses is derived from the Mississippi River and its tributaries. Groundwater is typically not extracted in any substantial quantities for residential or commercial use.

Tidal waters can be carried into the study area through the Bayou Barataria, Lake Salvador, Lake Cataouatche, and Bayou Verret. Freshwater is introduced into the area from the Mississippi River via the Harvey and Algiers Locks, direct rainfall, pumpage from leveed areas, and the Davis Pond Freshwater Diversion Canal.

Although water quantity is not a resource issue in the study area, water quality is a significant resource and is further described below.

4.3.1.1 WATER QUALITY

With the exception of direct rainfall and exchange from the Mississippi River through the Harvey and Algiers locks, essentially all waters which flow through the study area consist of pumped storm water runoff and wastewater treatment plant effluent. In general, the effects of industries along the Harvey Canal, treated wastewater effluent, and storm water discharges are compounding factors resulting in poor water quality within portions of the study area.

4.3.1.2 LOUISIANA WATER QUALITY INVENTORY: 305(B)/303(D) LIST

Section 303(d) of the Clean Water Act requires that states develop a list of waters that do not meet water quality standards and do not support their Designated Uses. In response to this mandate, LDEQ has prescribed water quality standards for surface waters within the state of Louisiana in order to promote a healthy and productive aquatic system. Surface water standards are set to protect the quality of all waters of the state, including rivers, streams, bayous, lakes, reservoirs, wetlands, estuaries, and many other types of surface water. Standards apply to pH, temperature, bacterial density, dissolved oxygen (DO), chloride concentration, sulfate concentration, metals and toxics concentrations, turbidity, color, and total dissolved solids (TDS). Established by the state, the Designated Use articulates the vision for the activities that each water resource can support. The Designated Use establishes the water quality management goals for the water body and determines the associated water quality standards to use to determine if the water body supports the Designated Use (USEPA, 2019).

Designated Uses of water bodies in and adjacent to the study area include Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR), Fish and Wildlife Propagation (FWP), and Drinking Water Supply (DWS). PCR covers any recreational activity that involves prolonged body contact with water, such as swimming, water skiing, tubing, snorkeling, and skin diving. Parameters measured to determine a water body's support of PCR include bacterial density, temperature, and metals and toxics concentrations. SCR covers any recreational activity that may involve incidental or accidental body contact with water and that involves a low probability

of ingesting water, such as fishing, wading, and recreational boating. Parameters measured to determine a water body's support of SCR include bacterial density and metals and toxics concentrations. FWP covers the use of water for preservation and reproduction of aquatic biota and includes maintenance of water quality at a level that prevents contamination of aquatic biota consumed by humans. Parameters measured to determine a water body's support of FWP include DO, temperature, pH, chloride, sulfate, TDS, turbidity, and metals and toxics concentrations. DWS covers a surface or groundwater source that, after conventional treatment, will provide safe, clear, potable, and aesthetically pleasing water for uses such as human consumption and food processing and cooking. Parameters measured to determine a water body's support of DWS include color, bacterial density, and metals and toxics concentrations.

The study area includes or is adjacent to numerous LDEQ sub-watersheds (Figure 4-4) some of which are on the LDEQ Water Quality Inventory Integrated Report (Section 305(b) and 303(d)) list for 2018 for violating pollution criteria (LDEQ, 2018). Table 4-6 presents the water quality attainment status, Designated Uses that are in nonattainment, suspected causes of impairment, and suspected sources of impairment of the LDEQ sub-watersheds associated with the study area.

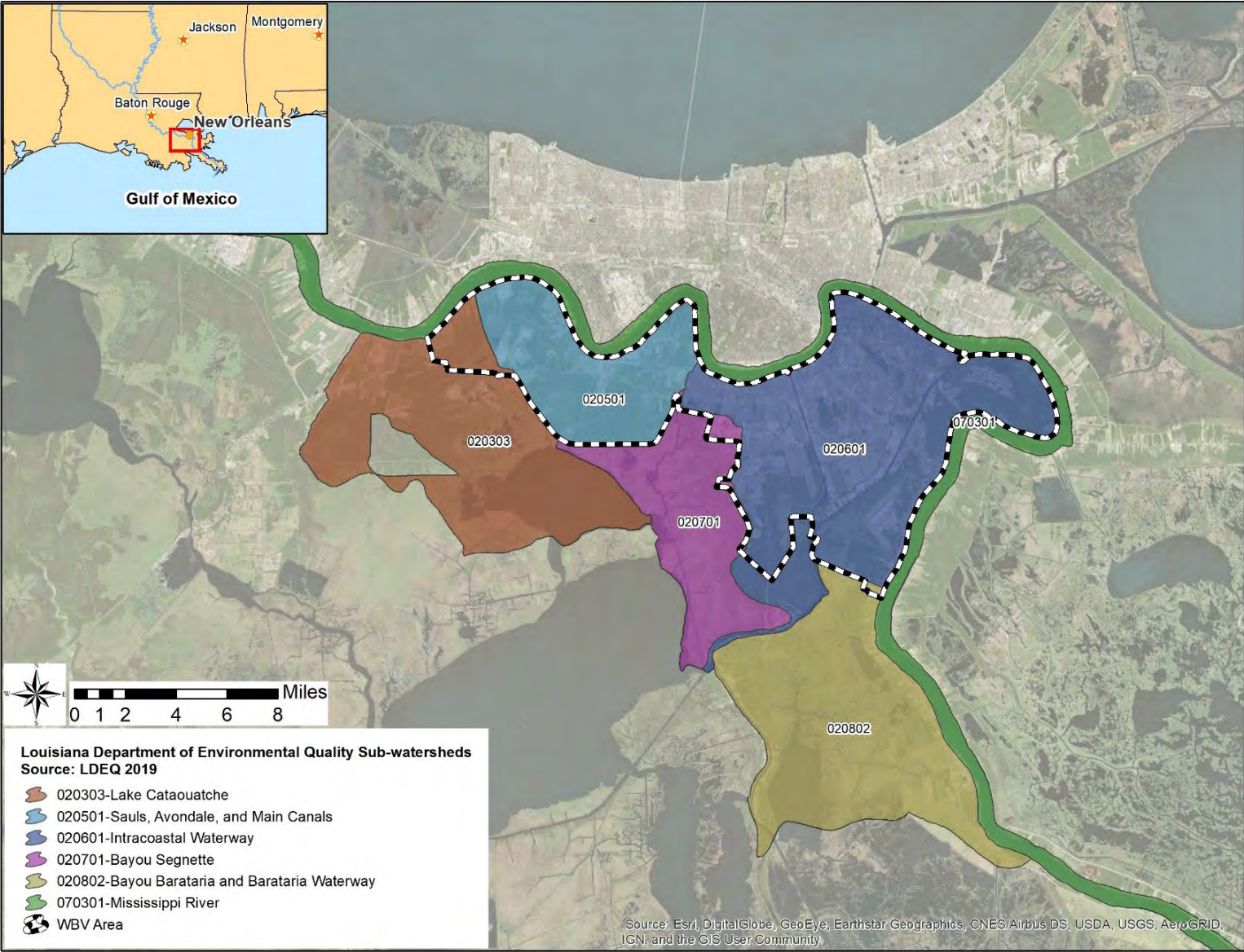


Figure 4-4. LDEQ Sub-watersheds Within and Adjacent to the Study Area

Table 4-6. Water Quality Attainment Status of LDEQ Sub-watersheds in and near the Study Area

Sub-Watershed ID#	Sub-Watershed Name	Water Quality Attainment Status	Suspected Causes of Impairment	Suspected Sources of Impairment
020303	Lake Cataouatche & Tributaries	Not supporting FWP	Turbidity - 303(d) List	Water diversions
020501	Sauls, Avondale, & Main Canals	Not supporting FWP	Chloride – 303(d) List Dissolved Oxygen – TMDL completed Nitrate/Nitrite – TMDL completed Total Phosphorus – TMDL completed Sulfate – 303(d) List Total Dissolved Solids – 303(d) List	Forced drainage pumping; Natural sources
020601	Intracoastal Waterway-From Bayou Villars to Mississippi River (Estuarine)	Not supporting FWP	Turbidity	Sediment re-suspension (clean sediment)
020701	Bayou Segnette-From headwaters to Bayou Villars	Fully supporting all designated uses		
020802	Bayou Barataria and Barataria Waterway-From ICWW to Bayou Rigolettes (Estuarine)	Fully supporting all designated uses		
070301	Mississippi River-From Monte Sano Bayou to Head of Passes	Fully supporting all designated uses		
FWP = fish and wildlife propagation (fishing)				

4.4 WETLAND AND FOREST RESOURCES

Vegetation found within the study area are typical of the Bottomland Hardwood Region of the Lower Mississippi River Alluvial Plain and are considered forested or non-forested wetlands providing a diverse suite of benefits to the study area (Table 4-7). Habitat types include oak-dominated bottomland hardwood forests, cypress-tupelo swamps, various fresh and saltwater emergent, shrub-scrub and forested wetlands, tidal channels, creeks, and estuaries.

The maintenance of habitat types in the region was historically dependent upon sediment input from freshwater flooding events producing a slow and gradual elevation transition. The gradual elevation change provides a highly elongated freshwater to saltwater transition zone capable of supporting a high diversity of wetland and marsh vegetation communities.

Currently, these coastal areas are in a transgressive phase resulting in the rapid replacement of freshwater marsh and swamp habitat within increasingly marine-dominated habitats (Roberts H. H., 1997). Historically, the coastal region encompassing the study area would receive freshwater and sediment inputs during frequent flooding events from the Mississippi River. These flooding events would act to maintain the freshwater habitat characteristics and negate the effects of tidal outwash through silt deposition; however, the construction of levees and other flood reduction measures have significantly altered the freshwater, nutrient, and sediment inputs. Levees and water pumping have decreased the flooding necessary to maintain the natural forest and wetland by conversion of existing bottomland forest to more upland-like habitats.

Figure 4-5 4-6 indicates the National Wetland Inventory data regarding wetland habitat in the study area. Certain locations within the study area have experienced a significant hydrological shift due to the construction of numerous pump stations during the 1960s to locally control drainage. These drained wetland habitats are found in areas along the entirety of the GIWW, Harvey Canal, and Algiers Canal. Much of this area has become heavily developed for both residential and industrial purposes. Small habitat fragments retain historic vegetative characteristics of bottomland hardwood forests.

Table 4-7. Benefits of Wetlands

- Buffer storm impacts
- Store & convey floodwater
- Absorb nutrients, sediment, & contaminants
- Carbon sequestration
- Nitrogen & phosphorus sink
- Maintain high biological productivity & diversity
- Serve as a nursery for fish and wildlife, including marine species and shellfish
- Base of food webs

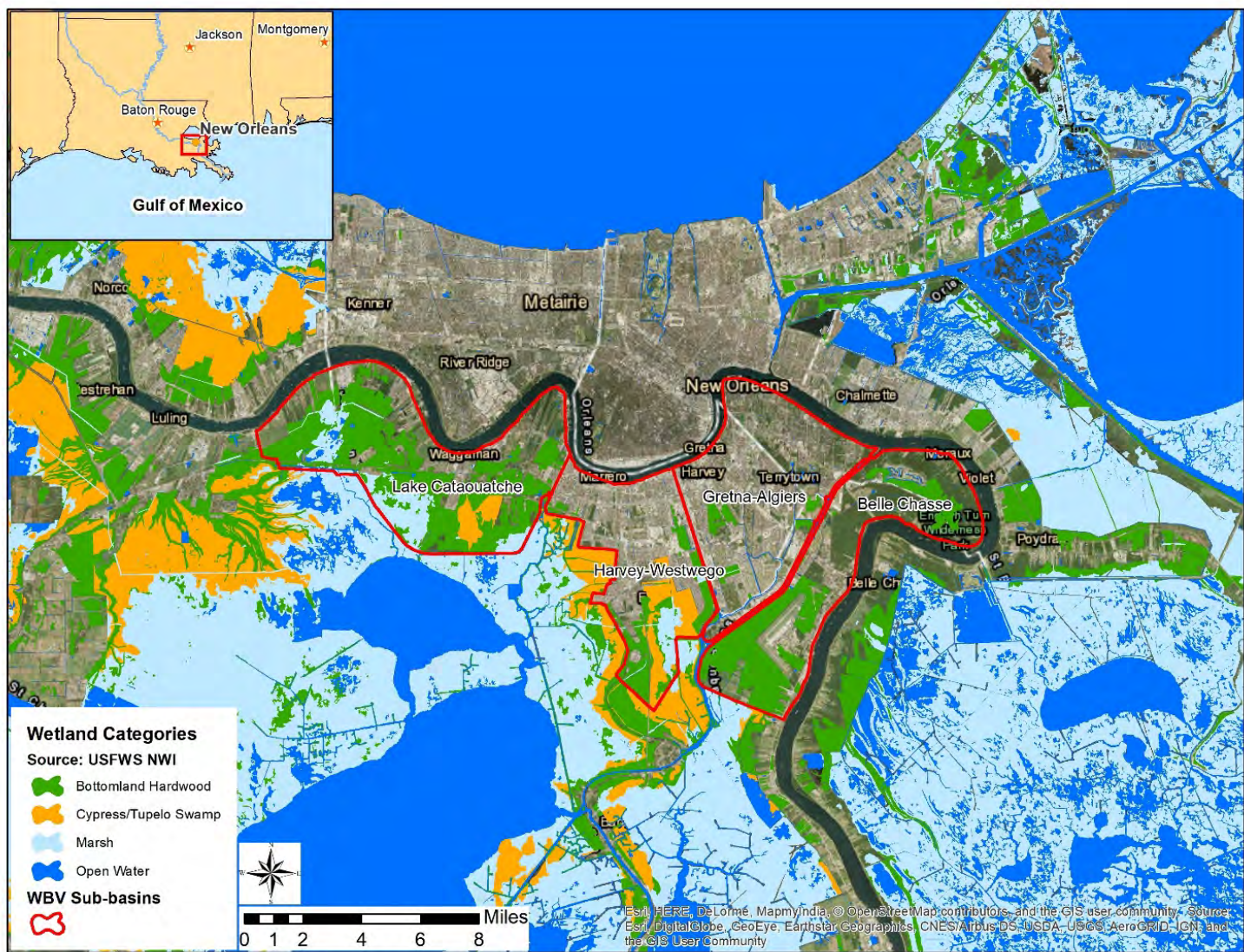


Figure 4-5. Location of Major Wetland Categories in the Vicinity of the Study Area

4.4.1 WETLANDS

Wetlands are areas where water saturation is the dominant factor determining the characteristics of soil development and types of plant and animal communities living in the area. Water is present either at or near the surface of the soil or within the root zone all year or at various durations throughout the year, including the growing season. The prolonged presence of water results in the selection of plants that are adapted to survive under saturated conditions and can grow in the soils that form under flooded and saturated conditions (hydric soils). Marshes, swamps, bogs, and BLH habitats are wetland habitats. Table 4-8 summarizes wetland habitat types found in the vicinity of study area and the following sections provide additional information on identified important wetland habitat types in the study area.

Table 4-8. Brief Description of Wetland Habitat Types in the Study Area

Wetland Habitat Type	Description	Common Plant Species Present	
		Common Name	Scientific Name
Freshwater Marsh	Marsh type dominated by herbaceous vegetation	Maidencane Alligator Weed Sedges Rushes	<i>Panicum hemitomom</i> <i>Alternanthera philoxeroides</i>
Open Water	Lakes, borrow ditches on either side of the levees, the GIWW, the Mississippi River, and smaller bayous	Submerged aquatic vegetation (SAV) including: Wild celery Widgeon Grass Slender Pondweed	<i>Vallisneria Americana</i> <i>Rubbia maritima</i> <i>Potamogeton perfoliatus</i>
Bottomland Hardwood Forest	Forested alluvial wetlands typically occupying floodplain regions of large flooding water bodies and rivers	Overcup Oak Nuttall Oak Water Oak Sweetgum Red Maple Green Ash Water Hickory Hackberry American Elm	<i>Quercus lyrata</i> <i>Q. nuttall</i> <i>Q. nigra</i> <i>Liquidambar styraciflua</i> <i>Acer rubrum</i> <i>Fraxinus pennsylvanica</i> <i>Carya aquatic</i> <i>Celtis laevigata</i> <i>Ulmus americana</i>
Cypress-Tupelo Swamp	Type of forested wetland that is nearly always inundated over the entire growing season	Bald Cypress Tupelo Gum Dwarf Palmetto Swamp Red Maple	<i>Taxodium distichum</i> <i>Nyssa aquatic</i> <i>Sabal minor</i> <i>Acer rubrum var. drummondii</i>
Flotant (Floating) Marsh	Type of freshwater or intermediate marsh type composed of thick, floating mats of vegetation with open water beneath	Maidencane Peat	<i>Panicum hemitomom</i>

Shrub-Scrub Swamp	A low, flat freshwater swamp with large shrubs and small trees less than 35 feet in height; often associated with newly accreted lands and partially drained wetlands	Waxmyrtle Buttonbush	<i>Myrica cerifera</i> <i>Cephalanthus occidentalis</i>
Brackish Marsh	Experiences irregular tidal flooding and dominated by salt-tolerant grasses. Located in the unprotected and undeveloped areas near the GIWW and within the Bayou aux Carpes CWA Section 404(c) area	Wire Grass	<i>Spartina patens</i>
Sources: USACE (2009); http://www.wlf.louisiana.gov/sites/default/files/pdf/fact_sheet_community/32326-Freshwater%20Marsh/freshwater_marsh.pdf ; http://www.wlf.louisiana.gov/sites/default/files/pdf/document/32870-cypress-tupelo-blackgum-swamp/cypress-tupelo-blackgum_swamps.pdf ; http://www.wlf.louisiana.gov/sites/default/files/pdf/fact_sheet_community/32333-Scrub/Shrub%20Swamp/scrub_shrub_swamp.pdf ; http://www.wlf.louisiana.gov/sites/default/files/pdf/document/32862-bottomland-hardwood-forest/bottomland_hardwood_forest.pdf accessed on 10 Jan 2019			

4.4.1.1 MARSH

Marshes are land masses that are frequently or continually inundated by water and are characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions (USEPA, 2019). Marsh types within the study area include fresh, intermediate, brackish, and saline marsh. Fresh and intermediate marshes are generally found upstream from brackish waterways, where there is minimal tidal action and a reduced level of saltwater in the systems. Common vegetation includes arrowhead (*Sagittaria* spp.), pickerelweed (*Pontedaria* spp.), pennywort (*Hydrocotyle* spp.), maidencane (*Panicum hemitomon*), and cattail (*Typha* spp.). Intermediate marshes generally have low salinities throughout the year, but salinity peaks during the late summer and early fall. Vegetation may include saltmeadow cordgrass (*Spartina patens*), bulltongue (*Sagittaria lancifolia*), and wild millet (*Echinochloa* spp.). The freshwater marsh within the study area is concentrated along the Mississippi River in Jefferson Parish and in the region surrounding Lake Cataouatche. Intermediate marsh is found within southern Belle Chasse, Gretna-Algiers, and Harvey-Westwego sub-basins. Some areas of freshwater and intermediate marshes in the project area are floatant marsh. Floatants are floating marshes that are entirely floating or poorly anchored to the underlying substrate and are composed of very little mineral matter.

Brackish and saline marshes are located in the unprotected and undeveloped areas near the GIWW and within the Bayou aux Carpes CWA Section 404(c) area. Brackish marshes experience low to moderate daily tidal action. Vegetation is typically dominated by smooth cordgrass (*Spartina alterniflora*) but also includes saltgrass (*Distichlis spicata*), black rush (*Juncus roemerianus*), and bulrush (*Schoenoplectus* spp.). Saline marshes are less floristically diverse, as they are dominated by only a few plant species that are tolerant of increased salinity levels, such as smooth cordgrass, saltgrass, and glasswort (*Salicornia virginica*) (USACE, 2004). There are relatively few saline marshes near the study area, and these are limited to the southern coastal areas.

4.4.1.2 OPEN WATER

Lake Cataouatche, borrow ditches on either side of the levees, the GIWW, the Mississippi River, and smaller bayous are all open water bodies classified as jurisdictional waters of the United States. Submerged aquatic vegetation (SAV) may occur within these open water bodies but it has limited distribution within the GIWW and Hero Canal.

The portion of the Mississippi River along the MRL is inherently low in primary productivity on a per acre basis because of high turbidity and has relatively poor benthic productivity because of shifting substrates and high current velocities in the area (USACE, 2009). The deep main river channel is the habitat of large predaceous fishes, some plankton feeders and a group of omnivorous species. Additionally, borrow pits excavated on the river-side of the existing MRL provide additional complexity of open water habitat for various species of wildlife, finfish, and shellfish (USACE, 2010e). These relatively stable water bodies support large populations of aquatic plants and animals. The growth of higher plants around these waters may reduce phytoplankton growth near the edges. The higher plants around these water bodies are also important primary producers in that a significant amount of leaf litter, branches, and other organic matter may wash into these lakes and borrow pits during high water conditions becoming a source of detritus (USACE, 2010).

4.4.1.3 FORESTED WETLANDS

The study area is in the southern portion of the Lower Mississippi Alluvial Valley, which extends from Cairo, Illinois, to the confluence of the Mississippi River with the Gulf of Mexico in Louisiana. Based on a recent forest inventory by U.S. Forest Service, 28 percent of the land area within the Mississippi Alluvial Valley is in forest cover, with the least forest cover in the northern portions adjacent to the Mississippi River and the coastal parishes of Louisiana (which includes the study area) (Figure 4-6).

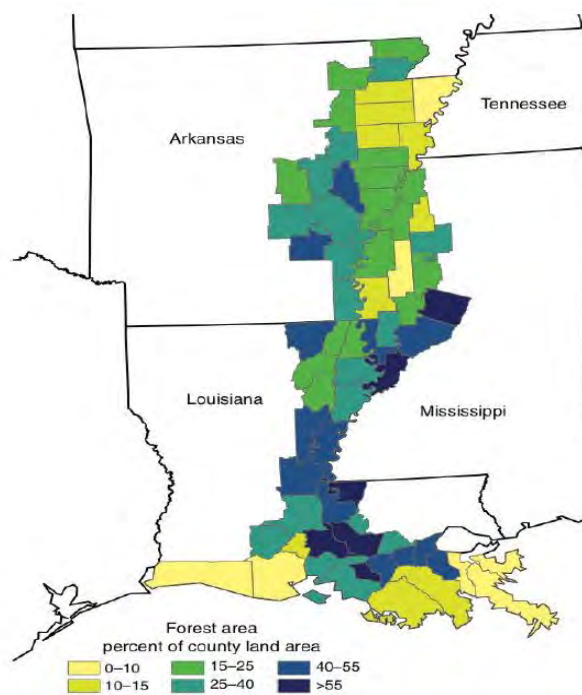


Figure 4-6. Percent of Land Area Classified as Forest by County in the Lower Mississippi Alluvial Valley, 2010 (Graphic from (Oswalt, 2013))

Cypress-tupelo swamps and BLH forests once were more common in the study area than they are today. The loss of these habitats due to wind, storm surge damage, and saltwater intrusion into previously freshwater or brackish marshes has greatly impacted the regional habitat and biological resources in the project area (USACE, 2008).

4.4.1.3.1 CYPRESS-TUPELO SWAMPS

Cypress-tupelo swamps are located in transitional zones between BLH and lower-elevation marsh or scrub/shrub habitats and flood on a regular basis. Cypress-tupelo swamps exist where salinities are very low (near zero), where there is minimal daily tidal action, and where it is usually flooded throughout most of the growing season. Bald cypress (*Taxodium distichum*) and water-tupelo (*Nyssa aquatica*) are the dominant vegetation within this habitat type, but Drummond red maple (*Acer rumbrum var drummondii*), green ash (*Fraxinus pennsylvanica*), and black willow (*Salix nigra*) also occur. Water lily (*Nymphaea odorata*), pickerelweed (*Pontederia cordata*), smartweed (*Polygonum punctatum*), and non-native alligator weed (*Alternanthera philoxeroides*) are also common.

Most of the cypress-tupelo swamps were removed from Louisiana between 1876 and 1956, a period of intense logging (Keddy, 1987).

4.4.1.3.2 BOTTOMLAND HARDWOOD FOREST

BLH forest is defined as forested alluvial wetlands typically occupying floodplain regions of large flooding water bodies and rivers (Cowardin, 1979). It occurs in areas where the natural hydrologic regime alternates between wet and dry periods. Common tree species found within these habitats include American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), water hickory (*Carya aquatica*), nuttall oak (*Quercus nuttallii*), Chinese tallow (*Triadica sebifera*), and red maple (*Acer rubrum*). Understory species may include dwarf palmetto (*Sabal minor*), waxmyrtle (*Myrica cerifera*), deciduous holly (*Ilex decidua*), and swamp dogwood (*Cornus foemina*). Other common species that may be present include poison ivy (*Toxicodendron radicans*), trumpet creeper (*Campsis radicans*), pepper-vine (*Ampelopsis arborea*), and greenbrier (*Smilax* spp.). BLH provides important foraging areas and habitat for a variety of wildlife, but because of the fragmented, disturbed, and secondary nature of the BLH within the study area, it is unlikely that many species would utilize the project area as a more expansive primary growth forest. Some areas classified as BLH in the study area are scrub/shrub habitat and are dominated by waxmyrtle, eastern baccharis (*Baccharis halimifolia*), rattlebox (*Sesbania* spp.), and black willow (*Salix nigra*). Most of the BLH in the study area, including scrub/shrub habitat, is disturbed and contains large concentrations of invasive Chinese tallow trees.

Approximately 200 years ago, 30 million acres of BLH covered the southeastern U.S., but it is estimated that loss rates were as high as 431,000 acres per year from 1965 to 1975. As a result, very little original BLH habitat exists in the southeastern U.S. (USEPA, 2019). Any remaining BLH forest within the study area has been dramatically impacted by alteration of natural hydrology due to extensive water control measures and development. This has led to the gradual deterioration of BLH through colonization by more upland species (Coastal Wetland Forest Conservation, 2005). In the last 100 years, a large portion of historical BLH habitat has been logged and converted into agricultural and urban lands (Dahl, 1991).

In the study area, BLH occurs as both jurisdictional BLH habitat (i.e., regulated under Section 404 of the CWA) and non-jurisdictional (i.e., upland) BLH habitat. USACE mitigates for impacts

on both jurisdictional and non-jurisdictional BLH habitat as required under WRDA 1986, Section 906, as amended.

4.4.2 WETLAND LOSS

Louisiana has lost wetlands due to relative sea level change, subsidence, storms, sediment deprivation and other factors at an average rate of approximately 14,000 acres (22 square miles) per year since 1932 (Couvillion B. H., 2017). From 1932 to 2016, approximately 1.2 million acres (1,866 square miles) of land was lost in coastal Louisiana, representing a decrease of approximately 25 percent (Couvillion B. H., 2017). Louisiana experiences greater coastal wetland loss than all other states in the contiguous United States combined (Couvillion B. H., 2017). The high rate of wetland loss in coastal Louisiana is directly related to the high rates of subsidence, as well as development of human infrastructure (USACE, 2008; Boesch, 1994). Some of the wetland loss is due to canalization or filling of wetlands for development. Hurricane-induced acceleration of coastal wetlands is also a source of wetland loss (Couvillion, et al., 2011). During the 2005 hurricane season, Hurricanes Rita and Katrina directly converted approximately 127,000 acres (198 square miles) of marsh into open water in Louisiana permanently (Barras, Bernier, & Morton, 2008). Figure 4-7 provides information on land change in the vicinity of the study area from 1932 to 2016.

Historically, a balance was maintained between wetland formation and loss in the Louisiana deltaic plain from overbank sediment deposition in actively forming delta lobes and subsidence and deterioration processes in abandoned delta lobes. The coastal wetlands balance has been interrupted by changes to the Mississippi River. The river's suspended sediment load has been reduced by 80 percent since 1850 (Kesel, 1987) due to dams on major tributaries, land use changes in the watershed, overbank storage and channel bed aggradation, and alterations to the landscape such as flood risk reduction projects and navigation channels (Allison, 2012). Overbank flooding of the Mississippi River and its tributaries has been greatly restricted, and in many cases eliminated, removing the source of sediment and freshwater that built and maintained coastal marshes relative to subsidence and sea-level rise (Roberts H. R., 1980). The maintenance of the Mississippi River in its current course and subsequent changes to the delta cycle now cause the majority of sediment deposition and fresh water to be discharged off the continental shelf. Another problem is the intrusion of saltwater into historically less-saline marshes. Although numerous wetlands restoration projects have been implemented in coastal Louisiana, to date, these projects have had little effect on the overall rate of wetland loss in the system (Barras, Bernier, & Morton, 2008).

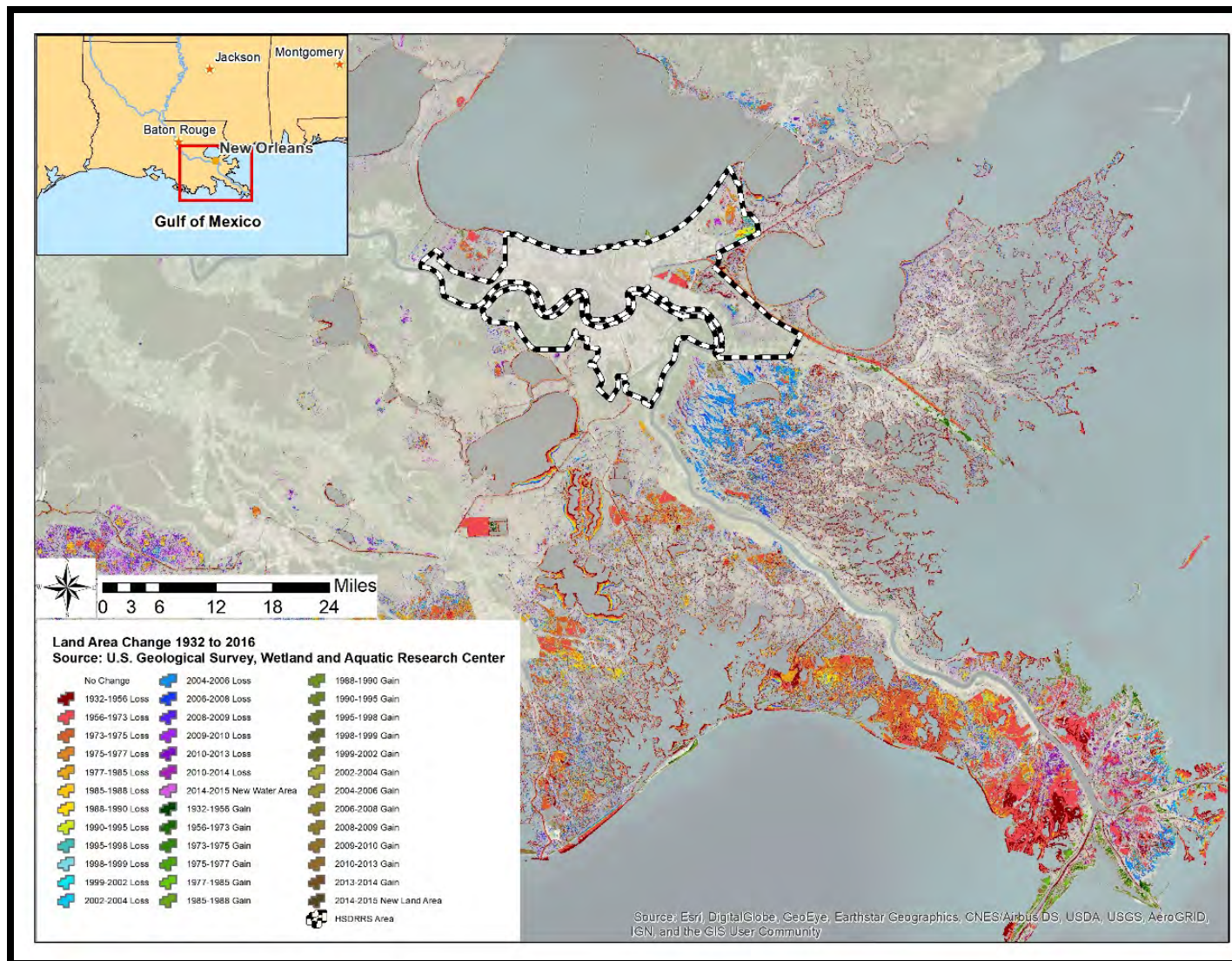


Figure 4-7. Land Change in the Vicinity of the Study Area from 1932 to 2016

4.4.3 USEPA DESIGNATED BAYOU AUX CARPES CLEAN WATER ACT 404(C) AREA

Within the WBV study area, the USEPA designated Bayou aux Carpes (Figure 4-1, above) as a nationally significant wetland under CWA Section 404(c) (CWA 33 U.S.C. 1251 et seq), which authorizes the administrator of the USEPA to deny or restrict the use of any defined area for specification as a disposal site, whenever he/she determines, after notice and opportunity for public hearings, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, and recreational areas.

The 3,200-acre Bayou aux Carpes CWA Section 404(c) area has been designated since 1985 (USEPA, 1985). The area is comprised of high quality wetland habitat including BLH forest, cypress-tupelo swamp, scrub-shrub wetland, and floatant marsh. The Bayou aux Carpes CWA Section 404(c) area is highly productive and diverse wetland habitat and is of significant value to the ecosystem for many species of fish and wildlife.

Additional background information regarding the USEPA-designated Bayou aux Carpes CWA Section 404(c) area can be found in Sections 3.1.7, 3.2.2, and 6.3 of the Individual Environmental Report #12 (USACE, Decision Record, Individual Environmental Report #12, 2009).

4.5 UPLANDS

Within the study area, upland resources were considered to be lands that exhibit upland habitat characteristics. These could be areas that technically could be classified as wetlands (Figure 4-5 above), but due to draining or clearing function more like an upland resource, or they could be areas that are naturally occurring uplands. The converted wetland resources exhibiting upland characteristics within the study area consist of cleared and drained BLH forest lands used primarily as pasture lands, levees, roads, and commercial or residential use. Non-wetland areas within the study area consist of cleared and drained bottomland hardwood forest lands used primarily as pasture lands, levees, roads, and commercial or residential use. Although many of these areas within the vicinity of the study area could be classified as wetlands, some areas exhibit more upland characteristics. The existing levees within the study area are the only areas resembling any substantial upland habitat characteristics (USACE, 2009b). Naturally occurring non-wetland upland resources are defined in areas naturally containing: (1) a prevalence of facultative or obligate upland plant species; (2) non-hydric soils; and (3) few or no occurrences of periodic inundation or soil saturation throughout the growing season (USACE, 2009b)

The areas considered uplands are mostly converted wetlands due to deposition of soil fill for construction of infrastructure and residential and commercial development, spoil from dredging of waterways, landfill material, or the result of draining wetland habitat (USACE, 2009a). Therefore, naturally occurring non-wetland uplands are not a significant resource in the study area. Although natural uplands and non-wetlands are not a significant resource, there are significant land uses in the study area that are typically associated with upland habitats. Within the study area, these land uses are limited to agricultural production (e.g., cattle grazing and citrus orchards) on previously cleared and drained BLH forest lands (USACE, 2009b).

4.6 FISHERIES

Coastal wetlands provide essential habitat for commercially important marine and freshwater species and game species that are wetland-dependent at some stage in their life-cycle. Areas in and adjacent to the study area are important contributors to the local and regional fisheries. Freshwater fisheries within the study area provide habitat for resident populations of numerous species. Due to the extensive decline of Louisiana's coastal marsh, protection of fragile aquatic habitat is a concern for all large construction activities.

The canals and surrounding marshes support bowfin (*Amia calva*), spotted gar (*Lepisosteus spatula*), shads (*Alosa* spp.), mosquitofish (*Gambusia affinis*), and channel catfish (*Ictalurus punctatus*), among others. No fish hatcheries are located within the study area (USFWS iPAC resource list; accessed 3 September 2019).

The Bayou aux Carpes area has abundant forage species (e.g., mosquitofish, minnow species), and is valuable spawning, feeding, and nursery habitat for recreationally important freshwater fish such as largemouth bass (*Micropterus salmoides*), bowfin (*Amia calva*), and sunfish (Centrarchidae species) and crustaceans such as crawfish (*Procambarus clarkii*), grass shrimp (*Palaemonetes pugio*), and the blue crab (*Callinectes sapidus*) (USACE, 2009a). The Bayou aux Carpes has been determined to be a major contributor to the greater Barataria Bay Estuary, providing sensitive habitat for both freshwater and marine species. Consequently, these wetland estuaries are critical to maintaining sustainable populations of commercially important marine and freshwater species, such as speckled trout (*Cynoscion nebulosus*), redfish (*Sciaenops ocellatus*), flounder (Bothidae species), croaker (*Micropogonius undulatus*), and numerous shellfish by functioning as nurseries.

The study area also has freshwater species highly valued by sport fisherman including: largemouth bass (*Micropterus salmoides*), alligator gar (*Atractosteus spatula*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), various species of sunfish (*Lepomis* spp.), blue catfish (*Ictalurus furcatus*), flathead catfish (*Pylodictis olivaris*), spotted gar (*Lepisosteus oculatus*), and red swamp crawfish (*Procambarus clarkii*).

The estuarine area surrounding the study area creates prolific nursery grounds for white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), blue crab (*Callinectes sapidus*), eastern oyster (*Crassostrea virginica*), and menhaden (*Brevoortia patronus*). These important fisheries contribute a significant portion of the annual commercial fish landings in Louisiana. Commercial fish landing data for Louisiana from 2008 through 2017, the most recent year for which data are available, were downloaded from NOAA Fisheries (NOAA, National Oceanic and Atmospheric Administration (NOAA) Office of Science and Technology Fisheries Information Query, 2019a) and used for the following analyses. Commercial fisheries landings in Louisiana averaged 1.02 billion pounds per year with an average value of \$351 million. Table 4-9 presents the five species of fish and invertebrates that provided the greatest economic impact on Louisiana fisheries.

Table 4-9. Average Annual Value of Commercial Landings of Top Five Species in Louisiana from 2008 to 2017

Species	Average Annual Landings 2008 to 2017 (Millions of Pounds)	Average Annual Landings Value 2008 to 2017 (Millions of Dollars)
White Shrimp	65.3	\$109.4
Menhaden	829.9	\$70.9
Blue Crab	42.2	\$45.6
Brown Shrimp	30.9	\$34.8
Eastern Oyster	6.1	\$27.5

Source: (NOAA, National Oceanic and Atmospheric Administration (NOAA) Office of Science and Technology Fisheries Information Query, 2019a)

In Louisiana, coastal and offshore recreational fishing stimulates \$757 million in economic output and creates 7,733 jobs (Southwick Associations, 2008). NOAA Fisheries recreational fishing data for Louisiana from 2008 through 2017, the most recent year for which data are available, indicate that the largest catch of marine recreational fish species by number in Louisiana were spotted trout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellata*), hardhead catfish (*Arius felis*), Atlantic croaker (*Micropogonias undulatus*), sand seatrout (*Cynoscion arenarius*), black drum (*Pogonias cromis*), and sheepshead (*Archosargus probatocephalus*). These seven species represented approximately 88% of the recreational catch, by number, for the period analyzed (NOAA, 2019a).

4.7 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act, as amended in 1996 by the Sustainable Fisheries Act and as reauthorized and amended in 2007 by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, requires the eight regional fishery management councils to describe and identify Essential Fish Habitat (EFH) in their respective regions, to specify actions to conserve and enhance that EFH, and to minimize the adverse effects of fishing on EFH. Congress defined EFH as “those waters and substrate necessary to marine fish for spawning, breeding, feeding, or growth to maturity” (PL 94-265, as amended PL 109-479). The Magnuson-Stevens Fishery Conservation and Management Act requires the National Marine Fisheries Service (NMFS) to assist the regional fishery management councils with their respective Fishery Management Plans (FMP). The EFH descriptions and identifications for Gulf of Mexico FMPs were approved on February 8, 1999, for 26 selected species and coral complexes. Today, the Gulf of Mexico Fisheries Management Council (GMFMC) manages EFH for 28 species of marine fish and invertebrates within their respective FMPs.

The WBV study area contains EFH along Bayou Verret near the project boundary within the Lake Cataouatche sub-basin and within the GIWW (Figure 4-8). The majority of EFH that exists is located outside of the study area, but in the vicinity including Lake Cataouatche, Salvador, Pontchartrain, and Borgne (Figure 4-8). Aquatic organisms that inhabit this highly diverse ecosystem are generally tolerant of a wide range of salinities. The landward boundary of estuarine EFH is the limit of permanent freshwater bottom and the seaward limits are the terminus of the U.S. exclusive economic zone. EFH includes all waters and habitats or substrates within these estuarine boundaries. The habitats are water bodies where federally-

managed fish, and the organisms they prey upon, live during the various stages of their life history. Specific categories of EFH include all estuarine waters and their mud, sand, shell, and rock substrate. Artificial reefs, oyster beds, and the associated biological communities, SAV, and adjacent intertidal vegetation (marshes and mangroves) are considered EFH. The EFH designation does not generally extend into the freshwater portions of rivers discharging to the estuarine system (GMFMC, 1998). Vegetated areas are emphasized because of their importance to fish production and because of their vulnerability to human activities. Marsh, oyster shell, SAV, and unvegetated bottom habitats that constitute EFH are found in the study area. Figure 4-8 displays EFH water bodies in the vicinity of the study area (NOAA, 2019b).



Figure 4-8. Essential Fish Habitat within Waterways in the Vicinity of the Study Area

4.7.1 FEDERALLY MANAGED FISH AND SHELLFISH EFH

EFH regulations protect the habitats of fish and shellfish managed by the GMFMC. The most common federally managed species in the vicinity of the study area is shrimp. The GMFMC lists brown shrimp, white shrimp, pink shrimp (*Farfantepenaeus duorarum*), red drum (*Scaenops ocellatus*), and Spanish mackerel (*Scomberomorus maculatus*) as known to exist in the estuaries near the study area. Table 4-10 presents a list of managed species found in the vicinity of study area.

Table 4-10. Federally Managed Species in the Vicinity of the Study Area

Managed Species	Life Stages	Designated EFH	Prey Species
Brown shrimp	Early juvenile	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Some zooplankton, various fish species, polychaetes, amphipods, benthic infauna
White shrimp	Early juvenile	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Phytoplankton, zooplankton, detritus, annelid worms, pericardid crustaceans, caridean shrimp, diatoms, gastropods, copepods, bryozoans, sponges, corals, filamentous algae, vascular plants
Pink shrimp	Early juvenile	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Copepods, small mollusks, benthic diatoms, blue-green algae, filamentous green algae, vascular plant detritus, bacterial films, slime molds, yeast
Red drum	Larvae, post larvae, early juvenile, late juvenile, adult	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Copepods, mysids, amphipods, shrimp, polychaetes, insects, small fish, isopods, bivalves, crabs, shrimp
Spanish mackerel	Early juvenile, late juvenile, adult	Water column	Various fish species, crustaceans, gastropods, and squid

Source: GMFMC 1998

4.7.2 ABUNDANCE OF FEDERALLY MANAGED SPECIES IN THE VICINITY OF THE STUDY AREA

Spawning of shrimp occurs in offshore waters of the Gulf of Mexico. The larval populations are driven inshore by winds and currents. The various species have similar estuarine-dependent life history stages and vary seasonally in abundance. In the vicinity of the study area, adult white shrimp begin to appear in Lake Pontchartrain and Lake Borgne with a major peak of abundance beginning in August during the high salinity season and extending through the end of January. They are common in the spring as salinity decreases, and then begin to migrate back to the sea

during June when bay salinities begin to increase. In non-vegetated areas, post-larval and juvenile white shrimp inhabit mostly muddy substrates that contain large quantities of detritus. Sub-adult white shrimp move from the estuaries to coastal areas in late August and September (GMFMC, 1998).

Brown shrimp utilize the same nursery grounds as white shrimp during the juvenile growth period from the post-larval stage to the adult stage. Adult brown shrimp move offshore to reproduce. Near the study area, the juvenile brown shrimp population is highly abundant in estuarine waterbodies. (GMFMC, 1998)

Adult and juvenile red drum are common in the study area throughout the year. Most of the population spawns offshore and then moves inshore to fertile estuarine waters. Juveniles and young adults are common in Lake Pontchartrain; however, fully grown adults prefer the higher salinities along the coast. Seagrass and coastal marsh habitats typically serve as nursery areas for juvenile red drum (GMFMC, 1998)

Adult Spanish mackerel are not present in the study area, although juveniles have been identified in the region. It is likely that larval and post-larval fish are driven inshore by wind and currents.

4.8 WILDLIFE

The diversity and abundance of wildlife in the study area are dependent on the quality and extent of suitable habitat present. Much of the study area is located in urban areas with industrial, commercial, and residential uses. Areas along the current floodwalls, canals, shoreline, and inshore areas of the lakes present a different habitat for wildlife as compared to previously disturbed urban areas and borrow sites. Undeveloped area near the existing levee system are dominated by freshwater and brackish marsh and varying quality of forested wetlands that provide valuable food and shelter to a wide range of wildlife species. Figure 4-9 shows the various wildlife habitats in and within the vicinity of the study area and Table 4-11 summarizes the wildlife that commonly use these habitats. The bottomland hardwood forests, cypress-tupelo swamps, marshes, and tidal channels provide habitat for an abundance of birds, mammals, amphibians, and reptiles. The wetlands of coastal Louisiana fall within the Mississippi Flyway, a major migration corridor for the majority of all bird species found in North America, and provide critical nesting and breeding habitat for resident species.

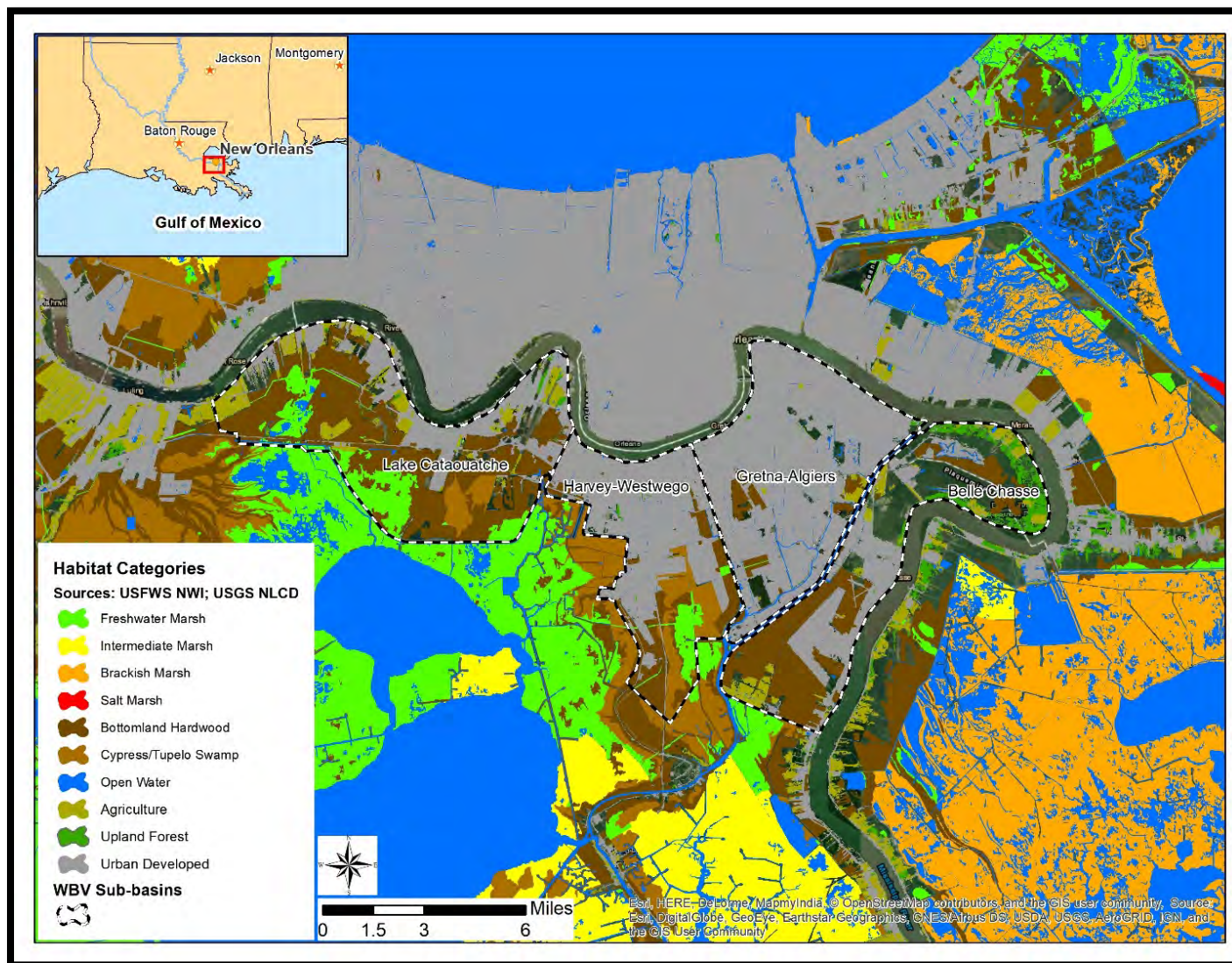


Figure 4-9. Wildlife Habitat Types in the Vicinity of the Study Area

Table 4-11. Wildlife Use of Habitat Found within the Vicinity of the Study Area

Habitat Type	Uses	Species
Freshwater Marsh/ Intermediate Marsh	Nesting and foraging habitat; nursery habitat	Wintering waterfowl; American alligator; wading birds; and fish
Bottomland Hardwood	Feeding, nesting, and escape habitat to numerous game and non-game species *disturbed by invasive Chinese tallow	Diversity of wildlife species; game and non-game species; important furbearers; songbirds; raptors; migratory and resident waterfowl; wading birds; woodpeckers; amphibians; reptiles
Cypress-Tupelo Swamp	Nesting, foraging, and cover habitat	Diversity of wildlife species; common wildlife species include: North American beaver (<i>Castor canadensis</i>), North American river otter (<i>Lontra canadensis</i>), nutria (<i>Myocastor coypus</i>), mud turtles (<i>Kinosternon</i> spp.), American alligator (<i>Alligator mississippiensis</i>), dabbling ducks, wading birds, and many other bird species
Open water (ponds, lakes, canals, estuaries, bayous, including SAV)	Feeding and foraging; adjacent sand spits and sand bars provide resting and roosting areas	Marine mammals and brown pelican (<i>Pelecanus occidentalis</i>) are known to occur in the inshore bays and estuaries. SAV provides important foraging habitat for numerous wildlife species.
Upland Forest	Breeding, wintering, and migratory habitats	Migratory non-game bird species; game and non-game mammals; gray fox (<i>Urocyon cinereoargenteus</i>); small mammals may include harvest mouse (<i>Reithrodontomys</i> spp.), hispid cotton rat (<i>Sigmodon hispidus</i>), old-field mouse (<i>Peromyscus polionotus</i>), and striped skunk (<i>Mephitis mephitis</i>).
Urban Developed	Low quality habitat	Common amphibians and reptiles include eastern garter snake (<i>Thamnophis sirtalis sirtalis</i>), Fowler's toad (<i>Bufo woodhousii fowleri</i>) and Gulf coast toad (<i>Bufo valliceps</i>). Mammals common to developed or urban habitats include raccoon (<i>Procyon lotor</i>), Virginia opossum (<i>Didelphis virginiana</i>), nine-banded armadillo (<i>Dasypus novemcinctus</i>), rabbits, grey squirrels (<i>Sciurus carolinensis</i>), mice, rats, and feral dogs and cats. Birds in this habitat type include the American crow (<i>Corvus brachyrhynchos</i>), songbirds, pigeons, and raptors.

4.8.1 BIRDS

The study area is located within the Mississippi Flyway. More than 325 bird species make the round-trip each year along this important migration route, from their breeding grounds in Canada and the northern United States to their wintering grounds along the Gulf of Mexico and in Central and South America (National Audubon Society, 2019).

Wetland game birds that occur in the study area include the wood duck (*Aix sponsa*), common snipe (*Gallinago gallinago*), and American woodcock (*Scolopax minor*). Non-game birds in the study area include many species of shorebirds, songbirds (both migratory and non-migratory), and wading birds.

Numerous rare migratory birds utilize study area habitats as stop-over points during migration (e.g., peregrine falcon). Other species of concern utilize the habitat for breeding and raising young (e.g., bald eagles).

The Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA) protect migratory birds. Any activity resulting in the “take” of migratory birds or eagles is prohibited unless authorized by USFWS. Twenty-six birds of conservation concern may be found within the study area (USFWS iPAC resource list; see Appendix G, *Environmental Compliance*).

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

In Louisiana, the bald eagle typically nests from October to mid-May. Following nesting activities in autumn, egg laying/incubation and hatching/rearing of young typically occur between autumn and spring, with fledging of young as early as January and typically by mid-May. Bald eagle nests typically are in bald cypress trees near fresh and brackish marshes or open water in southeastern Louisiana parishes.

4.8.2 MAMMALS

Common mammals found within the study area include: nutria (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), swamp rabbit (*Sylvilagus aquaticus*), cotton mouse (*Peromyscus gossypinus*), fox squirrel (*Sciurus niger*), and raccoon (*Procyon lotor*) (USACE, 2009a).

The study area supports a variety of game species including white-tailed deer (*Odocoileus virginianus*) and gray squirrel (*Sciurus carolinensis*) (USACE, 2009a).

4.8.3 AMPHIBIANS AND REPTILES

Common amphibians and reptiles use the study area, including frogs, toads, salamanders, lizards, turtles, and snakes. Amphibians likely to occur include the southern dusky salamander (*Desmognathus auriculatus*), dwarf salamander (*Eurycea quadridigitata*), central newt (*Notophthalmus viridescens louisianensis*), three-toed amphiuma (*Amphiuma tridactylum*), western lesser siren (*Sirens intermedia nettingi*), gulf coast toad (*Bufo valliceps*), and northern cricket frog (*Acris crepitans crepitans*) (USACE, 2009b). Reptiles likely to occur within the study

area include the common snapping turtle (*Chelydra serpentina*), green anole (*Anolis carolinensis*), broadhead skink (*Eumeces laticeps*), and western cottonmouth (*Agkistrodon piscivorous leucostoma*) (USACE, 2009b).

4.9 THREATENED AND ENDANGERED SPECIES

The USFWS provided a list of three federally-listed species that could potentially be found in the study area (St. Charles, Jefferson, Plaquemines, and Orleans Parishes, Louisiana) via a letter dated 3 September 2019 (Appendix G, *Environmental Compliance*). Federally-listed species include any plant or animal listed as endangered or threatened in the Endangered Species Act of 1973, as amended. *Endangered* species include any species that is in danger of becoming extinct. *Threatened* species include any species that is likely to become endangered in the foreseeable future. *Proposed* species include any species that is being reviewed by the USFWS for possible addition to the list of endangered and threatened species (see Appendix G, *Environmental Compliance*, for more details). Table 4-12 provides the list of threatened and endangered species that may occur in Orleans, Jefferson, St. Charles, and Plaquemines Parishes within the study area under USFWS and NMFS jurisdiction. Coordination documentation with both USFWS and NMFS is provided in Appendix G.

Table 4-12. Federally-listed Species Potentially Occurring in the Study Area

Species	Federal Status	Habitat	Potential to Occur in Study Area	Coordinating Agency
West Indian manatee (<i>Trichechus manatus</i>)	T	Open water	Yes	USFWS
Gulf Sturgeon (<i>Acipenser oxyrinchus desotoi</i>)	T	Inhabits coastal rivers from Louisiana to Florida during the warmer months and overwinters in estuaries, bays, and the Gulf of Mexico with sandy bottoms	Yes, in Plaquemines Parish; however, its range does not extend west of the Mississippi River.	NMFS
Pallid Sturgeon (<i>Scaphirhynchus albus</i>)	E	Missouri and Mississippi rivers and some tributaries from Montana to Louisiana	Yes, in Mississippi River, GIWW	USFWS

4.10 INVASIVE SPECIES (EXECUTIVE ORDER 13112)

Presidential Executive Order (EO) 13112 addresses the prevention of the introduction of invasive species and provides for the control and minimization of the economic, ecological, and human health impacts caused by invasive species. Table 4-13 summarizes invasive species found in or near the study area.

Table 4-13. Invasive Species Found in or near the Study Area

Group	Common Name	Scientific Name	Habitat
Amphibians-Frogs	Coastal Plain Toad	<i>Incilius nebulifer</i>	Freshwater
	Cane Toad	<i>Rhinella marina</i>	Freshwater
	Greenhouse Frog	<i>Eleutherodactylus planirostris</i>	Freshwater
	Cuban Tree Frog	<i>Osteopilus septentrionalis</i>	Freshwater
Crustaceans-Barnacles	Titan acorn barnacle	<i>Megabalanus coccopoma</i>	Marine
Crustaceans-Shrimp	Riverine Grass Shrimp	<i>Palaemonetes paludosus</i>	Freshwater
	Asian tiger shrimp	<i>Penaeus monodon</i>	Marine
Fishes	Rio Grande Cichlid	<i>Herichthys cyanoguttatus</i>	Freshwater
	Tilapia species	<i>Oreochromis sp.</i>	Freshwater
	Grass Carp	<i>Ctenopharyngodon idella</i>	Freshwater
	Common Carp	<i>Cyprinus carpio</i>	Freshwater
	Silver Carp	<i>Hypophthalmichthys molitrix</i>	Freshwater
	Bighead Carp	<i>Hypophthalmichthys nobilis</i>	Freshwater
	Sauger	<i>Sander canadensis</i>	Freshwater
	Rainbow Trout	<i>Oncorhynchus mykiss</i>	Freshwater
Mammals	nutria	<i>Myocastor coypus</i>	Freshwater
Mollusks-Bivalves	Asian clam	<i>Corbicula fluminea</i>	Freshwater
	Zebra Mussel	<i>Dreissena polymorpha</i>	Freshwater
Mollusks-Gastropods	Giant Apple Snail	<i>Pomacea maculata</i>	Freshwater
Plants	alligatorweed	<i>Alternanthera philoxeroides</i>	Freshwater
	Chinese tallow	<i>Triadica sebifera</i>	Forest; Swamp edges
	Cogon grass	<i>Imperata cylindrical</i>	Sandy soils with low nutrients; non-cultivated areas; areas with some disturbance
	Kudzu	<i>Pueraria lobata</i>	Any
	Tidal marsh amaranth	<i>Amaranthus cannabinus</i>	Brackish
	Dotted duckweed	<i>Landoltia punctata</i>	Freshwater
	Water lettuce	<i>Pistia stratiotes</i>	Freshwater
	Marsh dew flower	<i>Murdannia keisak</i>	Freshwater
	Cuban bulrush	<i>Cyperus blepharoleptos</i>	Freshwater
	Small flower umbrella sedge	<i>Cyperus difformis</i>	Freshwater
	Parrot feather	<i>Myriophyllum aquaticum</i>	Freshwater
	Eurasian water milfoil	<i>Myriophyllum spicatum</i>	Freshwater-Brackish

Group	Common Name	Scientific Name	Habitat
	Brazilian waterweed	<i>Egeria densa</i>	Freshwater
	hydrilla	<i>Hydrilla verticillata</i> [dioecious]	Freshwater
	duck-lettuce	<i>Ottelia alismoides</i>	Freshwater
	yellow floating-heart	<i>Nymphoides peltata</i>	Freshwater
	large-flower primrose-willow	<i>Ludwigia grandiflora</i>	Freshwater
	Air potato	<i>Dioscorea bulbifera</i>	Disturbed habitats
	Marsh weed	<i>Limnophila x ludoviciana</i> [indica x sessiliflora]	Freshwater
	rice	<i>Oryza sativa</i>	Freshwater
	Floating water hyacinth	<i>Eichhornia crassipes</i>	Freshwater
	Triangle water fern	<i>Ceratopteris richardii</i>	Freshwater
	water spangles	<i>Salvinia minima</i>	Freshwater
	giant salvinia	<i>Salvinia molesta</i>	Freshwater
	narrow-leaved cattail	<i>Typha angustifolia</i>	Freshwater
Insect	Asian Tiger Mosquito	<i>Aedes albopictus</i>	Artificial and natural containers with water
	Formosan Termite	<i>Coptotermes formosanus</i>	Wooden structures, trees, insulation
	Red Imported Fire Ant	<i>Solenopsis invicta</i>	Open, sunny areas
	Roseau Cane Scale	<i>Nipponaclerda biwakoensis</i>	Freshwater-Marine
Online Sources: Accessed 6 March 2019; http://is.cbr.tulane.edu/InvasiveSpecies.html ; https://nas.er.usgs.gov/queries/huc6_us.aspx ; https://www.lsuagcenter.com/topics/environment/invasive%20species			

4.11 CULTURAL AND HISTORICAL RESOURCES

The National Historic Preservation Act of 1966 (Public Law 89 80 655), as amended; NEPA of 1969 (Public Law 91-90), as amended; and other applicable laws and regulations require federal agencies to take into account the effects of their undertaking on the environment and any significant cultural resources, defined as historic properties, within the project area of the proposed undertaking, as well as its area of potential effects (APE). Typically, studies to inventory existing conditions require archival searches and field surveys to identify any cultural resources. When significant sites are recorded, efforts are made to minimize adverse effects and preserve the site(s) in place. If any significant sites cannot be avoided and would be adversely impacted, an appropriate mitigation plan would be implemented to recover data that would be otherwise lost due to the proposed undertaking.

For HSDRRS planning and construction, USACE completed studies of the potentially significant historic properties in the areas that would have been impacted by work associated with HSDRRS corridors. This required background historical research of the study area and identification of previous cultural surveys and known historic properties to assess the areas of probability for cultural resources. Phase I cultural resource surveys were conducted in the form of pedestrian surface surveys with systematic shovel test pit excavations and delineations of site boundaries, when necessary. Where applicable, Phase II site evaluations were conducted for assessing the National Register of Historic Places (NRHP) eligibility. In all cases, the cultural resource survey areas exceeded the size of the preliminary APE, which allowed the USACE project archaeologists to adjust the APE, as needed, to avoid any damage to historic properties with potential eligibility for the NRHP.

Identified significant cultural resources within the project area range from the prehistoric to the historic periods of occupation. No significant cultural resources are known to exist within the WBV area in St. Charles Parish. Within Jefferson Parish, one historic structure was previously identified, a late 18th century house. The structure was determined to be ineligible for the NRHP. One site was previously identified within Plaquemines Parish, site 16PL169 the Mahoney-Crouere Site. It is a historic shell midden dating between the mid-19th and late 20th century. 16PL169 was determined to be ineligible for the NRHP.

The Jean Lafitte National Historic Park and Preserve (JLNHPP) also exists within the study area. It is comprised primarily of five distinct types of historic resources: prehistoric shell piles; colonial roads, ditches, and settlements; nineteenth century sugar plantations; a nineteenth and twentieth century logging canal; and an early twentieth century subdivision and pecan-grove.

For the HSDRRS construction, in letters sent to the Louisiana SHPO and THPOs of the 12 federally recognized tribes with an interest in the region, the study team provided project documentation, evaluated cultural resources potential in the project area, and found that the HSDRRS actions had no impact on historic properties with the implementation of the USACE avoidance measures. Section 106 consultation for the HSDRRS projects was then concluded.

Through avoidance, minimization, monitoring and other mitigation, there were no known direct and long-term impacts to cultural resources as a result of the HSDRRS projects. Implementation of the HSDRRS projects had beneficial indirect impacts by providing an added level of flood risk reduction to known and unknown archaeological sites in the project vicinity on the protected side of the levees, thereby reducing the damage caused by flood events. Erosion of ground deposits during flood events can result in severe damage and destruction of archaeological sites.

A comprehensive summary of these studies, identified cultural resources, and previous Section 106 consultation for HSDRRS construction are presented in IERs #12, #13, #14, #15, #16, #17, and #33 and compiled and summarized in the Comprehensive Environmental Document Phase 1 and are incorporated herein by reference (USACE, Comprehensive Environmental Document, Phase I, Greater New Orleans Hurricane and Storm Damage Risk Reduction System, 2013). <https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/>.

4.12 AESTHETICS (VISUAL)

Environmental assessments and impact statements for USACE planning studies are supposed to focus on significant environmental considerations as recognized by technical, institutional and

public sources. The Visual Resources Assessment Procedure for USACE (VRAP) (Smardon, et al., 1988) provides a method to evaluate visual resources affected by USACE water resources projects. The following VRAP criteria are used to identify significant visual resource considerations in the study area:

1. Important urban landscapes including visual corridors, monuments, sculptures, landscape plantings, and green space.
2. Area is easily accessible by a major population center.
3. Project is highly visible and/or requires major changes in the existing landscape.
4. Areas with low scenic quality and limited visibility.
5. Historic or archeological sites designated as such by the National Register or State Register of Historic Places.
6. Parkways, highways, or scenic overlooks and vistas designated as such by a federal, state, or municipal government agency.
7. Visual resources that are institutionally recognized by federal, state or local policies.
8. Tourism is important in the area's economy.
9. (USACE, Comprehensive Environmental Document, Phase I, Greater New Orleans Hurricane and Storm Damage Risk Reduction System, 2013)Area contains parks, forest preserves, or municipal parks.
10. Wild, scenic, or recreational water bodies designated by government agencies.
11. Publically or privately operated recreation areas.

Much of the WBV corridor is currently comprised of levees, floodwalls, floodgates, and other development that reduces the visual appeal and interrupt the line of sight between the urban environment on the protected side and the natural environment on the flood side. Significant visual resources in the study area include the Jean Lafitte National Historical Park and Preserve and the Salvador/Timken Wildlife Management Area. Visually, the WBV corridor is characterized by a natural landscape that has been altered by rural and urban development. There are several parks located throughout the corridor, such as Marrero Park and the Bayou Segnette State Park that offers various recreational facilities including boat launches and cabins. The undeveloped landscape of the WBV corridor includes numerous bayous, small ponds, swamp, marsh, lakes, and other waterways. Lakes Cataouatche and Salvador offer open vistas surrounded by fresh and brackish water marsh.

Construction of the HSDRRS WBV and excavation of borrow sites had short-term adverse impacts to visual resources in the project area. After construction, the project corridor returned, to the maximum extent practicable, to pre-construction conditions. Direct long-term impacts on visual resources from the construction of the WBV were negligible.

These significant visual resource considerations in the study area are described in the Aesthetics, Cultural, and Recreation Resources sections of the CED Phase I (USACE, 2013) and are incorporated herein by reference.

(<https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/Comprehensive-Environmental-Document/>).

4.13 RECREATIONAL RESOURCES

This resource is institutionally significant because of the Federal Water Project Recreation Act of 1965 (P L 89-72), as amended, and the Land and Water Conservation Fund Act of 1965 (P L 88-578), as amended. Recreational resources are technically significant because of the high

economic value of recreational activities and their contribution to local, state, and national economies. Recreational resources are publicly significant because the public's utilization of parks, outdoor spaces, and other leisure activities improves quality of life and community interactions. The value the public places on recreational resources such as boating, fishing, and hunting can be directly measured by the large number of fishing and hunting licenses sold in Louisiana and the large number of recreational boat registrations per capita. Additionally, many levee segments in the WBV project area provide recreational opportunities for walking, running, and bicycling.

Recreational resources in the WBV study area are primarily limited to parks and activities such as fishing, hiking, dog-walking, running along the levee trails, and hunting in the marshes located within this sub-basin and vicinity. Lakes Salvador and Cataouatche and the Salvador/Timken WMA, just outside of the WBV study area, are popular destinations used locally for recreational boating and fishing. Numerous boat launches in the region provide direct access to estuarine water bodies.

The Jean Lafitte National Historic Park and Preserve (JLNHPP) is located adjacent to the Belle Chasse, Gretna-Algiers, and Harvey Westwego sub-basins and just outside of the HSDRRS. The JLNHPP provides a wide range of recreational opportunities for visitors that include bird watching, wildlife viewing, hunting, hiking, canoeing, biking, picnicking, and photography, as well as water-oriented sports like fishing, waterfowl hunting, and boating.

Bayou Segnette State Park is located in the WBV project area. A 580-acre park, Bayou Segnette State Park provides access to water-based recreation amenities such as boat launches, fishing piers, an outdoor swimming pool, and a wave pool (Louisiana Dept of Culture, Recreation, & Tourism, 2019). Both saltwater and freshwater recreational fishing are available within and near the park. Canals and borrow pits contain fish and shellfish that are important to recreational fishing. Wetlands in the study area provide habitat for recreationally harvested red swamp crawfish. There are also picnic sites, playgrounds, wildlife viewing areas, and overnight facilities at the park. Overnight facilities include campsites, waterfront cabins, a group camp site with dormitories, and a meeting room. Bayou Segnette provides boat access from the West Bank to Lake Cataouatche and Lake Salvador and the Barataria Basin. Lake Salvador and JLNHPP are south of the study area.

Hero Canal and the GIWW are used infrequently for recreational fishing, boating, water skiing, crabbing, and swimming. Both sides of Hero Canal near LA 23 are dedicated to industrial and heavy commercial activities that do not invite public access, but it is possible to walk on the WBV-12 levee from the floodgate west to the GIWW. Bank fishing in this area is possible.

4.14 AIR QUALITY

The USEPA sets national air quality standards for six common pollutants. These standards, known as National Ambient Air Quality Standards (NAAQS), include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM) 2.5, PM 10, and sulfur dioxide. Areas where air quality conditions violate these standards are classified as “non-attainment” and are subject to special air quality controls. As of December 2018, the study area (Orleans, St. Charles, Jefferson, and Plaquemines Parishes) is in attainment for all NAQs. Table 4-14 provides ambient air pollution levels in Jefferson Parish and similar levels are found in Orleans, St. Charles, and Plaquemines Parishes (USEPA, 2019).

Table 4-14. Ambient Air Pollution Levels in Jefferson Parish

Pollutant	Concentration	Standard Limit
Nitrogen Dioxide	0.01 ppm	0.053 ppm
Lead	0.13 µg/m ³	1.5 µg/m ³
Ozone (1-hour)	0.10 ppm	0.12 ppm
Ozone (8-hour)	0.08 ppm	0.08 ppm
Source: (USACE, 2009a) http://www.city-data.com/county/Jefferson_Parish-LA.html Accessed on 10 Jan 2019		

The General Conformity Rule (40 CFR Part 93) ensures that the actions taken by federal agencies in nonattainment and maintenance areas do not interfere with a state's plans to meet national standards for air quality. A conformity determination evaluates whether a federal action meets the requirements of the general conformity rule and must be performed when a federal action generates air pollutants that would exceed conformity threshold ("de minimis") levels in a region designated as a non-attainment or maintenance area for one or more NAAQS. It requires the responsible federal agency to evaluate the nature of the proposed action and associated air pollutant emissions, calculate emissions as a result of the proposed action, and if de minimis thresholds would be exceeded, the agency must prepare a general conformity determination demonstrating that project emissions would meet the requirements of the General Conformity Rule and would conform to the relevant state implementation plan before the action will be allowed to proceed. If the agency's projected emissions would not exceed de minimis levels, a conformity determination is not required.

4.15 NOISE

Noise is generally described as unwanted sound, which can be based either on objective effects (i.e., hearing loss, damage to structures, etc.) or subjective judgments (e.g., community annoyance). Sound is usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as sound level. The threshold of human hearing is approximately 3 dB, and the threshold of discomfort or pain is around 120 dB. Sound levels are typically expressed as A-weighted dB (dBA), which describes the relative loudness of sounds as perceived by the human ear.

Noise levels occurring at night generally produce a greater annoyance than do the same levels occurring during the day. People generally perceive intrusive noise at night as being 10 dBA louder than the same level of noise during the day. This perception is largely because background environmental sound levels at night in most areas are also about 10 dBA lower than those during the day. Noise levels are computed over a 24-hour period and adjusted for nighttime annoyances to produce the day-night average sound level (DNL). DNL is the community noise metric recommended by the USEPA and adopted by most federal agencies (USEPA 1974). The U.S. Department of Housing and Urban Development (HUD) established acceptable DNL noise levels for construction activities in residential areas (HUD, 1984):

- **Acceptable (not exceeding 65 dBA)** – The noise exposure may be of some concern, but common building construction will make the indoor environment acceptable, and the outdoor environment will be reasonably pleasant for recreation and play.

- **Normally Unacceptable (above 65 dBA but not greater than 75 dBA)** – The noise exposure is significantly more severe; barriers may be necessary between the site and prominent noise sources to make the outdoor environment acceptable; special building construction may be necessary to ensure that people indoors are sufficiently protected from outdoor noise.
- **Unacceptable (greater than 75 dBA)** – The noise exposure at the site is so severe that the construction costs to make the indoor noise environment acceptable may be prohibitive, and the outdoor environment would still be unacceptable.

A DNL of 65 dBA is the impact threshold most commonly used for noise planning purposes and represents a compromise between community impact and the need for activities like construction. USEPA identified a DNL of 55 dBA as a level below which there is no adverse impact (USEPA, 1974).

There are no noise ordinances at the state level; however, there are noise ordinances at the local level. The maximum permissible sound levels by land use category are outlined in Table 4-15 for each parish in the study area. Sounds generated from construction and demolition activities are exempt from the New Orleans ordinance between 7:00 am and 6:00 pm (11:00 pm for areas other than residential; Chapter 66 Article IV New Orleans Municipal Code). In Jefferson Parish, industrial sound level limits apply to construction activity for all land use categories. In addition, the Jefferson Parish ordinance specifically prohibits the operation of any construction equipment within 300 feet of any residential or noise-sensitive area between 9:00 pm and 7:00 am Monday through Saturday, and 9:00 pm and 8:00 am on Sundays and holidays, except for emergency work (Section 20-102 Jefferson Parish Municipal Code).

Table 4-15. Noise Level Limits by Land Use Category in Study Area Parishes

Receiving Land Use Category	Time	Maximum Permissible Sound Level Limit dB(A)			
		St. Charles ¹	Jefferson ²	Plaquemines ³	Orleans ⁴
Residential & Public Space	7:00am - 10:00pm	50	60	60	70
	10:01pm – 6:59am	45	55	55	60
Commercial	7:00am - 10:00pm	65	65	65	75
	10:01pm – 6:59am	60	60	60	65
Industrial	At all times	-	-	75	-
¹ Chapter 24 Section 24-4 St. Charles Municipal Code; ² Section 20-102 Jefferson Parish Municipal Code, ³ Section 17-133 Plaquemines Parish Municipal Code, ⁴ Chapter 66 Article IV New Orleans Municipal Code					

4.16 TRANSPORTATION

The study area is near the Gulf of Mexico, Mississippi River, major highways, bridges, ports, international airport, U.S. Naval Air Station Reserve Base in Belle Chasse, and numerous rail lines. **Figure 4-10** shows the primary transportation network in the study area. Table 4-16 summarizes the major roadways, waterways, and air transportation in the vicinity of the study area.

Interstate 10 (I-10), an east-west bi-coastal thoroughfare, connects Houston and Baton Rouge, crosses the northern part of the study area, and is a primary route for hurricane evacuation and post-storm emergency response. US-90, another evacuation and emergency response route, is located south of I-10.

The Louis Armstrong New Orleans International Airport is in the vicinity of the study area and is the primary commercial airport for the New Orleans area.

The Regional Transit Authority provides public transit within the New Orleans area. There are 34 bus routes, five streetcar lines, and two ferry routes that provide more than 19 million rides per year (New Orleans Regional Transit Authority, 2019). The streetcars have been an integral part of New Orleans public transportation network since 1923. There are also several taxi cab companies that offer cab service, vehicles for hire, delivery service, and ground transportation.

Table 4-16. Transportation Within the Vicinity of the Study Area

<u>Major Highways & Interstates:</u> US 90, US 61, Interstate 10, LA 18, LA 45, LA 23, LA 406
<u>Local Roads:</u> Lapalco Boulevard, Engineers Road, Barriere Road, Peters Road, Destrehan Avenue, Walker Road, Buccaneer Road, East Bayou Road
<u>Waterways:</u> Mississippi River, GIWW, Algiers Canal, Harvey Canal
<u>Port:</u> Port of New Orleans
<u>Bridges:</u> Intracoastal Waterway Bridge, Belle Chasse Bridge and Tunnel, Lapalco Bridge
<u>Airports:</u> Louis Armstrong International Airport; U.S. Naval Air Station Joint Reserve Base New Orleans; New Orleans Lakefront Airport

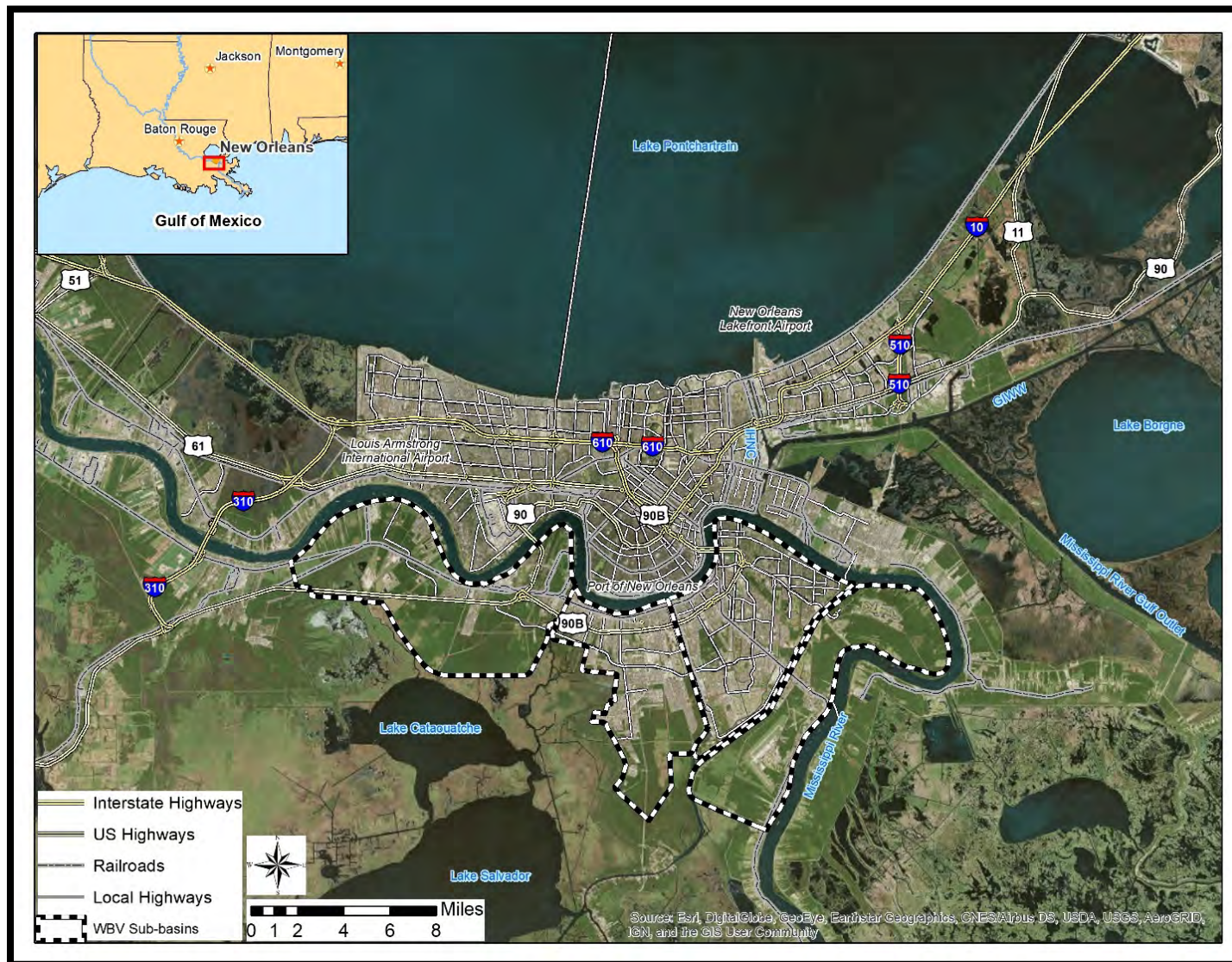


Figure 4-10. Locations of Transportation Systems in the Study Area

4.17 HUMAN ENVIRONMENT

The study area encompasses the entirety of the four parishes, Jefferson, Plaquemines, Orleans, and St. Charles. The parish seats are Gretna, Point a la Hache, New Orleans and Hahnville, respectively.

4.17.1 POPULATION & HOUSING

Table 4-18 and Figure 4-11 show the population trend in the four-parish area and state of Louisiana from 1970 to 2010 and projections through 2040. The U.S. Census Bureau predicts the state-wide population will rise over this period.

Table 4-17. Population Trends in the Study Area*, Total Population in Thousands

Parish	Year							
	1970	1980	1990	2000	2010	2020	2030	2040
Jefferson	338.75	456.62	448.57	454.94	432.75	447.04	466.71	478.88
Orleans	594.38	558.43	495.74	485.61	347.90	399.23	416.80	427.67
Plaquemines	25.26	26.13	25.53	26.76	23.12	24.07	25.13	25.79
St. Charles	29.60	37.52	42.47	48.12	52.84	54.12	56.50	57.97
State of Louisiana	3,650.20	4,226.70	4,221.53	4,471.89	4,545.00	4,732.42	4,816.69	4,868.18
U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast								

*Population data is presented by parish. Population trends are expected to continue through the end of the planning period.

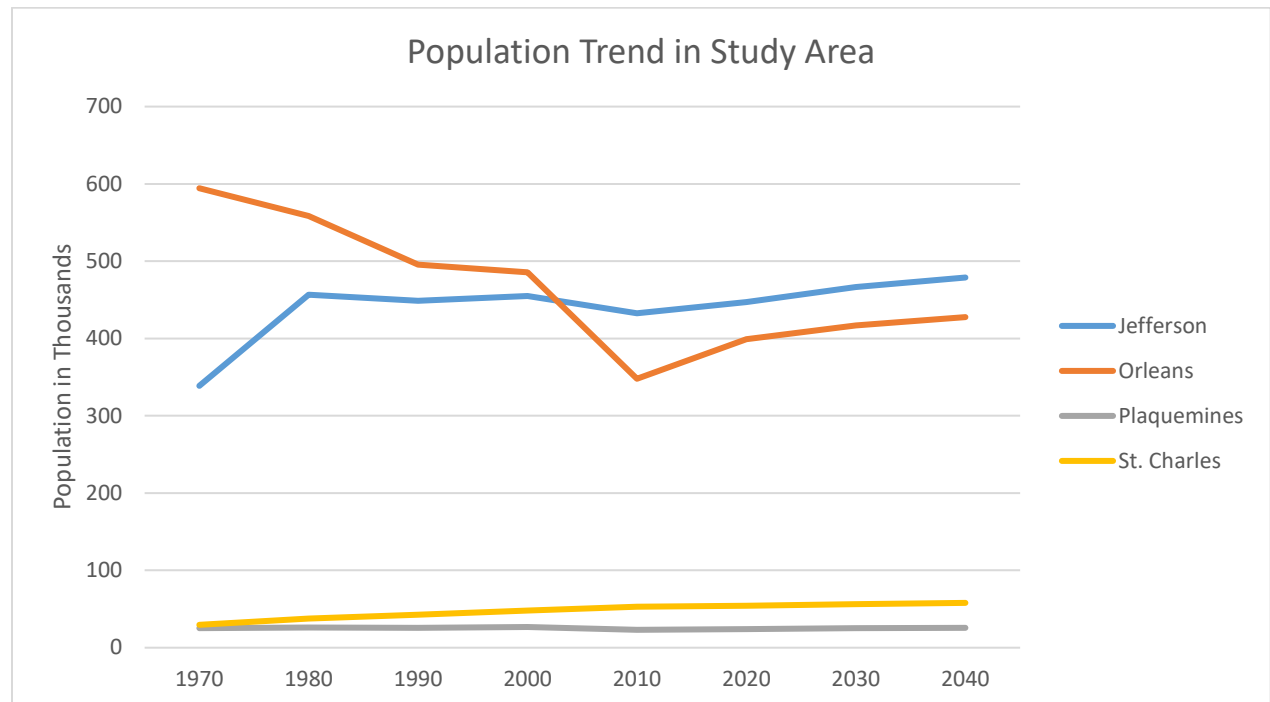


Figure 4-11. Total Population Trends for Study Area Parishes

The trend in household formation, shown in Table 4-19, is predicted to level off by 2020 and show a slight growth through the year 2040.

Table 4-18. Number of Households in the Study Area*, Total Number in Thousands

Parish	Year							
	1970	1980	1990	2000	2010	2020	2030	2040
Jefferson	95.75	156.40	166.50	176.41	169.89	184.40	201.34	213.79
Orleans	191.46	206.80	187.79	189.02	143.98	173.18	188.68	200.03
Plaquemines	6.54	7.78	8.20	9.04	8.11	8.93	9.79	10.44
St. Charles	7.59	11.57	14.35	16.47	18.60	20.12	22.08	23.52
State of Louisiana	1,053.61	1,418.77	1,499.82	1,660.62	1,734.57	1,887.22	2,010.60	2,104.10

U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast

*Household data is presented by parish. Population trends are expected to continue through the end of the planning period.

4.17.2 EMPLOYMENT, BUSINESS, AND INDUSTRIAL ACTIVITY

Table 4-20 shows the growth of non-farm employment and leading employment sectors within the study area from 1970 to 2040. The leading employment sectors are Trade, Transportation, & Utilities; Government, Local Government; and Office-using Industries. The unemployment rate in all four parishes is generally higher than the state of Louisiana unemployment rate.

Table 4-19. Employment within the Study Area.

Industry	Employment, in thousands of people, by year*							
	1970	1980	1990	2000	2010	2020	2030	2040
Total Non-Farm	342.17	496.33	477.74	530.53	419.15	467.54	498.39	536.32
Trade, Transportation, & Utilities	103.51	130.27	117.76	106.99	81.09	93.36	101.80	111.26
Government	45.07	71.29	68.06	86.19	62.66	54.35	62.60	70.66
Local Government	21.84	33.89	32.76	48.17	32.61	31.74	38.30	44.79
Office-using Industries	56.30	86.87	99.92	111.69	74.43	104.76	104.95	106.84

U.S. Bureau of Labor Statistics; Census Employment & Wages (QCEW-ES202); Moody's Analytics (ECCA) Forecast

*Employment trends are expected to continue through the end of the planning period.

4.17.3 PUBLIC FACILITIES & SERVICES

Public facilities and services have historically grown to meet population demands. The area includes a mixture of community centers, schools, hospitals, airports, colleges, and fire protection.

4.17.4 COMMUNITY & REGIONAL GROWTH (INCOME)

Community and regional growth primarily track population and employment trends that were described in the preceding sections. Table 4-21 shows per capita growth in income since 1970 and predictions through the year 2040. Per capita income has been steadily increasing since the 1970 and is predicted to continue that trend.

Table 4-20. Per Capita Income* (\$) within the Study Area

Parish	Year							
	1970	1980	1990	2000	2010	2020	2030	2040
Jefferson	\$3,962	\$10,427	\$18,086	\$28,376	\$42,033	\$53,808	\$75,451	\$111,512
Orleans	\$3,774	\$9,553	\$17,500	\$26,386	\$41,769	\$53,296	\$76,039	\$112,316
Plaquemines	\$3,189	\$9,659	\$15,589	\$21,536	\$42,074	\$52,930	\$74,587	\$109,724
St. Charles	\$3,188	\$10,462	\$16,908	\$24,634	\$39,557	\$53,117	\$77,117	\$117,900
State of Louisiana	\$170,960	\$477,970	\$878,524	\$1,295,073	\$2,123,377	\$2,842,042	\$4,017,923	\$5,786,992
U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast								

*Income data is presented by parish. Income trends are expected to continue through the end of the planning period.

4.17.5 TAX REVENUE & PROPERTY VALUES

Historically, damages from storm surge events have adversely impacted business and industrial activity, agricultural activity, and local employment and income, which then led to proportionate negative impacts to property values and the tax base upon which government revenues rely.

4.17.6 COMMUNITY COHESION

Community cohesion is based on the characteristics that keep the members of the group together long enough to establish meaningful interactions, common institutions, and agreed-upon behaviors. These characteristics include race, education, income, ethnicity, religion, language, and mutual economic and social benefits. The study area is comprised of communities with a long history and long-established public and social institutions including places of worship, schools, and community associations.

4.18 ENVIRONMENTAL JUSTICE

An Environmental Justice (EJ) analysis focuses on the potential for disproportionately high and adverse impacts to minority and low-income populations during the construction and normal operation of the federal action – in this case, the proposed levee lifts to segments of the HSDRRS. The EJ assessment identified the minority and low-income communities in nine communities that are part of the study area, as shown in Table 4-22. An impacts assessment identifies EJ communities near project alternative alignments and compares the minority and low-income population to the Parish reference community and determines if any high, adverse impacts are disproportionate. Additionally, if the impact is appreciably more severe or greater in magnitude on minority or low-income populations than the adverse effect suffered by the non-minority or non-low-income populations after taking offsetting benefits into account, then there may be a disproportionate finding. If disproportionately high and adverse effects were identified, the agency would address those effects to the extent practicable through avoidance and/or mitigation..

Methodology Environmental Justice is institutionally significant because of Executive Order 12898 of 1994 (E.O. 12898) and the DoD's Strategy on Environmental Justice of 1995, which direct federal agencies to identify and address any disproportionately high adverse human health or environmental effects of federal actions to minority and/or low-income populations. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, Pacific Islander, some other race, or a combination of two or more races. A minority population exists where the percentage of minorities in an

affected area either exceeds 50 percent or is meaningfully greater than in the general population. Low-income populations as of 2019 are those whose income are below \$25,750 for a family of four and are identified using the Census Bureau's statistical poverty threshold. The Census Bureau defines a "poverty area" as a census tract or block group with 20 percent or more of its residents below the poverty threshold and an "extreme poverty area" as one with 40 percent or more below the poverty level. This resource is technically significant because the social and economic welfare of minority and low-income populations may be positively or disproportionately impacted by the proposed actions. This resource is publicly significant because of public concerns about the fair and equitable treatment (fair treatment and meaningful involvement) of all people with respect to environmental and human health consequences of federal laws, regulations, policies, and actions.

The methodology to accomplish an EJ analysis, consistent with E.O. 12898, includes identifying low-income and minority populations within the study area using up-to-date economic statistics, aerial photographs, U.S. Census Bureau decennial data, and the 2015-2019 American Community Survey (ACS) estimates, as well as conducting community outreach activities such as public meetings. The analysis also includes information on Limited English Proficiency (LEP) populations in the study area in order to comply with Executive Order 13166. Executive Order 13166 requires federal agencies to examine the services they provide, identify any need for services to LEP communities, and develop and implement a system to provide those services so LEP communities can have meaningful access. The U.S. Census Bureau defines a limited English speaking household as one in which all members 14 years old and over have at least some difficulty with English. The ACS estimates provide the latest socioeconomic community characteristics, including minority and poverty level data and English proficiency, released by the U.S. Census Bureau and are based on data collected between January 2015 and December 2019.

The U.S. Census Bureau identifies and provides demographic data on nine cities or Census Designated Places in the WBV study area. The WBV study area includes the cities of Westwego and Gretna and seven Census Designated Places including Avondale, Marrero, Estelle, Woodmere, Harvey, Terrytown, and Timberlane. The largest community in terms of population is Marrero followed by Terrytown. Six of the communities have a majority minority population identifying as Black/African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races. Most of the minority population identifies as Black/African American. Hispanic ethnicity is between 3.5 percent and 23.8 percent of total population.

All nine of the communities in the study area are located in Jefferson Parish. Approximately 37 percent of Jefferson Parish residents identify as being a minority; most minorities are Black or African American, while about 14 percent of the Jefferson Parish population are Hispanic or Latino ethnicity.

Three of the nine communities in the study area, including Westwego, Marrero, and Terrytown have 20 percent or more of individuals living below the poverty level, which in 2019 is \$25,750 for a family of four. Less than 20 percent of the population lives below the poverty level in Avondale, Estelle, Gretna, Harvey, Woodmere, and Timberlane (Table 4-25).

LEP households are below 10% in all communities within the study area. Terrytown, Avondale, and Gretna have the highest rates of LEP with 9.4%, 8.3%, and 6.9%, respectively. Less than

6% of households in Westwego, Marrero, Estelle, Woodmere, Harvey, and Timberland are LEP households.

Table 4-21. Total Population and Racial/Ethnic/LEP Composition of Communities in the WBV Study Area

Subject	Avondale	Westwego City	Marrero CDP	Estelle CDP	Woodmere CDP	Harvey CDP	Gretna City	Terrytown CDP	Timberland CDP	Jefferson Parish
Total Population	5,321	8,438	30,894	17,968	10,173	21,054	17,774	24,953	9,950	434,850
RACE										
One race	99.8%	98.2%	97.7%	96.5%	97.0%	98.7%	98.4%	95.3%	96.5%	97.8%
White	47.3%	61.9%	40.8%	56.7%	13.1%	37.8%	53.4%	39.9%	43.7%	62.4%
Black or African American	35.4%	27.5%	50.4%	26.6%	78.8%	51.6%	36.0%	39.4%	40.9%	27.0%
American Indian and Alaska Native	0.0%	1.4%	0.5%	0.2%	0.2%	0.2%	0.3%	1.2%	0.1%	0.4%
Asian	15.9%	4.4%	5.2%	6.2%	4.0%	0.0%	1.9%	3.1%	7.2%	4.2%
Native Hawaiian and other Pacific Islander	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Some other race	1.2%	2.9%	0.8%	6.6%	0.9%	4.1%	6.8%	11.7%	4.5%	3.8%
Two or more races	0.2%	1.8%	2.3%	3.5%	3.0%	1.3%	1.6%	4.7%	3.5%	2.2%
Minority	52.7%	38.0%	59.2%	43.2%	86.9%	57.2%	46.7%	60.1%	56.2%	37.6%
HISPANIC OR LATINO										
Total population	5,321	8,438	30,894	17,968	10,173	21,054	17,774	24,953	9,950	434,850
Hispanic or Latino (or any race)	9.0%	7.4%	4.9%	12.3%	3.5%	9.5%	16.0%	23.8%	10.6%	14.5%
LIMITED ENGLISH PROFICIENCY										
All households	1,729	3,265	11,660	5,700	3,536	8,119	7,156	8,609	3,441	169,452
Limited English-speaking Households	8.3%	2.8%	2.5%	5.5%	1.8%	5.1%	6.9%	9.4%	4.6%	5.5%

Source: U.S. Census Bureau 2019 ACS.

Table 4-22. Persons Living Below Poverty Level in Communities in WBV Study Area

Place	Estimate*	Below Poverty Level	Percent Below Poverty Level
Avondale CDP	5,278	782	14.8%
City of Westwego	8,417	2,381	28.3%
Marrero CDP	30,570	6,423	21.0%
Estelle CDP	17,968	2,573	14.3%
Woodmere CDP	10,173	1,965	19.3%
Harvey CDP	20,805	3,454	16.6%
City of Gretna	16,743	2,972	17.8%
Terrytown CDP	24,921	5,696	22.9%
Timberland CDP	9,888	846	8.6%
*Population for whom poverty status is determined			

Source: U.S. Census Bureau 2019 ACS.

The HSDRRS CED Phase I study identifies EJ communities and EJ resource impacts from construction of the HSDDRS for WBV and those findings are incorporated into this analysis. The USACE New Orleans District website provides the IERs, the CED report and the EJ analysis for the five parish HSDRRS study area (USACE, 2019). The following is a brief summary of the EJ findings presented in the CED Phase I report.

The WBV levee alignment passes through Orleans, Jefferson, Plaquemines and St. Charles Parishes. In Orleans Parish, the WBV corridor abuts low-income and minority communities including the Forest Isle neighborhood on both sides of Woodlawn Highway. IER 12 discusses EJ communities in Orleans Parish. The levee corridor in Jefferson Parish is assessed in IER #12, and includes one EJ community near the proposed levee work along Peters Road. However, most of the IER #12 levee corridor is adjacent to industrial or undeveloped land in Jefferson Parish. Continuing through Jefferson Parish, the levee corridor is adjacent to the Estelle community near Barataria and Ames Boulevards, which is identified as an EJ community and discussed in IER #14. The remainder of the levee corridor segment in Jefferson Parish, discussed in IER #15 and #16, is located in undeveloped sections that are removed from residential areas. Finally, the CED Phase I report and IER 13 describes EJ communities in Plaquemines Parish, including the Oakville community along the levee corridor crossing LA Highway 23.

The WBV MRL segments in Orleans and Plaquemines Parishes that are not discussed in the CED Phase I report pass adjacent to communities in Belle Chase and Algiers. Belle Chasse is a Census Designated Place (CDP) and as a whole is not an EJ community. According to EPA's EJSCREEN demographic tool which provides data for small geographic areas, it is very likely that neighborhoods located adjacent to the levee segments in Belle Chase are low-income or minority areas. Low-income and minority data is not available for the community of Algiers. The parish seat, Orleans, is low-income and consists of a majority of residents identifying as minority. Specifically, the levee segment passing near Aurora Gardens and Old Algiers are EJ communities. EJ neighborhoods are near the proposed MRL lifts and all of the levee improvements that are on the protected side will be completed within the existing ROW.

Table 4-23. WBV MRL Minority/LEP Population

Subject	Orleans Parish*	Belle Chasse CDP
Total Population	390,845	14,024
Minority	66.1%	20.6%
HISPANIC OR LATINO		
Hispanic or Latino (of any race)	5.5%	10.5%
LIMITED ENGLISH PROFICIENCY		
All households	153,819	5,099
Limited English-speaking households	2.0%	1.2%
*Algiers is located in Orleans Parish. Data is not available for Algiers		

Note: Red font identifies minority population exceeding 50 percent, which is an Indicator of an EJ community.

Source: 2019 U.S. Census Bureau ACS.

Table 4-24. WBV MRL Low-Income Population

Place	Estimate*	Below Poverty Level	Percent Below Poverty Level
Orleans Parish**	377,695	89,340	23.7%
Belle Chasse CDP	13,863	1,562	11.3%
*Population for whom poverty status is determined			
**Data not available for Algiers; therefore Orleans Parish is shown			

Note: Red font identifies low-income population exceeding 20 percent, which is an Indicator of an EJ community.

Source: 2019 U.S. Census Bureau ACS.

4.19 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

USACE regulations (ER 1165-2-132 and ER 200-2-3) require procedures be established to facilitate early identification and appropriate consideration of potential HTRW in feasibility, preconstruction engineering and design, land acquisition, construction, operations and maintenance, repairs, replacement, and rehabilitation phases of water resources studies or projects by conducting HTRW Phase I Environmental Site Assessments (ESAs). USACE specifies that these assessments follow the process/standard practices for conducting Phase I ESAs published by the American Society for Testing and Materials (ASTM). This assessment was prepared using the following ASTM Standards:

- E1527-13: Standard Practice for Environmental Site Assessments – Phase I Environmental Site Assessment process
- E1528-06: Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process (interview questionnaires)

- E2247-08 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property

The purpose of a Phase I ESA is to identify, to the extent feasible in the absence of sampling and analysis, the range of contaminants within the scope of the USEPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and petroleum products.

After the devastation of the 2005 hurricane season, the U.S. embarked on one of the largest civil works projects ever undertaken, at an estimated cost of \$14.6 billion, with restoration, accelerated construction, improvements, and enhancements of various risk reduction projects and ecosystem restoration projects within southeastern Louisiana, including the WBV. With the completion of the levees, floodwalls, gates, and pumps that together form the LPV and WBV, 1% AEP level of hurricane and storm damage risk reduction was brought to the areas within LPV and WBV. At this time, Phase I ESAs were performed for the selected project features and Recognized Environmental Conditions (RECs) were identified and remediated or avoided prior to construction. Some RECs were identified in the Phase I ESAs within the Rights-of-Way (ROW) for the WBV, on adjacent or adjoining properties, and outside, but near, the project areas. All of these RECs were easily remediated or avoided and were unlikely to affect the HSDRRS, personnel working on the project, or the public.

During the feasibility phase, an abridged Phase I ESA was performed to determine the potential for HTRW problems which could impact or be impacted by potential project features. This abridged Phase I ESA was conducted in the current HSDRRS levee and floodwall ROW and the results are presented directly below. The abridged Phase I ESA included the following tasks: 1) the review of previous HTRW Phase I ESAs to identify previously recorded RECs that may have been found prior to the construction of the HSDRRS features, and 2) a field survey to determine if new RECs are within the HSDRRS levee and floodwall ROW.

The abridged Phase I ESA tasks and results are:

Task 1 Results – According to the 2013 HSDRRS CED Phase I Volume I, RECs were avoided and the probability of encountering HTRW in the project area was low, no impacts from HTRW were anticipated. If a REC was not avoided, then the non-federal sponsor was responsible for remediation. If construction revealed the existence of previously unknown HTRW, then work in that area stopped until the risk from HTRW was evaluated and an appropriate response was determined. After a thorough review of previous Phase I ESAs related to the original HSDRRS construction, only one REC, a dry and plugged oil well, was found within the WBV ROW at coordinates 29°48'31.7" N, -90°3'6.03" W. A 300-foot radius for a No-Excavation Zone around the dry and plugged well was proposed. Several potential RECs (petroleum product pipelines) were noted to be crossing the project footprint, and care was taken to prevent damaging the pipelines. Other than one dry and plugged oil well, the previous Phase I ESAs indicated that no RECS fell within the WBV levee or floodwall ROWs.

Task 2 Results – Study team personnel made a site visit to the WBV levee and floodwall ROWs on 09 April 2019. The MRL co-located portion of the study area was inspected on 17 October 2019. The WBV levee and floodwall ROWs were inspected for the presence of pipes, containers, tanks or drums, ponds or lagoons, car bodies, tires, refrigerators, trash dumps, electrical equipment, oil drilling equipment, gas or oil wells, discoloration of vegetation or water sheens, discoloration of soils, out-of-place dirt mounds or depressions in the landscape, evidence of fire, stressed soils with lack of vegetation, discoloration of vegetation, animal

remains, unusual animal behavior, biota indicative of a disturbed environment, and odors indicative of poor water quality or chemical presence. None of the aforementioned indicators were found during the site visits. Specifically, the REC location discovered under Task 1 above was visited on 09 April 2019, and the dry and plugged oil well was not located at the said coordinates. As mentioned above, the No-Excavation Zone was likely to have been enforced and care was taken near the pipelines during HSDRRS construction activities.

Historic Phase I ESAs have indicated that no RECs were found within the footprint of the WBV levee and floodwall systems as well as the portions of the MRL co-located levee and floodwall systems that were incorporated into the study.

5 FUTURE WITHOUT PROJECT CONDITION

The Future Without Project (FWOP) Condition is developed to describe the most likely future conditions in the project area if no federal action is taken to address the identified problems. It is also sometimes referred to the Future Without Action Condition (FWAC) when a project already exists and the study is considering making modifications to the project. It forms the baseline for identifying the effects of the alternatives and is similar to the No Action alternative. The future is inherently uncertain and conditions change over time. For example, the levee risk may change if there are changes in the climate that affect storm frequency and intensity, storm surge elevations, and wave heights; and the condition of the levee system can degrade over time due to subsidence and settlement, even with adequate maintenance.

In order to identify the FWOP condition to be used for evaluation purposes, the study team began with the existing conditions information and considered where potential changes could occur in the future. Forecasted changes to the affected environment are summarized in Section 5.6 and are fully described under the “No Action” alternative in Section 7 when comparing environmental effects of each alternative. This section provides a detailed discussion on future conditions related to flooding risks associated with levee overtopping.

A forecast period of 50 years was selected as a reasonable time frame for analyzing potential changes in the project area. This period of analysis begins in the year that project benefits begin to be realized, if a project were constructed. USACE policy requires a 50-year period of analysis except for major multipurpose reservoir projects (which can be evaluated for up to 100 years) or projects for which the beneficial or adverse effects will occur over less than 50-years. For this project, the effects are expected to extend beyond 50 years but it is not a reservoir project; therefore a 50-year period of analysis was chosen. For the purpose of alternatives comparison, this period of analysis begins in 2023 (the “base year”). USACE policy also requires consideration of a project’s engineering performance with regard to potential sea level change over 100 years, which is particularly relevant to this study, as the combined effects of subsidence, settlement and sea level change will continue beyond the 50-year period of analysis. Performance to this 100-year horizon is discussed in Section 8.4.

This section discusses six areas of potential changes during the forecast period which the team felt could result in a FWOP condition that differs from the existing conditions and, where needed, documents the differences. These six areas are levee system conditions, climate change, hydrology and hydraulics, economics, future conditions risk, and relevant natural resources.

5.1 FUTURE LEVEE SYSTEM CONDITIONS

This section contains detailed discussion about future settlement and subsidence. Additionally, the following general assumptions were made regarding future conditions related to levee system conditions:

- The sponsor will continue to operate and maintain all levee system components as described in the operation and maintenance manual(s). This includes general maintenance of the existing system and maintenance of the Section 408 levee lift alterations and the armoring already completed by CPRAB and Southeast Louisiana Flood Protection Authority - East and/or PLD. It does not include any lifts or other actions

to address settlement, subsidence and sea level rise and maintain the original design elevations.

- The MR&T levees will continue to be maintained at the authorized levels.

5.1.1 SETTLEMENT

Future levee settlement amounts will vary around the system, primarily based on the amount of time that has elapsed since construction. Survey data from 2018 was used to evaluate past settlement rates. Lift schedules previously developed to estimate lift needs through 2057 for the segments of each reach were compared to actual settlement and the curve that best represented actual settlement was selected to represent that reach. It should be noted that not all lift schedules were previously developed for all levee segments.

The 2018 average survey values of the control segment were then plotted on the lift schedules. If armoring by articulated concrete blocks was completed, because the survey elevation was at the top of the blocks, the survey was lowered 6 inches to account for the concrete block. The settlement curve was then projected to 2073 following the general curvature of the curve to 2057 or following the trend of settlement from the actual lift to the survey elevation.

An MRL reach is typically raised to the 1973 required flowline plus freeboard. Freeboard is an increment of height added to a flood risk reduction feature to increase the likelihood of the design event being contained without overtopping. Since the levees were already previously constructed to those elevations and have already had many decades of settlement, the foundation for those levees are not anticipated to experience any additional settlement. Therefore, any lift required to bring the levee back to those elevations will also have minimal settlement. A 6-inch over-build is typically used on lifts to account for any potential settlement/shrinkage. The study estimates that the MRL levees above the existing cross-over points may settle up to 6 inches between 2023 and 2073, although if the levee settles below the MR&T authorized grade, then it is assumed to be lifted to the MR&T authorized grade under that program. In other words, the analysis assumes the MR&T levees remain at the authorized grade throughout the period of analysis.

Levee settlement values vary by location. Settlements ranged from 1.7 feet to 3.3 feet in WBV. Figure 5-1 shows projected levee settlement values by 2073. Levees are plotted as a green line. Floodwalls are gray lines. No settlement was assumed at floodwalls. Floodwalls were originally designed to limit long term settlement to 2" or less under HSDRRS. It was assumed that floodwalls may settle, but settlement slows down over time and some walls have reached a point where settlement is minimal.

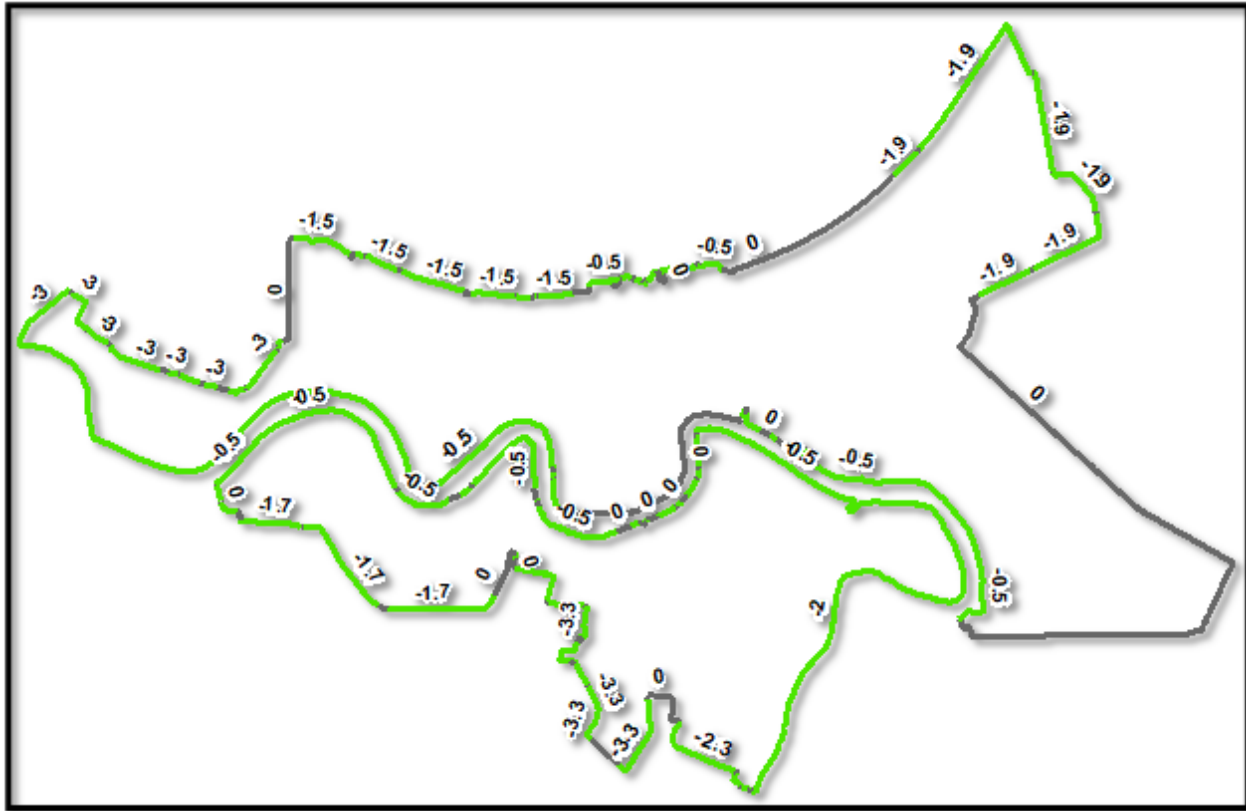


Figure 5-1. Projected Levee Settlement Values (feet) by 2073

5.1.2 SUBSIDENCE

Future subsidence was estimated as part of the RSLR calculations. This is discussed in Section 5.2.1 as part of the relative sea level change calculations.

5.2 CLIMATE CHANGE

USACE has an overarching climate preparedness and resilience policy and specific policies and guidance related to assessment of potential climate change impacts to inland hydrology and sea level change. This overarching policy requires consideration of climate change in all current and future studies to reduce vulnerabilities and enhance the resilience of communities. In support of its policies and guidance, USACE relies on climate change science performed and published by agencies and entities external to USACE. The conduct of science as to the causes, predicted scenarios, and consequences of climate change is not within the USACE mission as a water resources management agency.

ER 1100-2-8162 (Incorporating Sea Level Change in Civil Works Programs) applies to sea level change and calls for potential relative sea level change to be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. This ER requires a quantitative estimate of three sea level change scenarios (low, intermediate, and high) and also requires these scenarios to be utilized during the alternatives' formulation, evaluation, and comparison.

Engineer and Construction Bulletin (ECB) 2018-14 (Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects) applies to inland hydrology. Due to observations of more extreme seasonal conditions of rainfall and runoff (flooding or drought) and altered snow volume and melt in some regions, assumptions of past trends continuing into the future are no longer appropriate in some locations. This ECB helps support a qualitative assessment of potential climate change threats and impacts that may be relevant to the particular USACE hydrologic analysis being performed.

5.2.1 RELATIVE SEA LEVEL CHANGE

RSLC is the local change in sea level relative to the elevation of the land at a specific point on the coast. RSLC is a combination of both global and local sea level change, as well as local and/or regional vertical land motion (subsidence or uplift).

Values were calculated for three RSLC scenarios: low, intermediate, and high. Per ER 1100-2-8162 the low sea level change scenario is the historic rate of sea-level change extended into the future plus local subsidence, the intermediate sea level change scenario uses the modified National Research Council (NRC) Curve I plus local subsidence, and the high sea level change rise scenario incorporates the modified NRC Curve III plus local subsidence. This high scenario exceeds the upper bounds of Intergovernmental Panel on Climate Change estimates from both 2001 and 2007 to accommodate potential rapid loss of ice from Antarctica and Greenland.

Local subsidence rates at 7 gages were entered into the USACE climate change website to determine the RSLC scenarios at each location. Table 5-1 contains subsidence rates and the corresponding RSLC projections at the 7 gages. Figure 5-2 displays the location of the 7 gages relative to HSDRRS.

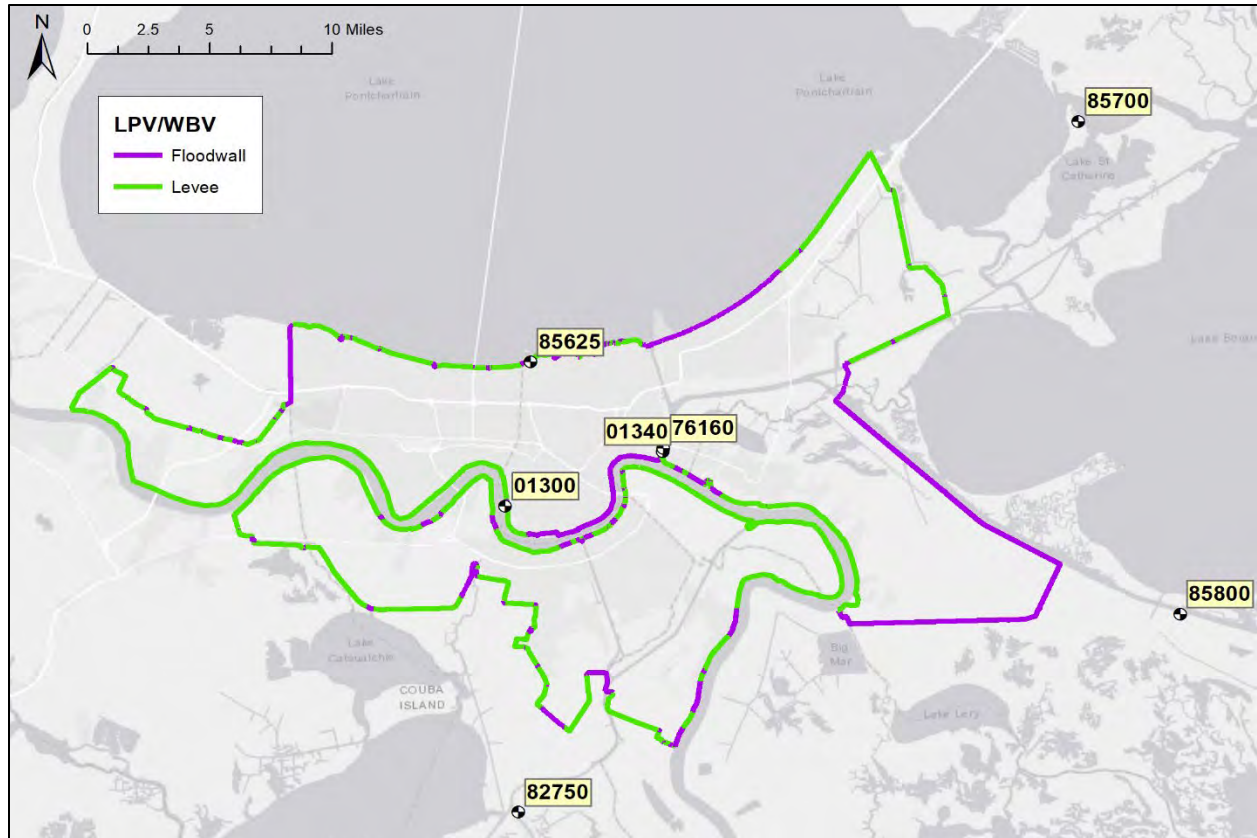


Figure 5-2. Location of Water Level Gages Used for RSLC Subsidence Projections

The study team averaged the results for each gage to obtain regional RSLC values to apply to the study area over the period of analysis. As seen in Table 5-1, the three average relative sea level change scenario values are: low (1.3ft), intermediate (1.8 ft.), and high (3.4 ft.). Additionally Table 5-1 shows the three RSLC scenarios are all projecting relative sea level to rise. For the remainder of this report and to be clear about the direction of change, the RSLC scenarios will all use the term relative sea level rise (RSLR).

Table 5-1. RSLC Projections

Location	Projected Subsidence (ft.) 2023-2073	Projected SLC 2023 to 2073			Projected RSLC 2023 to 2073		
		Low (ft.)	Int (ft.)	High (ft.)	Low (ft.)	Int (ft.)	High (ft.)
Lake Pontchartrain West End (85625)	1.2	0.2	0.7	2.3	1.4	1.9	3.5
Rigolets (85700)	0.5	0.2	0.7	2.4	0.7	1.2	2.9
IHNC (76160)	1.4	0.3	0.8	2.4	1.7	2.2	3.8
Bayou Barataria (82750)	0.9	0.3	0.7	2.3	1.2	1.6	3.2
IHNC Lock (01340)	0.8	0.3	0.8	2.4	1.1	1.6	3.2
MS River at Carrollton (01300)	0.9	0.3	0.8	2.3	1.2	1.7	3.2
MRGO Shell Beach (85800)	1.4	0.3	0.8	2.3	1.7	2.2	3.7
Average:	1.0	0.3	0.8	2.3	1.3	1.8	3.4

Additionally, Corps policy requires consideration of relative sea level change for major infrastructure projects for a time period of 100 years, which would be the year 2123. Table 5-2 shows the results of these additional projections for the years 2073 to 2123.

Table 5-2. USACE Relative Sea Level Rise (feet) from 2023 to 2123. Average of 7 gages.

	Low	Int	High
2073	1.3	1.8	3.4
2078	1.4	2.0	3.8
2083	1.5	2.2	4.3
2088	1.7	2.4	4.7
2093	1.8	2.6	5.2
2098	1.9	2.8	5.7
2103	2.1	3.1	6.3
2108	2.2	3.3	6.9
2113	2.3	3.5	7.4
2118	2.4	3.8	8.0
2123	2.6	4.0	8.6

For the FWOP condition and alternatives development, the intermediate RSLR scenario was selected. An intermediate RSLR scenario accounts for future acceleration of global mean sea level rise without the significant ice melt projected in the high RSLR scenario. This is consistent with other USACE studies that have been performed in this area. Section 8.4 discusses the sensitivity of the alternatives to the low and high RSLC scenarios.

5.2.2 INLAND HYDROLOGY

One key assumption in the inundation modeling is a 400,000 cubic feet per second (cfs) Mississippi River discharge as a model boundary condition (just upstream of Baton Rouge) during hurricane season, which is an assumption carried forward from the previous ADCIRC modeling. The study team considered if this value should be maintained or adjusted for the study.

Observed hurricane-season daily flow records were checked for the entire period of record and the data shows that discharge in the river is, on average, lower than 400,000 during the peak of hurricane season (August/Sept), but there are exceptions. The original HSDRRS analysis processed river discharges from 1976 to 2002. When the latest data through 2019 is added and statistics processed, there appears to be a small increase in the expected discharge during hurricane season. For example, the 50% or mean discharge during July was approximately 410,000 cfs with the data from 1976 to 2002. When the data is updated, the mean discharge during July becomes 450,000cfs. Updating the assumed design discharge from 400,000 to 450,000 might change design water levels by 0.5 ft. to 1.0 ft. based on crude approximations. See Appendix C for additional information about river discharges.

Another assumption that can change stage-frequency information in the river is observed hurricane frequency by month. In the older HSDRRS analysis, a sample of 14 observed storms provided the hurricane probability by month. Since 2005, more storms have impacted New Orleans including Gustav, Ike, Isaac, Karen and Barry. Storms above Category 1 since 2005 were added to the dataset and an updated analysis was performed for the entire period of record. The results did not indicate a significant increase in storm frequency.

The latest hurricane frequency and river discharge data suggests that the assumptions made concerning hurricane frequency and discharge frequency are still valid for a feasibility level study. However, they have changed enough to warrant a revisit during later design assessments such as the design phase of this project.

5.3 FUTURE HYDROLOGY AND HYDRAULICS

The overtopping calculations, River Analysis System (RAS) simulation and Joint Probability-Optimal Sampling (JPM-OS) statistics were repeated for the 2073 future no-action condition. ADCIRC simulations of the future condition for various RSLR conditions were used to develop future condition surge and wave time-series.

The modeling of future surge and wave conditions took into consideration any potential effects from authorized but unconstructed USACE projects in the area. It did not consider potential effects from implementation of actions under the Gulf Spill Restoration Plan (such as the mid-Barataria Sediment Diversion), as the permitting, implementation timing and likely effects of these potential plans are uncertain.

Future condition overtopping calculations factor in levee settlement, subsidence, and eustatic sea level rise over the 50-year period of evaluation (discussed in Section 5.1.1). Modeled future storm surge elevations for a range of events were plotted against the levee and floodwall elevation data to determine potential locations for surge overtopping. Additionally, in areas where surge or waves were estimated to overtop the levees or floodwalls, overtopping rates were calculated. Levee settlement and RSLR result in larger overtopping volumes and more inundation in the HEC-RAS simulations. Figure 5-3 displays the resulting 1% AEP flood depths

for the future no-action scenario assuming intermediate 1.8 ft. RSLR. Figure 5-4 displays the resulting 0.2% AEP flood depths for the future 2073 no-action scenario assuming intermediate 1.8 ft. RSLR. Maps depicting flood inundation under the low or high RSLR scenarios would reflect different inundation coverage and depths. All statistical water surfaces and depths were utilized in the economic damage evaluations.

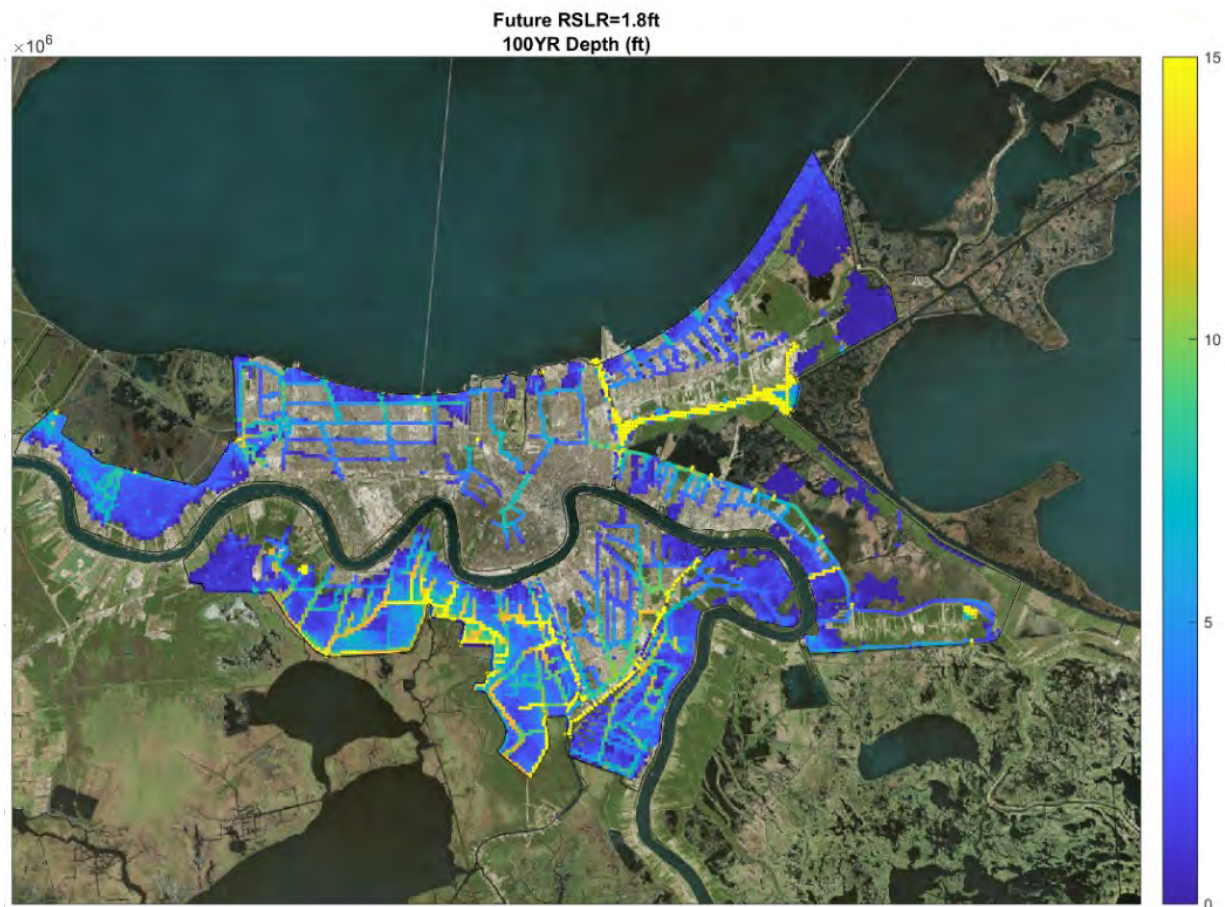


Figure 5-3. 1% AEP Peak Depths for Future 2073 Intermediate RSLC Conditions

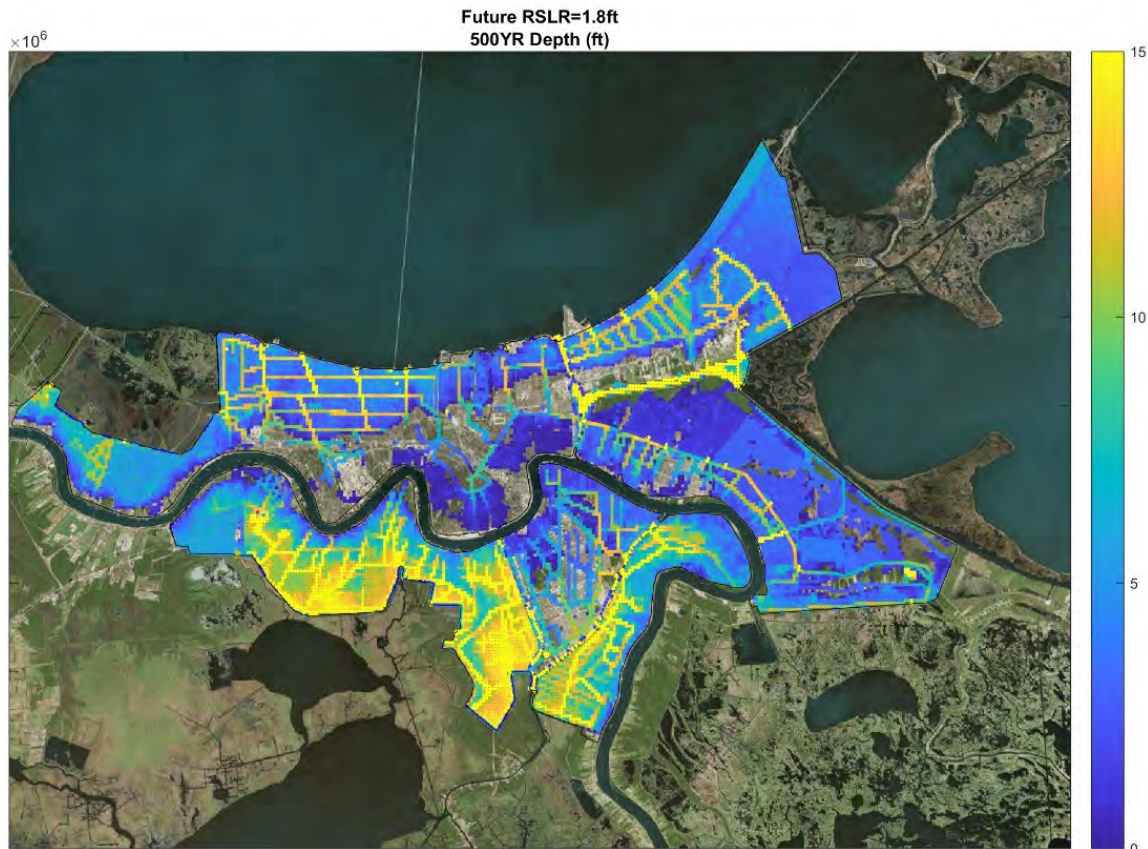


Figure 5-4. 0.2% AEP Peak Depths for Future 2073 Intermediate RSLC Conditions

These plots demonstrate that in a future 2073 without project scenario where an intermediate RSLR is experienced, there are many reaches where surge elevations for the 1% and 0.2% AEP events overtops levees/floodwalls. Additionally, the overtopping rates (including waves and surge) are above design requirements in most reaches for the 0.2% AEP event.

5.4 FUTURE ECONOMIC DAMAGES

The projected hydrologic conditions were entered into the HEC-FDA program to estimate potential future economic damages if no action is taken to address the combined effects of settlement, subsidence and sea level rise (intermediate scenario) on the WBV system. No other parameters were changed from the existing conditions modeling. Aside from the new airport terminal in Kenner, no new major construction is expected to occur in the near future. The current trend of repurposing existing retail and office buildings into residential units is expected to continue. Neither the new terminal nor the building repurposing was included in the structure inventory at this time because they would have only a very small effect on the overall damage calculations.

The future conditions damages by probability event are displayed in Table 5-3 and the expected annual damages and equivalent annual damages are displayed in Table 5-4 (by sub-basin).

Table 5-3. Future Conditions Damages by Probability Event

West Bank and Vicinity: Damages by Probability Event 2073 (\$1000s)	
100%	\$0
10%	\$0
5%	\$20,999
2%	\$784,364
1%	\$7,472,152
0.5%	\$15,340,932
0.2%	\$28,042,111
0.1%	\$31,067,161

Table 5-4. Future Conditions Economic Damages

West Bank and Vicinity Expected and Equivalent Annual Without-Project Damages FY 19 Price Level; FY 20 Discount Rate \$1,000s			
Sub-basin	Expected Annual Damages 2073	Equivalent Annual Damages 2023-2073	
Belle Chasse	\$19,140	\$8,912	
Gretna-Algiers	\$19,978	\$12,678	
Harvey-Westwego	\$108,805	\$42,168	
Lake Cataouatche	\$31,910	\$12,742	
Total	\$179,833	\$76,500	

5.5 FUTURE CONDITIONS RISK

For future conditions risk estimates, the risk team utilized the updated hydrology and hydraulics information to evaluate the future breach and non-breach risks due to overtopping. The life safety risk assessment did not include any increase or decrease the population. As can be seen in Table 4-18 in Section 4.17.1.1, the population projections over the next 20 years show less than a 3% increase (the year 2040 is the last year for which we have projections). This small change would not materially affect the conclusions of the risk assessment and, therefore, the assessment utilized existing population and structure data.

5.5.1 RISK ASSESSMENT ASSUMPTIONS

The FWOP condition assumes both settlement of the levees and 1.8 feet of relative sea level rise. Levee settlements amounts ranged from 0.2 to 3.3 feet in WBV. Floodwalls were assumed to have no settlement. MRL levees were assumed to be maintained at authorized heights through the MR&T program.

5.5.2 CONSEQUENCES

Life loss consequences for the future condition were estimated using the LifeSim model at the 1% AEP and the 0.2% AEP events, respectively. No changes to the variable inputs for the LifeSim model were made for the future condition. Non-breach consequences were modeled for

the FWOP because the combined effects of settlement and RSLR allows stillwater overtopping (when the surge elevation exceeds the top of the levee or floodwall) in the future. Breach consequences were also developed and the difference between the two numbers provides the incremental consequences. For WBV, the incremental life loss estimates varied by breach location and ranged from moderate to very high.

Critical infrastructure is included in the structure inventory and economic damages to those structures are accounted for in the total economic damage estimates provided in Section 5.4. However, when these particular structures are inundated to the point where they are no longer able to provide services to the community, there is also a potential for life safety risk. Critical infrastructure data was obtained from the Homeland Security Infrastructure Program (HSIP) Gold 2015 database, which is a data inventory assembled by the National Geospatial-Intelligence Agency in partnership with the Department of Homeland Security. Table 5-5 summarizes the number of critical infrastructure structures, by category, which are inundated in the FWOP scenario.

Table 5-5. Critical Infrastructure Inundated in the FWOP Scenario

Intermediate SLR Without-Project WBV – Critical Infrastructure	
Category	Number
Agriculture	1
Chemicals	2
Communications	2
Education	49
Emergency Services	17
Energy	7
Law Enforcement	2
Manufacturing	4
National Symbols	0
Public Venues	16
Transportation-Air	4
Transportation-Ground	1
Transportation-Water	79
Water Supply	1
Total	185

5.5.3 FUTURE RISK CHARACTERIZATION

The estimated total annual probability of failure (APF) for WBV future conditions is between 3E-04 and 3E-03 (0.0003 and 0.003) failures per year and the best estimate of the average annual incremental life loss is 1E-01 (0.1) lives per year. Life risks in the future condition are above tolerable risk levels and are driven by wave overtopping of armored levees leading to breach in Ames, Westwego, and Belle Chase.

5.6 RELEVANT RESOURCES

Future conditions of the relevant resources are summarized in Table 5-6 and are more fully described in Section 7 under the No Action Alternative narratives, for ease of comparison with the action alternatives.

Table 5-6. Summary of Future Conditions of Relevant Resources

Resource	FWOP/ No Action Summary
Soils	Continued impacts from past and ongoing development, constructed levees, and other risk reduction structures. Actions by others to use soils for borrow would continue.
Water Quality Resources	Continued impacts to water resources in the vicinity due to population growth and industrialization.
Wetland & Forest Resources	Continued wetland and bottomland hardwood loss. No new impacts due to routine maintenance of existing risk reduction features.
Uplands	Actions by others to use uplands as borrow would continue.
Fisheries	RSLR and likely increase to saltwater intrusion would degrade fish habitat. Commercial and recreational fishing would continue. Maintenance of existing WBV system into the future would continue with less than significant impacts to fisheries resources.
Essential Fish Habitat	RSLR would continue. Maintenance of existing WBV system into the future would continue with no impacts to EFH.
Wildlife	Maintenance of existing WBV system would continue. Wildlife that use the levees would continue to do so with negligible and temporary impacts. Actions by others would continue and RSLR would lead to habitat loss.
Threatened & Endangered Species	Degradation and loss of habitat would continue. Recovery plans would offset impacts. Maintenance of existing WBV system into the future would not likely adversely affected listed species.
Invasive Species	Continued threats of invasive species would continue. Existing invasive species would persist.
Cultural & Historical Resources	Existing WBV system would continue to be maintained and would have no effect on cultural resources. Structures within the protected side of the WBV system may have higher risk of damage during hurricane and tropical storms.
Aesthetics	Increasing risk of impacts to aesthetic resources with no action.
Recreation	Increasing risk of impacts to recreational resources with no action.
Air Quality	Existing maintenance of the WBV system into the future would continue. No changes to the attainment status for the study area is anticipated. Continued human development, industrialization, and urbanization.
Noise	Similar to existing conditions into the future.
Transportation	Routine maintenance of public roads would continue. Major transportation corridors within the study area would become more vulnerable to hurricane and tropical storm damage in the future.

Human Environment	The existing WBV system would not provide hurricane and storm damage risk for a 1% AEP storm, leading to increased perceived and actual risks to the communities. Potential for residents to re-locate.
Environmental Justice	The existing WBV system would not provide hurricane and storm damage risk for a 1% AEP storm, leading to increased perceived and actual risks to minority and/or low-income populations. Potential for residents to re-locate.
HTRW	Existing maintenance of the WBV into the future would continue. Continued human population growth and industrialization would have potential new HTRW impacts.

6 PLAN FORMULATION*

The guidance for conducting civil works planning studies, ER 1105-2-100, Planning Guidance Notebook, requires the systematic formulation of alternative plans that contribute to the federal objective. This section presents the results of the plan formulation process. Alternatives were developed in consideration of study area problems and opportunities as well as study objectives and constraints with respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability).

Reducing flood risk in conjunction with a levee system can be accomplished, in general, by four strategies:

1. Reducing the flood hazard or load on the levee system (magnitude and likelihood of the hazard);
2. Improving the performance or response of the levee system to the load (add to or modify features of the levee system to address failure modes or to promote system resilience and sustainability);
3. Reducing the exposure of the people and item(s) (property, infrastructure, etc.) at risk (for example by altering or limiting future land development or relocating current populations away from the leveed area); and
4. Reducing the vulnerability of the people and items at risk to harm (for example through actions such as strengthening emergency action and evacuation plans, improved warning systems, road improvements, enhanced building codes, and fostering effective response to such warnings by households and businesses, including vertical evacuation as appropriate).

When examining the four methods above, the study team concluded that while there may be no way to modify the source of the hazard (hurricanes), there may be ways to reduce the load on the system (#1) by considering actions to reduce surge elevations and wave heights. This could possibly be accomplished via structural measures (Section 6.2.1) or nature-based measures (Section 6.2.3)

Improving the performance or response of the levee system (#2) could be addressed via structural measures, which are discussed in Section 6.2.1.

While large-scale plans to limit development or relocate the population within the levee system would not likely be supported by the local population and governments, measures to reduce exposure (#3) are included in the plan formulation and are discussed in Section 6.2.2.

Finally, an assessment of existing emergency action and evacuation plans (#4) concluded that the existing plans are already at a very high level of effectiveness and the future condition is not expected to be significantly different even when using the “Best” present curves available in the LifeSim model. However, some minor improvements to risk communication may be possible. Measures to address this strategy were developed as non-structural measures and are discussed in Section 6.2.2.

6.1 ASSUMPTIONS

In the formulation of measures and alternatives, the study team utilized the following overarching scope assumptions:

1. The period of analysis is 50 years from 2023. All future without project and future with project analyses will estimate conditions in 2073.

2. A full range of flood frequencies will be considered at 2073.
3. Semi-quantitative risk assessments will evaluate existing conditions (baseline), future without project/action, and future with project/action for each alternative in the final array.
4. Estimates of RSLR, regional subsidence, and settlement were used to inform conceptual designs and evaluation of alternatives. The intermediate RSLR scenario was used, which also incorporated future subsidence rates. Finally, projected levee settlement rates were based on 2018 data.

6.2 MEASURE DEVELOPMENT

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. The study team developed and screened structural, non-structural, and nature based/natural measures utilizing information on existing infrastructure, existing reports, and subject matter expertise. Coastal risk reduction can be achieved through a variety of approaches, including natural or nature-based features, structural features, and nonstructural interventions. The two-dimensional representation (Figure 6-1) shows the variety of measures considered and the following sub-sections describe the measures in more detail. Numerous risk reduction measures can be combined to form alternative plans. Risk reduction in any given coastal area is achieved through a combination of approaches described in more detail below. Application of the full array of features in any coastal system must consider interactions among the features (e.g., the effects of seawalls on down-drift beaches) and the multiple objectives being sought for the system (e.g., erosion control, navigation, risk reduction).

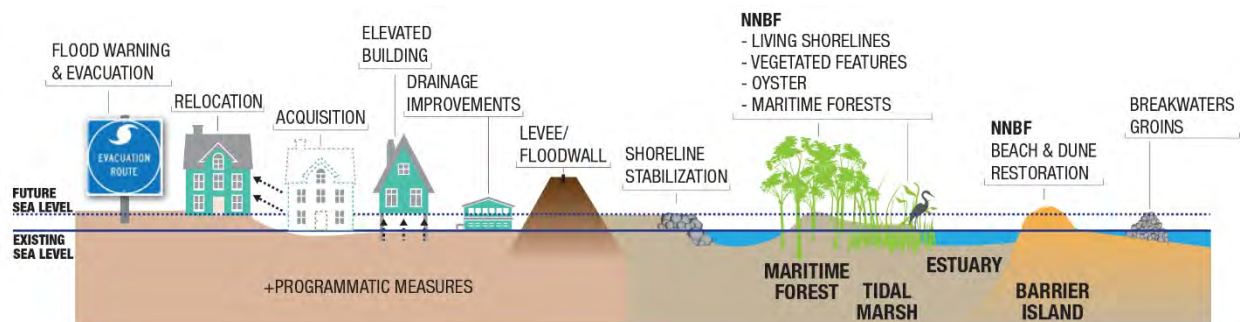


Figure 6-1. Two-dimensional Representation of Potential Measures Considered

6.2.1 STRUCTURAL MEASURES

Structural measures can be designed to decrease shoreline erosion or reduce coastal risks associated with wave damage and flooding. Traditional structures include levees, floodwalls, storm surge barrier gates, seawalls, revetments, groins, and nearshore breakwaters. Structural measures were identified from the CPRA master plan, in addition to professional expertise.

LEVEE LIFT – Levees in coastal areas are typically onshore structures with the principal function of protecting low-lying areas against hurricane and tropical storm surge. Side slopes used by USACE for levee design vary by project. Front (flood side) slopes range between 3H: 1V (three horizontal feet for every one vertical foot) and 6H: 1V, while back (interior) slopes range between 3H: 1V and 4H: 1V. A top width of 10 feet was used for all levees as is typical of USACE earthen levee projects to provide reasonable access for maintenance after levee construction.

For levees over soft foundations such as those in the study area, engineers typically recommend construction in several lifts over a timeframe of several years due to cost, real estate, and constructability concerns associated with constructing a levee that would meet the full intended design height, after accounting for future subsidence and other factors over time. Levee lifts are conceptually illustrated in Figure 6-2.

A levee built without lifts would typically require either very costly stabilization measures to increase their strength or the project would require significantly more real estate to allow for construction of wide stability berms to support the higher levee. By constructing in lifts, the levee may be built to a height that meets the near term elevation requirements related to hydraulic design with a nominal overbuild, but the levee is allowed to settle over a period of time, which allows the foundation soils to consolidate and gain in shear strength. After a period of settlement, future lifts are constructed on the levee to reestablish either its original construction height or the current design height based on hydraulic and other factors. The design of levee lifts over time also attempts to account for the soil strength increase due to consolidation, which allows for additional loading (i.e., higher levee elevation), without an increased levee footprint. The thickness of future levee lifts is typically limited to a foot or so of additional fill so that stability concerns don't require increases in the levee footprint such as shallower slopes or berms. This method may require several lifts be constructed periodically over time, but it is a cost-effective method to assure the levee crown elevation will be at or above the design elevation. Figure 6-2 is a conceptual illustration of performing levee lifts over time as the levee top elevation is reduced.

This measure also includes any secondary levee features that are related to the robustness of the levees, such as landside armoring and foreshore protection, which are both already being utilized.

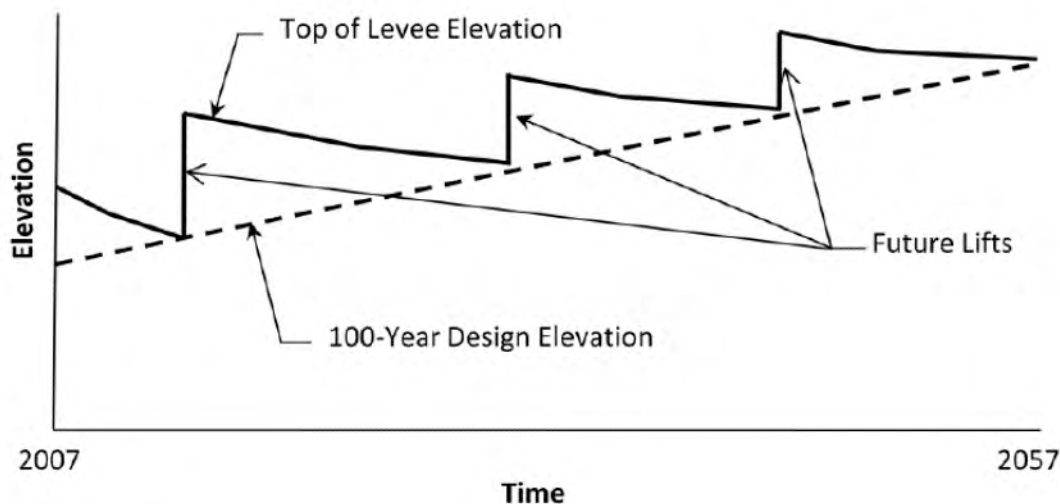


Figure 6-2. Conceptual Levee Lifts

BARRIER ISLAND/SURGE BARRIER – In most cases the barrier consists of a series of movable gates that normally stay open under normal conditions to let the flow pass but are closed when storm surges are expected to exceed a certain level. Storm surge barriers are often chosen as a preferred alternative to close off estuaries and reduce the required length of storm risk reduction measures behind the barriers. Storm surge barriers are often required

within a levee system to prevent surge from propagating up navigable waterways and distributaries. Storm surge barriers are typically opened during normal conditions to allow for navigation and saltwater exchange with the estuarine areas landward of the barrier. Examples of moveable storm surge barriers include floating sector gates, sluice gates, barge gates, lift gates, stop log gates, and tainter gates.

A barrier island is a permanent offshore structure that is intended to dissipate storm surge before it approaches the shoreline. Island barriers reduce risk to estuaries against storm surge flooding and waves.

NEW OR MODIFIED FLOODWALLS – Floodwalls are onshore structures built parallel to the shoreline with the principal function of reducing flood risk due to storm surge and its overtopping, as well as consequent flooding of land and infrastructure behind them. Floodwalls are a structural risk reduction measure to reduce flood risk by acting as physical barriers against storm surge. Floodwalls can be permanent or temporary. However, because this is an existing system, there is little to no opportunity to consider implementation of temporary floodwalls and therefore all reference to floodwalls in this document refer to permanent floodwalls.

BREAKWATERS – Detached breakwaters are nearshore structures built parallel to the shore just seaward of the shoreline in shallow water depths, with the principal function of reducing beach erosion by reducing wave height and thus longshore and cross-shore sediment transport. They may or may not become inundated during a surge event and if inundated, become less effective. They are more typically used for everyday waves. Submerged detached breakwaters are used in some cases because they do not spoil the view, but they represent a serious non-visible hazard to boats and swimmers.

INTERIOR DRAINAGE IMPROVEMENTS – A drainage system can carry water away via conveyance systems and, during times of high water, may store water until it can be carried away. Conveyance systems utilize measures such as pump stations, culverts, drains, and inlets to remove water from a site quickly and send it to larger streams. Storage facilities are used to store excess water until the storm or flood event has ended.

ADD ARMORING ON THE FLOOD SIDE – Adding armoring or revetments to onshore structures has the principal function of protecting the shoreline from erosion. Revetments typically consist of a cladding of stone, concrete, or asphalt to armor sloping natural shoreline profiles. Armoring is designed to add resiliency to the earthen levees. Foreshore protection typically consists of placement of rock or a rock dike on or immediately in front of a levee wave berm or shoreline and it is intended to prevent erosion of earthen material during daily wave action. Flood-side armoring is generally more effective against riverine flood events than tropical events and will only be utilized as appropriate.

WAVE BERMS – Wave berms are generally earthen extensions on the flood-side of a levee that are inundated during surge events and whose purpose is to reduce wave heights. By building up the land they cause these areas to be shallower and waves to become depth limited and break far enough from the levee crown that it reduces run-up and therefore design heights.

6.2.2 NON-STRUCTURAL MEASURES

Nonstructural measures essentially reduce the consequences of flooding, as compared to structural measures, which may also reduce the probability of flooding. Nonstructural measures addressed by the USACE National Nonstructural Floodproofing Committee include building

acquisitions or relocations, flood proofing of structures, implementing flood warning systems, flood preparedness planning, establishment of land use regulations, development restrictions within the greatest flood hazard areas, and elevated development.

Nonstructural measures (such as elevations for new construction) are most often under the jurisdiction of state and local governments (and individuals) to develop, implement, and regulate. They can be encouraged or incentivized but are usually not imposed by the federal government. As a result, the effective implementation of the full range of flood and coastal flood hazard mitigation actions relies on a collaborative, shared responsibility framework between federal, state, and local agencies and the public (Comfort et al. 2010).

RISK COMMUNICATION WITH THE PUBLIC/FLOOD WARNING – Flood warning systems and evacuation planning are applicable to vulnerable areas. Despite improved tracking and forecasting techniques, the uncertainty associated with the size of a storm, the path, or its duration necessitate that warnings be issued as early as possible. Evacuation planning is imperative for areas with limited access, such as barrier islands, high density housing areas, elderly population centers, cultural resources, and areas with limited transportation options. In general, risk communication in the New Orleans area is already at a high level (see discussion in Section 3.2). However, aspects of risk communication are essential for all alternatives.

BUYOUTS – Property acquisition and structure removal are usually associated with frequently damaged structures. Implementation of other measures may be effective but if a structure is subject to repeated storm damage, this measure may represent the best alternative to eliminating risks to the property and residents.

FLOOD-PROOFING – A non-elevated structure in the flood zone is prone to flooding. Dry floodproofing involves sealing the structure to make it watertight below the level that needs protection to prevent floodwaters from entering. Making the structure watertight requires sealing the walls with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete. Generally, dry floodproofing is used when the expected flood depths are low such as a few inches of water. Wet floodproofing is a design method that allows water to move in the enclosed parts of a structure (e.g., crawlspace or unoccupied area) and then out when water recedes.

ELEVATED BUILDINGS – An elevated building is a structure that has no basement and that has its lowest elevated floor raised above flood level by foundation walls, shear walls, posts, piers, pilings, or columns. Elevation of a structure is usually limited to smaller residential and commercial buildings. Whether a structure may be elevated depends on a number of factors including the foundation type, wall type, size of structure, condition, etc.

6.2.3 NATURE BASED / NATURAL MEASURES

The team also considered the full array of natural measures. Specific examples of coastal storm risk management nature based measures include marsh creation, mechanical beach or dune creation, and resilient living shorelines for stabilization and wave attenuation (see Figure 6-3). Nature-based features can be placed in different areas along the shoreline including upland, bank face, tidal marsh, or subtidal areas. Measures such as planting tidal wetland plants for marsh creation, submerged aquatic vegetation, or artificial reefs address the risk associated with storm surge and flooding such as wave attenuation, wave height, water level, and storm duration. Natural and nature-based features can enhance the resilience of coastal areas

challenged by sea level rise (Borsje et al. 2011) and coastal storms (e.g., Gedan et al. 2011, Lopez 2009).

MARSH CREATION (REHABILITATION) – Marsh creation establishes new wetlands in open water areas such as bays, ponds, and canals. This can be achieved through sediment dredging and placement, diversion, or hydrologic restoration. Diversions use channels and/or structures to divert sediment and fresh water from the Mississippi and Atchafalaya Rivers into adjacent basins. Hydrologic Restoration conveys fresh water to areas that have been cut off by man-made features or prevents the intrusion of salt water into fresh areas through man-made channels and eroded wetlands.

Coastal wetlands may contribute to coastal storm surge reduction through wave attenuation and sediment stabilization. The dense vegetation and shallow water in wetlands can slow the advance of storm surge somewhat and slightly reduce the surge landward of the wetland or slow its arrival time (Wamsley et al. 2009 and 2010). Wetlands can also dissipate wave energy, potentially reducing the amount of destructive wave energy propagating on top of the surge, though evidence suggests that slow-moving storms and those with long periods of high winds that produce marsh flooding can reduce this benefit (Resio and Westerlink 2008). The magnitude of these effects depends on the specific characteristics of the wetlands, including the type of vegetation and the wetlands' rigidity, structure, extent, and position relative to the storm track.

BEACH/DUNES/RIDGE RESTORATION – Beaches are natural features that can provide coastal storm risk reduction and resilience. The sloping nearshore bottom causes waves to break, dissipating wave energy over the surf zone. The breaking waves typically form an offshore bar in front of the beach that helps to dissipate the following waves.

Dunes that may back a beach can act as a physical barrier that reduces inundation and wave attack on the coast landward of the dune. Although the dune may erode during a storm, in many cases it provides a sediment source for beach recovery after a storm passes.

Ridge restoration uses dredging, sediment placement, and vegetative plantings to restore natural ridge functions in basins. Ridge restoration projects are intended to reestablish historical ridges through sediment placement and vegetative plantings to provide additional storm surge attenuation and restore forested maritime habitat.

The functions of engineered beaches, dunes, and ridges are similar to natural features. These measures can contribute to coastal storm risk reduction through breaking of offshore waves, attenuation of wave energy, and slow inland water transfer. Engineered beaches, dunes, and ridges are nature-based infrastructure specifically designed and maintained to provide coastal risk reduction services, although these features often require beach nourishment to mitigate ongoing erosion and other natural processes. Introducing additional sand into the system through beach nourishment reinforces the natural protection to the upland afforded by the beach.

LIVING SHORELINE - Living shorelines are essentially tidal wetlands constructed along a shoreline to reduce coastal erosion. Living shorelines can contribute to coastal storm surge reduction through breaking of offshore waves, attenuation of wave energy, and slow inland water transfer. Living shorelines maintain dynamic shoreline processes and provide habitat for organisms such as fish, crabs and turtles. An essential component of a living shoreline is constructing a nearshore rock structure (breakwater/sill) parallel to the shoreline to serve as

protection from wave energy that would impact the wetland area and cause erosion and damage to or removal of the tidal plants. Oyster barrier reefs may be a component of a living shoreline, which are bioengineered to improve oyster propagation and serve as breakwaters to attenuate wave energies.

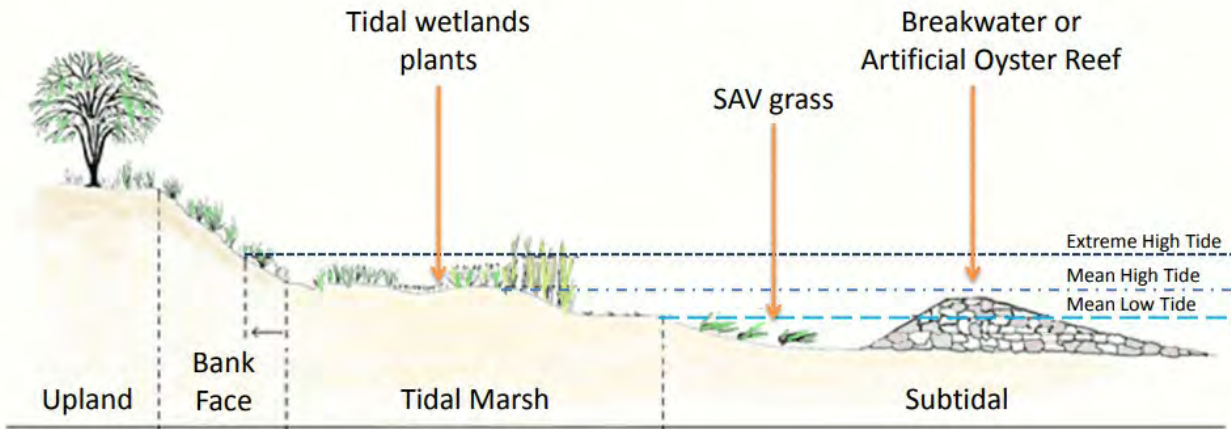


Figure 6-3. Example Nature-Based Measures (Image adapted from Burke Environmental Associates)

6.3 SCREENING OF MEASURES

Screening is the process of eliminating, based on planning criteria, those measures that will not be carried forward for consideration. Criteria are derived for the specific planning study, based on the planning objectives, constraints, and the opportunities and problems of the study/project area.

6.3.1 SCREENING CRITERIA

The study team developed and screened the following measures seen in Table 6-1. Screening criteria included whether the measure meets planning objectives (described in Section 2.5) and avoids constraints (described in Section 2.6) as well as qualitative assessments of effectiveness, efficiency, and acceptability. More detail on rationale for elimination of specific measures is outlined in Section 6.3.2 below.

Table 6-1 Measures and Screening

Measure	Structural, Non-Structural, Nature/Natural	Meets Objective	Retained for further evaluation
Levee Lift	Structural	1,2	Yes
Surge Barrier	Structural	1,2	No
New or Modified Floodwalls	Structural	1,2	Yes
Breakwaters	Structural	1,2	No
Interior Drainage Improvements	Structural	1,2	Yes
Add armoring at the Flood Side	Structural	1,2	Yes

Wave Berms	Structural	1,2	Yes
Risk Communication with the public/Flood Warning System	Non-structural	1,2	Yes
Buyouts	Non-structural	1,2	Yes
Floodproofing	Non-structural	1,2	Yes
Elevation	Non-structural	1,2	Yes
Marshes	Nature-based/Natural	1,2	No
Dunes/Beaches	Nature-based/Natural	1,2	No
Living Shore Line	Nature-based/Natural	1,2	Yes

6.3.2 SCREENING RESULTS

As described above, screening criteria included whether the measure meets planning objectives and avoid constraints. In addition, qualitative assessments of effectiveness and efficiency were also used to evaluate measures at this stage.

The surge barrier measure meets planning objectives and is effective at providing coastal storm risk management benefits. However, this measure was screened out because there is no appropriate location to implement this kind of feature within the WBV study area. Since the study area is focused on the west bank of the Mississippi River, there is no technically feasible location to implement floating tainter gates, barrier islands, or other offshore structures.

Breakwaters were also screened out due to information from prior investigations indicating this measure has both high costs and high environmental impacts. The 2017 Coastal Master Plan evaluated a range of breakwater alternatives with costs as high as \$495 million. Potential environmental impacts include disrupted sediment transport patterns which could damage nearshore habitat areas.

The marsh creation measure was screened out due to low effectiveness and low efficiency. In addition, this measure is already being implemented across the region by local entities. The 2017 Coastal Master Plan includes the nation's largest investment in marsh creation using dredged material and sediment diversion projects. Because this measure establishes new wetlands in open water areas, the areas for it to be successfully implemented within the highly-developed project area are substantially limited. Implementation of this measure within the project area would have a high cost per acre for a relatively low effect due to land acquisition costs associated with wetland or marsh creation in urban areas. Finally, marsh creation would not provide substantial risk reduction benefits compared to other structural measures that enable broader risk reduction in urban areas. As such, marsh creation was screened out from further analysis.

Finally, the dunes/beaches measure was screened out because the measure would be located too far from the study area to effectively reduce storm and flood risk within the project area. Creation of dunes or beaches would be more effective at restoring or augmenting offshore barrier islands and headlands in coastal regions beyond the project area.

6.4 FORMULATION CONSIDERATIONS

As described above, a management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. The management measures carried forward are all intended to be potentially implemented in combination with one another (i.e., not standalone). It is anticipated that a combination of measures can function as viable components of an integrated system to address overtopping flood risk in the study area.

In addition to these considerations about the combinability of measures, the following considerations also guided the development of the initial array of alternatives.

6.4.1 LIMITS OF AUTHORIZING LANGUAGE

The authority for this study and any subsequent construction limits the Secretary of the Army to “carry out measures that address consolidation, settlement, subsidence, sea level rise, and new datum to restore Federally authorized hurricane and storm damage reduction projects that were constructed as of the date of enactment of this Act to the authorized levels of protection of the projects... shall only apply to those projects for which the executed project partnership agreement provides that the non-Federal interest is not required to perform future measures to restore the project to the authorized level of protection of the project to account for subsidence and sea-level rise as part of the operation, maintenance, repair, replacement, and rehabilitation responsibilities.” This language has two impacts on the formulation of alternatives.

First, there are only five categories of changed or changing conditions that can be addressed. Any other potential system concerns which do not fall into one of these five categories are not within the scope of the study authority.

Second, while the study can consider many alternatives of varying levels of risk reduction, the recommendation is limited to restoration of the currently authorized level of risk reduction (1% AEP). Therefore, the study cannot recommend higher levels of risk reduction and is not required to consider lower levels if restoring the authorized level is found to be “technically feasible, environmentally acceptable, and economically justified.” It also limits the ability to recommend some measures that are not part of the perimeter system.

Given the limits of the authorizing language, the study team closely coordinated with the study sponsor throughout the formulation process and sought agreement on the range of measures and alternatives to be considered, as well as feedback on whether a locally preferred plan may be identified. A locally preferred plan is one that is not recommended by the study but is desired by the local sponsor.

6.4.2 TOLERABLE RISK GUIDELINES (TRG)

USACE Planning Bulletin 2019-04 (Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies) requires that studies identify at least one alternative that addresses TRG 1 and TRG 4, defined below.

Per Planning Bulletin 2019-04 (Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies), study teams will use the USACE TRGs for levee systems throughout the study including problem identification and study objectives, conceiving solutions to the identified problems in order to achieve study objectives, evaluating alternatives, and finally support decisions about risk management activities. The following paragraphs explain each TRG. TRG 1 was the primary focus during formulation of measures and alternatives because it establishes

a threshold for life safety risk tolerability. Because the study's authorization focused on addressing the combined effects of consolidation, settlement, subsidence and sea level rise, this standard was applied only to the risks associated with overtopping risk. Due to this limitation, TRG determinations reflect only the tolerability of the overtopping risk and do not reflect the tolerability of total levee system risk as experienced by the residents of the leveed area.

TRG 1 – The first TRG involves determining that society is willing to live with the risk associated with the levee system to secure the benefits of living and working in the leveed area. USACE will consider the life safety, economic and environmental risk for TRG 1.

Life safety risk is considered in relation to TRGs: societal life risk and individual life risk. The societal life safety tolerable risk line shown in Figure 6-4 reflects that society becomes more averse to risk as the number of life loss increases. Total risks that plot above the societal life risk line are considered unacceptable except in extreme circumstances. USACE has chosen to use 1 in 10,000 (i.e. 1.0×10^{-4}) per year for the tolerable probability of life loss for an individual or group of individuals most at risk. This tolerable risk guideline is also shown on Figure 6-4.

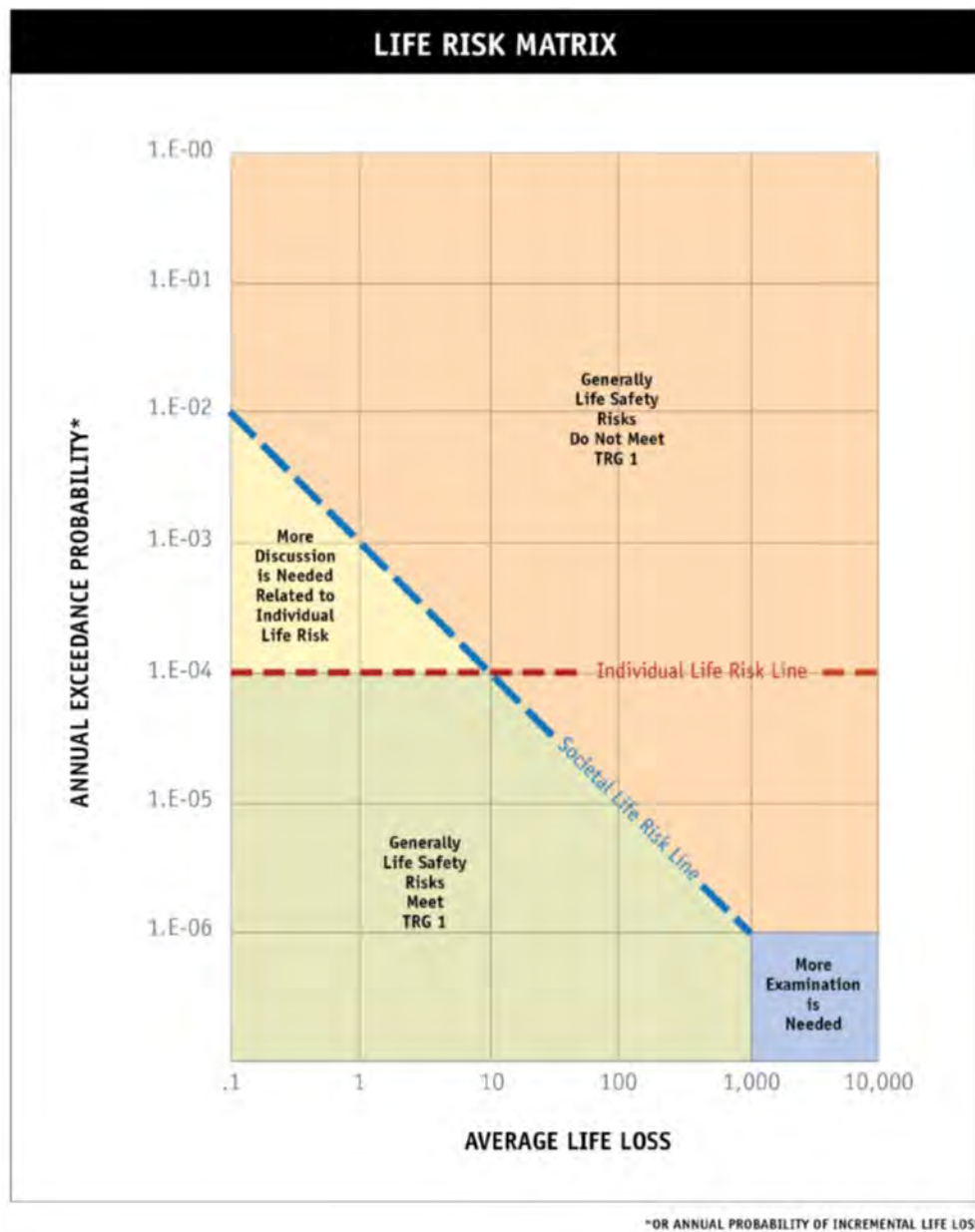


Figure 6-4. USACE Life Risk Matrix

TRG 2 – The second TRG involves determining that there is a continuing recognition of the levee risk because the risk associated with levee systems are not broadly acceptable and cannot be ignored. The rationale for meeting TRG 2 will be determined qualitatively and may consider if the levee sponsor has access to and is aware of the best available levee risk information, if the community in the leveed area has been provided the best available risk information associated with the levee system, and if flood risk (residual risk) and potential changes to flood risk over time have been communicated to the community.

TRG 3 – The third TRG involves determining that the risks associated with the levee system are being properly monitored and managed by those responsible for managing the risk. The rationale for meeting TRG 3 will be determined qualitatively and may be met through demonstrated monitoring and risk management activities. This would include an active

operation and maintenance program, visual monitoring (documented regular inspections), updated and tested emergency plans, an instrumentation program, and a best available risk characterization.

TRG 4 – The fourth TRG involves determining that those responsible for managing the risk associated with a levee system continue to reduce the risk still further as practicable. The rationale for meeting TRG 4 will be determined qualitatively and USACE will take into account the level of life safety risk in relation to the societal and individual tolerable risk lines; the disproportion between implementing the risk reduction measures and the subsequent risk reduction achieved; the cost-effectiveness of the risk reduction measures; and societal concerns as revealed by consultation with the community and other stakeholders.

The plan formulation and evaluation during the study focuses on achieving risks that society is willing to live with to secure certain benefits (TRG 1). At a minimum, there will be at least one alternative that addresses TRG 1 identified during the study. TRGs 2-4 primarily will be met through life-cycle OMRR&R requirements and the required floodplain management plan. Activities of the levee safety program may be identified and used to determine if and how TRGs 2-4 will be met. All requirements must be identified and accounted for in the benefits and costs in order for the alternative plans to be considered effective and complete. Actions necessary to make the project complete, including consideration of TRGs 2-4, will be included in the report.

Contributions to meeting TRGs 1 and 4 will be identified as being fully, partially, or not met. The TRGs will be considered in the context of the four Principles and Guidelines criteria (completeness, acceptability, efficiency, and effectiveness) and the four evaluation accounts (NED, Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ)), as appropriate.

6.4.3 2057 DESIGN

As described throughout the report, this GRR will re-evaluate the performance of the WBV project to determine if additional actions are recommended to sustain the authorized level of risk reduction for hurricanes and tropical storms. As previously discussed, the existing floodwalls and hardened structures project design elevations were intended to provide 1% AEP risk reduction in the year 2057 (the “2057 design”) as estimated at the time they were designed. Alternatives will consider increasing, maintaining, or decreasing these elevations and this level of risk reduction in order to ensure all reasonable alternatives have been evaluated.

Additionally, the original design of the perimeter hard structures may have used projections for subsidence, sea level rise and other variables that are different from those used in this study. Therefore, this study may find that some WBV features do not achieve the originally intended level of risk reduction. Cost concerns related to modifying or re-building of hard structures may limit the overall achievable level of risk reduction.

6.5 INITIAL ARRAY OF ALTERNATIVES

This section summarizes the strategies utilized to identify the initial array of structural and non-structural alternative plans based on initial data collection and professional judgment. At this stage of the planning process, the potential alternatives do not consist of any particular structures, structural modifications, or non-structural alternatives.

The initial array of alternatives includes:

- No Action Alternative
- Alternative 1: System Levee Lifts to the Projected 1% AEP Event at 2057
- Alternative 2: System Levee Lifts to the Projected 1% AEP Event at 2073
- Alternative 3: System Levee Lifts at 2073 that Maximize Benefits
- Alternative 4: Selective Levee Lifts
- Alternative 5: Non-Structural

The term “levee lifts” in this initial array of alternatives is used to indicate that levee lifts are anticipated to be the primary measure in those alternatives but is not meant to imply the exclusion of other measures. No minimum lift amount was assumed for alternatives; levee lifts are planned to occur when the previous lift settles to the project grade (i.e., the design elevation at the top of the levee, which varies across the system). Conducting a “lift” at this stage will ensure that the system maintains the intended level of risk reduction. As described in Section 6.2.1, the levee will be built to a height that meets the immediate elevation requirements related to hydraulic design. After a period of settlement, future lifts are constructed on the levee to reestablish the levee to either its original construction height or the current design height based on hydraulic and other factors. This method may require several lifts be constructed periodically over time, but it is a cost-effective method to assure the levee crown elevation will be at or above the design elevation.

At this stage of the planning process, alternatives were conceptually formulated to include a number of placeholder measures (e.g., interior drainage improvements) for possible inclusion. For most alternatives, levee lifts or floodwall modifications/replacements were determined to be integral features of any structural alternative and were the foundation of the formulation strategy at this stage. The other remaining measures (e.g., floodside armoring, wave berms, etc.) could provide ancillary benefits as secondary measures. As such, the descriptions of the initial array of alternatives focus on the primary features (levees/floodwalls) that provide risk reduction for varying events (e.g., 1% AEP at 2057). These descriptions focus on the overall strategy to provide risk reduction rather than a detailed overview of each measure considered for inclusion. The need for other remaining measures (e.g., interior drainage improvements) will be considered following selection of the recommended plan.

The structural alternatives described below (all alternatives except the No Action Alternative and Alternative 5, Non-Structural) were formulated to address the level of risk reduction provided at the existing system perimeter of this large area. Three of them provide a uniform level of risk reduction at the perimeter (which would reduce the risk of interior flooding uniformly but not reduce flood depth uniformly, due to variations in interior topography) while one considers less comprehensive, site-specific structural improvements (e.g., levee lifts in targeted areas). Section 6.7.1.3 provides more information on the formulation and evaluation of non-structural measures in site-specific locations.

6.5.1 NO ACTION

The No Action Alternative assumes the FWOP conditions in the absence of any additional federal action beyond the non-federal sponsor operation and maintenance (O&M) of existing authorized features. Levee lifts are not currently specified as O&M requirements under the Project Partnership Agreements (PPAs) WBV. Any specified O&M and any reasonable activities to be pursued by state and local interests in the future are assumed to be undertaken. The No Action Alternative forms the basis against which all other alternatives plans are measured.

6.5.2 ALTERNATIVE 1. SYSTEM LEVEE LIFTS WITHOUT HARD STRUCTURE MODIFICATION

The first alternative would incrementally raise the elevation of levees over time but not modify the hard structures. This alternative is anticipated to be less costly than other alternatives which require both levee lifts and floodwall modifications, as there are significant costs associated with the modification or re-building of hard structures. The hard structures were designed for the 1% AEP event at the year 2057 (as calculated in 2006 following project authorization) and would be a limiting factor to the amount of risk reduction achievable under this alternative. Therefore, this alternative includes levee lifts only and could include the addition of co-located levees along the Mississippi River. Note that this alternative would result in less than 1% AEP risk reduction at the end of the 2073 period of analysis because some hard structures would not meet the height requirements.

6.5.3 ALTERNATIVE 2. SYSTEM LEVEE LIFTS TO THE PROJECTED 1% AEP EVENT AT 2073

The second alternative would incrementally raise the elevation of levees and floodwalls (if needed) over time to restore the system's ability to provide risk reduction from the projected future (2073) 1% AEP coastal storm event. Existing WBV authorization is to construct the level of risk reduction required for participation in the NFIP at the time of construction, which requires a levee be accredited to the 1% AEP level of risk reduction. However, absent additional construction, that 1% AEP LORR would be lost sometime during the study's period of analysis due to subsidence and sea level rise. Alternative 2 would extend that 1% AEP level of risk reduction to 2073, which is the end of this GRR study's 50-year period of analysis.

6.5.4 ALTERNATIVE 3. SYSTEM LEVEE LIFTS AT 2073 THAT MAXIMIZES BENEFITS

The third alternative would seek to identify the maximum benefits achievable in the 50-year period of analysis (which may be more or less than the 1% AEP event). This alternative considers whether higher net benefits could be achieved by either 1) adding measures to Alternative 1 or Alternative 2 that would improve project performance or reduce costs or 2) considering different levels of risk reduction..

6.5.5 ALTERNATIVE 4. SELECTIVE LEVEE LIFTS UP TO 1% AEP EVENT

The fourth alternative considers the possibility that there may be no need or possibly insufficient benefits to raise the entire system. For this "selective lifts" alternative, consideration would be given to the feasibility of constructing features to maintain a consistent level of risk reduction across the system or reduce risk in areas where life safety risk associated with overtopping is highest and/or where economic damages are greatest.

6.5.6 ALTERNATIVE 5. NONSTRUCTURAL

Alternative 5 is a non-structural plan that avoids levee modifications as much as possible. While non-structural measures may be included as part of any of the structural plans, Alternative 5 is the only standalone non-structural alternative formulated for the study.

6.5.7 SUMMARY: INITIAL ARRAY OF ALTERNATIVES

Table 6-2 provides a high level indication of how the alternatives were initially conceptualized as summarized above. All structural alternatives include levee lifts (and floodwall measures if needed). Other measures were added to each structural alternative to demonstrate how each is conceptually different from the others. The non-structural alternative consists of purely nonstructural measures.

Table 6-2. Array of Alternatives

Type ¹	Measures	Alternatives				
		1 1% to 2057	2 1% to 2073	3 2073 Max Benefits	4 Selective Raise 1%	5 Non- Structural
S	Levee Lift	X	X	X	X	
S	New or Modified Floodwalls		X	X	X	
S	Interior Drainage Improvements		X	X	X	
S	Add Flood-side Armoring			X		
S	Wave Berms			X		
N	Risk Communication w/ Public					X
N	Buyouts					X
N	Floodproofing					X
N	Elevations					X
NB	Living Shore Line			X		

¹S = structural, NS = nonstructural, NB = nature-based

6.6 SCREENING OF INITIAL ARRAY OF ALTERNATIVES

6.6.1 SCREEING CRITERIA

Because the initial array of alternatives were developed to satisfy criteria for completeness (having all features needed to achieve the anticipated benefits) and acceptability (viable with respect to acceptance by state and local entities, tribes, and the public and compatible with existing laws, regulations, and public policies), the initial array of alternatives was qualitatively or semi-quantitatively evaluated and screened based on preliminary H&H, life safety risk, and economic damages information (effectiveness and efficiency). First, existing and FWOP H&H conditions were modeled and preliminary economic damages were assessed using HEC-FDA. In addition, a semi-quantitative risk assessment of existing conditions was completed to identify relevant potential failure modes and evaluate overtopping performance of the systems as well as assess potential life loss and economic consequences for different conceptual breach locations across the system.

For all of these analyses, an intermediate RSLR scenario was utilized. The low RSLR scenario was not selected because the low 2073 projection is very similar (within 6 inches) of the

intermediate RSLR projection. While the high RSLR scenario was not selected at this stage, it will be used as a comparison tool when the recommended plan is optimized.

At this stage of the study, economic benefits (estimated damages and associated flood risk management benefits) were the primary factor used to screen smaller-scale alternatives from further consideration. Table 6-3 below presents the results of the screening process.

Table 6-3. Evaluation of Initial Array

#	Alternative Details	Status
No Action	No Action	Final Array
1	System levee lifts without hard structure modification	Screened from further analysis: Preliminary analysis shows there are sufficient benefits to justify floodwall improvements, so this alternative is too narrow in scope.
2	System levee lifts to the projected 1% AEP event at 2073	Final Array
3	System levee lifts at 2073 that maximizes benefits	Final Array
4	Selective levee lifts up to the 1% AEP event	Screened from further analysis: Preliminary benefits show no justification to consider selective areas.
5	Non-Structural	Final Array

6.6.2 SCREENING RESULTS

The No Action Alternative was carried forward as the basis against which all other alternatives plans are measured.

Alternative 1 was formulated as a smaller-scale plan that would be constrained by current floodwall heights (i.e., in case the potential economic benefits would not support the cost of modifying the floodwalls). This would maintain the 1% AEP level of risk reduction until sometime in the future when sea level rise would cause the floodwall design to be exceeded. While the exact time that the floodwall design elevations would be exceeded was not estimated, initial modeling indicated it would be within the 50-year period of analysis. Preliminary economic analysis indicated that there are sufficient potential benefits to include floodwall modifications or replacements in an alternative that provides the 1% AEP level of risk reduction at the end of the period of analysis. Thus, Alternative 1 was screened out; other alternatives that include floodwall modifications were carried forward.

Similar to Alternative 1, Alternative 4 envisioned a scenario where the cost of raising the whole system to a single uniform perimeter 1% AEP level of risk reduction would not be justified and selective levee lifts in targeted areas would need to be pursued. This would create an uneven level of risk reduction around the systems and would constrain the level of risk reduction to something less than 1% AEP in the future as un-raised reaches continued to be impacted by the combined effects of subsidence, settlement, and potential sea level rise. However, based on the magnitude of potential economic benefits across the entire system, alternatives that implement

system-wide levee lifts appeared to be justified. As such, Alternative 4 was screened out; other alternatives that include system-wide levee lifts were carried forward.

6.7 FINAL ARRAY OF ALTERNATIVES

Features recommended in this report are generally presented at a 35% design level commensurate with a Class 3 cost estimate per Engineer Regulation 1110-2-1302 Civil Works Cost Engineering, and utilizing existing data (such as topography and subsurface conditions) as much as possible. Design is completed during the Preconstruction Engineering and Design (PED) phase, when detailed data is acquired and final design calculations are performed. The non-federal sponsor and others have completed some Section 408 levee lift alterations independently from the federal project, which may require the recommended project features to be adjusted in those reaches.

Based on the evaluation of the initial array as described above, the following alternatives were carried forward into the final array for further development and evaluation:

- No Action Alternative
- Alternative 2: System Levee Lifts to the Projected 1% AEP Event at 2073
- Alternative 3: System Levee Lifts at 2073 that Maximizes Benefits
- Alternative 5: Non-Structural

All alternatives were developed and evaluated utilizing the intermediate RSLR projection at 2073.

6.7.1 INITIAL EVALUATION OF FINAL ARRAY OF ALTERNATIVES

6.7.1.1 ALTERNATIVE 2: SYSTEM LEVEE LIFTS TO THE PROJECTED 1% AEP EVENT AT 2073

When 1% AEP design heights were calculated for this alternative (see Appendix C – Hydraulics for a description of the design process), it became apparent that levee lifts alone would not be sufficient and many floodwalls would also have to be modified or replaced to achieve the elevations required by current HSDRRS design criteria. This resulted in much higher than anticipated project costs, but there continued to be sufficient economic benefits to support those costs. Additionally, by maintaining the current level of risk reduction, this alternative was anticipated to return the future life safety risk due to overtopping to tolerable levels, thus satisfying the policy requirement to have at least one alternative which addresses TRG 1 and TRG 4.

6.7.1.2 ALTERNATIVE 3: SYSTEM LEVEE LIFTS AT 2073 THAT MAXIMIZES BENEFITS

As described above, Alternative 3 was originally formulated to potentially capture greater benefits than Alternative 2 by either 1) identifying measures in addition to levee lifts that could provide additional economic benefits (reduce overall cost and/or improve project performance), or 2) considering other levels of risk reduction. During preliminary analyses it became clear that levee lifts (and, later, floodwall modifications or replacements) would be integral to any structural alternative. The other remaining measures (e.g., living shoreline, flood side armoring, interior drainage improvements, etc.) would be insufficiently effective (alone or in combination with each other) if there were no levee or floodwall modifications or replacements.

To consider ways to reduce costs, the study team evaluated potential locations for wave berms in the project area. Wave berms would have the effect of causing waves to break far enough from the levee crown that it reduces run-up and therefore decreases design heights. However, there were few technically feasible locations to place wave berms in the project area and thus no significant improvements in overall project performance were determined to be likely.

Although the authorizing language limits the recommendation to the 1% AEP level of risk reduction, in order to consider a reasonable range of alternatives, the team then considered if a higher (greater than 1% AEP) level of risk reduction may yield greater net benefits. To determine this, a 0.5% AEP design was developed and net economic benefits were estimated. While both alternatives still produced significant positive net benefits, the 0.5% AEP yielded fewer net benefits than the 1% AEP design. Given that net benefits declined between the 1% AEP and 0.5% AEP designs (see Table 8-7), no additional levels of risk reduction were considered.

6.7.1.3 ALTERNATIVE 5: NON-STRUCTURAL ALTERNATIVE EVALUATION

The study team completed a targeted economic evaluation of Alternative 5 (Non-Structural). To evaluate the viability of the non-structural alternative, an equivalent annual damage (EAD) value for each structure was compared to an annualized cost for a generic non-structural measure. This assessment helped the team determine the number of structures within the structure inventory that are economically justified for a non-structural action. A non-structural measure would be economically justified if the expected storm damages to a structure (Expected Annual Damages – EAD) or group of structures are greater than the cost of a non-structural improvement to the structure or structure group.

First, the EAD was calculated for each structure in the inventory using output files from the HEC-FDA model. Next, the EAD per structure was compared against the average annualized cost of applying a non-structural measure (e.g., house raising and dry floodproofing). Average costs for non-structural measures were identified using the Southwest Coastal study as a proxy reference. In this instance, similar per-structure costs (approximately \$150,000) were used as a commensurate estimate for this screening-level assessment.

Using this same methodology, approximately 970 structures would be economically justified for the non-structural alternative for WBV, meaning the EAD for each of the 970 structures was greater than the approximate \$150,000 cost to implement a non-structural solution at each structure. This total is 1% of the total structure inventory in the study area and 2% of the subset of structures damaged from inundation. Nine smaller economically justified aggregations of structures were identified, roughly corresponding to a city block; no large economically justified aggregations of structures were identified.

The study then considered whether a focus on reducing overtopping flood risk to critical infrastructure could be justified based on reductions to life risk. Critical infrastructure includes emergency services such as hospitals, fire stations, schools, refineries, and other high value facilities (see Section 5.5.2).

After a qualitative evaluation of the type and location of the critical infrastructure affected in the future with-out project conditions it was determined that reducing damage to only critical infrastructure using non-structural measures without addressing the significant economic damages discussed in Section 5.4 and risk to life discussed in Section 5.5.2, does not meaningfully address the objectives of the study.

Based on this assessment, the stand-alone non-structural alternative is not considered sufficiently effective to consider further. Implementation of a stand-alone non-structural alternative would not provide comprehensive flood risk management solutions in the study area and would result in a large residual flood risk in the system. A more likely application of non-structural and flood proofing techniques to reduce flood risks could be implemented for individual buildings that still exhibit substantial residual flood damages once a more comprehensive solution is in place. Possible improvements to risk communication could also be considered as part of a structural plan.

6.7.2 SUMMARY: FINAL ARRAY OF ALTERNATIVES

Based on the evaluations summarized above, Alternatives 2 and 3 were the only action alternatives that were found to be complete, effective, efficient, and acceptable while meeting study objectives. The study sponsor indicated that these alternatives met their needs and requested no additional alternatives.

Figure 6-5 depicts the general footprint for both Alternatives 2 and 3. It should be noted that both alternatives are located in generally the same footprint as the existing WBV project area and existing MRL levees. Project features for both alternatives include levee lifts along the existing levee alignment as well as floodwall modifications and replacements along the existing alignment. In addition, approximately 5.6 acres of foreshore protection is included for both alternatives. It should be noted that not all reaches of the existing WBV project require levee lifts or floodwall replacement in order to meet the design height requirements. Existing landside armoring would be restored following levee modifications. The primary difference between Alternatives 2 and 3 is the height of the levees and floodwalls to be lifted and the amount of co-located levee to be added to each project. These alternatives are compared to each other in Section 8.



Figure 6-5. WBV Alternative 2 and 3 – General Footprint

7 ENVIRONMENTAL CONSEQUENCES*

7.1 BACKGROUND

In accordance with NEPA, this section includes the scientific and analytic basis for comparison of the considered alternatives identified in Section 6 – Plan Formulation. This section discusses the important environmental resources located in the study area and describes those resources impacted, directly or indirectly, by the proposed actions (Table 7-1). The impact analysis follows Council on Environmental Quality (CEQ) (1978) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act since the Notice of Intent was issued (2 April 2019) before the effective date (14 September 2020) of the CEQ 2020 Final Rule. *Direct impacts* are those actions that are a result of the implementation of an action alternative and occur at the same location and time. *Indirect impacts* are those impacts that occur later in time and/or farther removed from the study area but are still reasonably foreseeable. *Cumulative impacts* are defined as the “impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such action” (40 Code of Federal Regulations [CFR]. § 1508.7). Cumulative impacts are discussed in Section 7.1.3 and at the end of each resource section within this section of this EIS.

The resources described in this section are those recognized as significant by laws, EOs, regulations, and other standards of national, state, or regional agencies and organizations; technical and scientific agencies, groups, or individuals; and the general public. The environmental impacts discussed are summarized and incorporate by reference the previous IERs, CED Phase I (USACE, 2013), and draft Phase II associated with the HSDRRS Emergency Alternative Arrangements¹.

The relevant resources discussed in detail include: soils, water quality resources, wetlands, uplands, fisheries, essential fish habitat, wildlife, threatened and endangered species, noise, transportation, recreation, aesthetics, and the human environment (*i.e.*, socioeconomics). Although invasive species, cultural and historical resources, air quality, EJ, and HTRW have negligible impacts from proposed actions, they are nonetheless discussed in the following sections to demonstrate compliance with applicable laws.

7.1.1 DETERMINATION OF SIGNIFICANCE

Pursuant to NEPA, this section addresses the impacts in proportion to their significance (40 CFR § 1502[b]). *Significance* requires consideration of context and intensity². To determine whether an action has the potential to result in significant impacts, the context and intensity of the action must be considered. *Context* refers to impact of timing and duration. Context is estimated as either short-term or long-term. *Short-term* effects include those impacts that would occur during implementation of the project, as well as transient ecological effects that can be expected to occur during the first one to three years. *Long-term* effects might be expected to persist for up to ten years and beyond. *Intensity* refers to the area and severity of the impact.

¹ These documents are available online at: <https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/> Accessed 9 July 2019

² Context means the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Intensity refers to the severity of impact (CFR § 1508.27)

For purposes of this analysis, intensity definitions (*i.e.*, negligible, minor, moderate, and major) have been developed to assess the magnitude of effects for all of the affected resource categories resulting from implementing of either Proposed Action Alternatives.

From the purpose of this analysis, the intensity of impacts are classified as negligible, minor, moderate, or major and defined as the following:

- **Negligible:** A resource was not affected or the effects were not appreciable; changes were not of any measurable or perceptible consequence.
- **Minor:** Effects on a resource were detectable, although the effects were localized, small, and of little consequence to the sustainability of the resource and were determined to be less than significant.
- **Moderate:** Effects on a resource were readily detectable, long-term, localized, and measurable and were determined to be significant.
- **Major:** Effects on a resource were obvious, long-term, and had substantial consequences on a regional scale and were determined to be significant.

7.1.2 PROPOSED ALTERNATIVES

This section compares the effects of use of the generalized borrow areas (as described in Section 7.1.4) and the following Proposed Alternatives:

- **No Action Alternative**
- **Alternative 2:** Raising floodwalls and system levee lifts to the projected 1% AEP event at year 2073 with intermediate relative sea level rise (1.8 feet)
- **Alternative 3:** Raising floodwalls and system levee lifts to the projected 0.5% AEP event at year 2073 with intermediate relative sea level rise (1.8 feet)

It should be noted that Alternative 3 was not included in feasibility level of design efforts because Alternative 2 is the Recommended Plan. Only Alternative 2 designs, quantities, etc. have been updated since the draft report was released for public review and those updated numbers for Alternative 2 are presented in the impact analyses in this chapter. However, Alternative 3 is still included as part of this feasibility study and Environmental Impact Statement to facilitate comparison of alternatives by decisionmakers and the public. For resources where the lack of updated information for Alternative 3 is important to the analysis, information as such is provided in the discussion for that resource.

Table 7-1. Magnitude of Impacts for the West Bank and Vicinity Proposed Alternatives and Generalized Borrow Areas

Resource	Proposed Alternative	Less than Significant		Significant	
		Negligible Impacts	Minor Impacts	Moderate Impacts	Major Impacts
Soils	No Action	<input checked="" type="checkbox"/>			
	Alt 2				<input checked="" type="checkbox"/>
	Alt 3				<input checked="" type="checkbox"/>
	Borrow Areas				<input checked="" type="checkbox"/>
Water Quality Resources	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
Wetlands & Forest Resources	No Action		<input checked="" type="checkbox"/>		
	Alt 2			<input checked="" type="checkbox"/>	
	Alt 3			<input checked="" type="checkbox"/>	
	Borrow Areas		<input checked="" type="checkbox"/>		
Uplands	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas			<input checked="" type="checkbox"/>	
Fisheries	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
Essential Fish Habitat	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
Wildlife	No Action	<input checked="" type="checkbox"/>			
	Alt 2			<input checked="" type="checkbox"/>	
	Alt 3			<input checked="" type="checkbox"/>	
	Borrow Areas		<input checked="" type="checkbox"/>		
Threatened & Endangered Species	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
Invasive Species	No Action		<input checked="" type="checkbox"/>		
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
Cultural & Historical Resources	No Action			<input checked="" type="checkbox"/>	
	Alt 2	<input checked="" type="checkbox"/>			
	Alt 3	<input checked="" type="checkbox"/>			
	Borrow Areas	<input checked="" type="checkbox"/>			
Aesthetics	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			

Resource	Proposed Alternative	Less than Significant		Significant	
		Negligible Impacts	Minor Impacts	Moderate Impacts	Major Impacts
Recreational	No Action				<input checked="" type="checkbox"/>
	Alt 2	<input checked="" type="checkbox"/>			
	Alt 3	<input checked="" type="checkbox"/>			
	Borrow Areas	<input checked="" type="checkbox"/>			
Air Quality	No Action	<input checked="" type="checkbox"/>			
	Alt 2	<input checked="" type="checkbox"/>			
	Alt 3	<input checked="" type="checkbox"/>			
	Borrow Areas	<input checked="" type="checkbox"/>			
Noise	No Action	<input checked="" type="checkbox"/>			
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas		<input checked="" type="checkbox"/>		
Transportation	No Action				<input checked="" type="checkbox"/>
	Alt 2			<input checked="" type="checkbox"/>	
	Alt 3			<input checked="" type="checkbox"/>	
	Borrow Areas			<input checked="" type="checkbox"/>	
Human Environment	No Action		<input checked="" type="checkbox"/>		
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
Environmental Justice	No Action			<input checked="" type="checkbox"/>	
	Alt 2		<input checked="" type="checkbox"/>		
	Alt 3		<input checked="" type="checkbox"/>		
	Borrow Areas	<input checked="" type="checkbox"/>			
HTRW	No Action		<input checked="" type="checkbox"/>		
	Alt 2	<input checked="" type="checkbox"/>			
	Alt 3	<input checked="" type="checkbox"/>			
	Borrow Areas	<input checked="" type="checkbox"/>			

7.1.3 CUMULATIVE IMPACTS ANALYSIS

NEPA requires a federal agency to consider not only the direct and indirect impacts of a proposed action, but also the cumulative impacts of the action. Cumulative impacts are defined as those impacts that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes the actions. Representative past, present, and future regional projects were utilized in the cumulative impacts analysis.

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

The CEQ issued a manual entitled *Cumulative Effects Under the National Environmental Policy Act* (CEQ, 1997). This manual presents an 11-step procedure for addressing cumulative impact analysis. The cumulative impacts analysis for the WBV GRR followed these 11 steps, shown in Box 7-1. The cumulative impacts analysis concentrated on whether the actions proposed for this study, combined with the impacts of other projects, would result in a significant cumulative impact, and if so, whether this study's contribution to this impact would be *cumulatively considerable*.³

Future levee lifts conducted by USACE have been discussed in CED Phase I as part of HSDRRS 2057. In summary, the impacts discussion for each resource incorporates by reference the impacts previously described in the CED Phase I Volumes I, II, and III⁴ and that are described in the CED Phase II, which is currently in draft and will be released for initial public review in Spring 2021 and for final public review in late 2021.

7.1.3.1 BOUNDING CUMULATIVE IMPACTS ANALYSIS

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

The cumulative impacts geographic boundary is not restricted to the project impact area. Rather it is based on cumulative cause-and-effect relationships wherein the action's direct and indirect effects on resources are no longer measurably contribute to cumulative impacts (Shipley, 2016).

GEOGRAPHIC SCOPE OF THE HUMAN ENVIRONMENT – The geographic scope of the human environment for the WBV lies within the greater New Orleans area and includes portions of St. Charles, Jefferson, Orleans, and Plaquemines parishes (Figure 4-1 above). The future borrow sites would be located within 11 parishes in Louisiana; these include, in addition to the aforementioned parishes, Ascension, East Baton Rouge, Lafourche, St. James, St. John the Baptist, Iberville, and St. Tammany parishes.

GEOGRAPHIC SCOPE OF THE NATURAL ENVIRONMENT – The WBV comprises 4 separate sub-basins (Lake Cataouatche, Harvey-Westwego, Gretna-Algiers, and Belle

Box 7-1. Approach to Cumulative Impacts

Scoping

1. Identify resources
2. Define the study area for each resource
3. Define time frame for analysis

Describing the Affected Environment

4. Identify other actions affecting the resources
5. Characterize resources in terms of its response to change and capacity to withstand stress
6. Characterize stresses in relation to thresholds
7. Define baseline conditions

Determining the Environmental Consequences

8. Identify cause-and-effect relationships
9. Determine magnitude and significance of cumulative effects
10. Assess the need for mitigation of significant cumulative effects
11. Monitor and adaptive management, accordingly

³ Cumulatively considerable means that the incremental effects of an individual action are significant when viewed in connection with the effects of past, present, and probable future actions.

⁴ Available online at: <https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/Comprehensive-Environmental-Document/> accessed 29 Aug 2019.

Chase) located on the west descending bank of the Mississippi River within the greater New Orleans area (Figure 4-2, above).

Figure 7-1 displays the ecoregions in the vicinity of the WBV study area and potential future borrow areas. Ecoregions denote ecosystems similar in type, quality, and quantity of environmental resources that are critical for structuring and implementing ecosystem management strategies across federal and state agencies and nongovernment organizations. Ecoregions stratify the environment recognizing the capacities and potentials of ecosystems by their probable response to disturbance. Ecoregions are characterized by their geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. For example, the proposed actions along Mississippi River effects the Level III ecoregion Mississippi Alluvial Plain that extends north into Arkansas. More specifically, this area is characterized as Level IV ecoregion 73k (Southern Holocene Meander Belts), a subcomponent of the larger Level III ecoregion. This Level IV ecoregion is dominated by flat plains and river meander belts with levees, with prominent land cover and land use of forested wetlands, croplands, and urban and industrial areas (Daigle, et al., 2006)

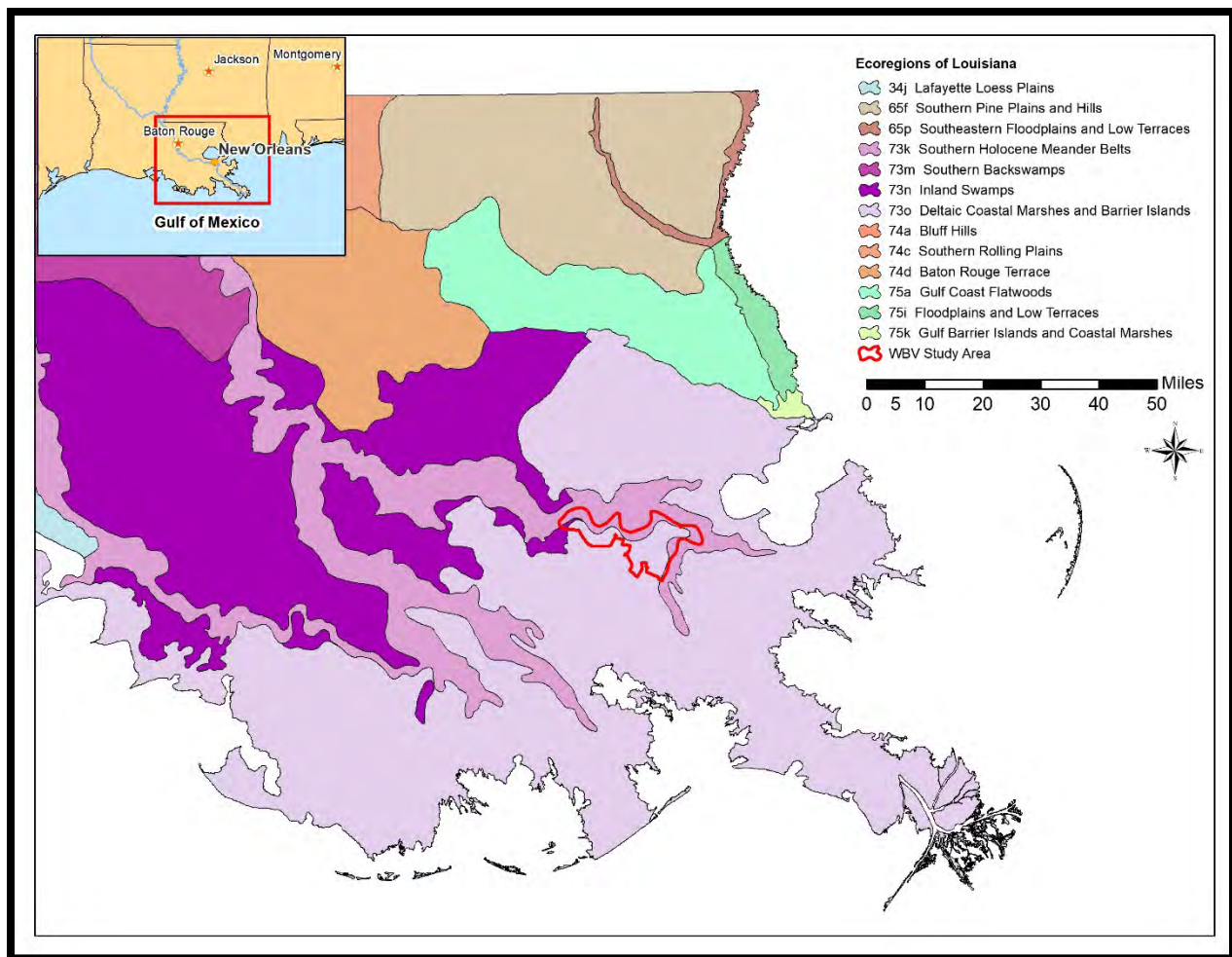


Figure 7-1. Ecoregions of Louisiana in the vicinity of the WBV Study Area

Source: <https://www.epa.gov/eco-research/ecoregions>

TIMEFRAME FOR THE ANALYSIS – The timeframe for the cumulative impacts analysis for each considered resource begins when past actions began to change the status of the resource from its original condition, setting the long-term trend currently evident and likely to continue into the reasonably foreseeable future. Historic or past actions are those occurring before October 2018 (the start of this GRR study). The present includes actions from October 2018 to the present date of GRR study report. The reasonably foreseeable future includes the 50-year period of analysis which extends from the present through 2073.

7.1.3.2 IDENTIFYING PAST, PRESENT, AND REASONABLY FORESEEABLE FUTURE ACTIONS

Section 4 discusses the existing condition of each resource by describing the present condition and providing historical context (*i.e.*, the past condition) for how the resource was altered to the current conditions. The study team used information from field surveys, discussions with project sponsor and subject matter experts, scoping comments, and literature searches to assess the past and existing conditions of the resource and to identify present and reasonably foreseeable future actions.

“Reasonably foreseeable actions” are defined as actions or projects with a reasonable expectation of actually happening, as opposed to potential developments expected only on the basis of speculation. Other present and future regional projects and programs that are applicable for the WBV study human environment and natural resources have been previously described in the IERs, supplemental IERs, and CED Phase I⁵ and are not repeated here. Only those past, present, and reasonably foreseeable future actions that overlap in space and time with the direct and indirect effects are considered; with the boundary for cumulative effects expanded to the point which the action’s direct and indirect effects no longer measurably contribute to cumulative effects.

7.1.3.3 CUMULATIVE IMPACTS BY RESOURCE

The cumulative impacts for each resource considered are discussed within each relevant resource below. Table 7-2 is a checklist identifying potential incremental cumulative effects on the resources affected by the WBV DEIS-GRR. Table 7-3 summarizes the cumulative impact analysis which includes the past, present, and reasonably foreseeable actions that might impact each resource category identified to have an incremental cumulative effect.

⁵ Previous NEPA documents available online at <https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/>. Accessed on 23 September 2019

Table 7-2. Checklist for Identifying Potential Cumulative Impacts

Resource	Past Actions	Other Present Action	Other Future Actions	Without Project	With Project		Project's Incremental Cumulative Impact
					Construction	Operation	
Soils	●	●	●	●	●	○	●
Water Quality Resources	●	●	●	○	●	○	○
Wetland & Forest Resources	●	●	●	○	○	○	○
Uplands	●	●	●	●	○	○	○
Fisheries	●	○	○	○	○	○	○
Essential Fish Habitat	●	○	○	○	○	○	○
Wildlife	●	○	○	○	○	○	○
Threatened & Endangered Species	●	○	○	○	○	○	○
Invasive Species	●	○	○	○	○	○	○
Cultural & Historical Resources	●	○	○	○	○	○	○
Aesthetics	●	○	○	○	○	○	○
Recreational Resources	●	○	○	○	○	○	○
Air Quality	●	○	○	○	○	○	○
Noise	●	○	○	○	○	○	○
Transportation	●	○	○	●	○	○	○
Human Environment	●	○	○	○	○	○	○
Environmental Justice	●	○	○	○	○	○	○
HTRW	●	○	○	○	○	○	○
KEY: ○ = Less than Significant Impact ○ = Moderate, Significant Impact ● = Major, Significant Impact							

Table 7-3 Cumulative Effects Analysis Summary for Identified Resources

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Soils	Previous levee construction and hurricane and storm damage reduction projects had significant impacts on soils, including prime farmland, throughout coastal Louisiana due to the need for borrow. The HSDRRS projects resulted in significant impacts on prime farmland soils.	Ongoing levee modifications for hurricane and storm damage reduction projects within the study area are continuing to impact soils, including prime farmland, due to the need for borrow.	Future actions in SE Louisiana will continue to need borrow to construct/maintain levee modifications for hurricane and storm damage reduction projects and flood risk reduction projects. These future actions would likely require borrow, and likely come from prime farmland.	Continued impacts from past and ongoing development, constructed levees, and other risk reduction structures. The area within the HSDRRS would have increased flood risk resulting in prime farmlands and soils being more prone to flooding into the future. Existing borrow areas would continue to be used by private individuals, non-federal, and federal agencies for other construction activities.	Alternative 2 would require 3.1 million cubic yards of fill material. Alternative 3 would require 5.086 million cubic yards of fill, likely impacting prime farmland (Alternative 3 quantities were not updated during feasibility level design). Significant impacts on soils are expected from the proposed actions due to the need from borrow likely coming from prime farmland soils. See Sections 7.2.2 and 7.2.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Water Quality Resources	<p>Clean Water Act of 1977, NEPA of 1966, Coastal Zone Management Act, and institutional recognition to restore and protect waters. Past industrial use and channelization of water bodies for oil and gas exploration and all past actions to the water bodies have significantly impaired water quality. Construction of levees along the Mississippi River to reduce riverine flooding into adjacent wetlands have reduced nutrient retention; excess nutrients from the Mississippi River watershed entering the Gulf of Mexico contributing to the Dead Zone formation.</p>	<p>Continued impacts to water resources due to population growth, oil & gas exploration and industrialization. Continued regulation enforcement and societal recognition help reduce water degradation. Programs by state and non-profit agencies as well as private citizens to improve water quality; continued localized dumping</p>	<p>Continued impacts to water resources due to population growth, oil & gas exploration, and industrialization. Continued regulation enforcement and societal recognition help reduce water degradation. Programs by state and non-profit agencies as well as private citizens to improve water quality; continued localized dumping</p>	<p>Continued impacts to water resources due to population growth and industrialization. The existing levees and flood walls would continue to be operated and maintained into future. Existing borrow areas would continue to be operated.</p>	<p>Construction-related impacts to water resources likely to occur due to increased turbidity and sedimentation, decreased DO, and increased water body temperature. The foreshore protection would impact 5.6 acres of shoreline within the GIWW and Hero Canal. The levee expansions along the MRL and filling in of BLH-Wet habitat permanently eliminate the affected wetlands' ability to perform water quality functions. Less than, significant impacts to water quality resources are expected from the proposed actions.</p> <p>See Sections 7.3.2 and 7.3.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Wetland & Forest Resources	Numerous natural (e.g., hurricanes, subsidence, erosion) and human-induced sources (e.g., coastal excavation, construction of canals and levees, drainage, invasive species), of wetland loss in southeast Louisiana, and conversion to other land use	Wetland loss and conversions to other land use. Mitigation projects and bank credits offset adverse impacts to wetlands due to constructed projects.	Wetland loss and conversion to other land use. Mitigation will continue to be used to offset wetland damages due to future actions.	Wetland loss in coastal Louisiana is expected to continue related to subsidence, sea level rise, and human development. No impacts to wetlands are expected due to routine maintenance. No impacts to Bayou aux Carpes Clean Water Act 404(c) area would occur.	<p>No permanent impacts to marsh or Cypress-Tupelo swamp habitats are anticipated with the proposed actions. Wetland impacts would occur due to MRL flood side levee shifts, impacting BLH-Wet only. These impacts would be offset through mitigation (Appendix K). The flood side shift would impact approximately 60 acres for Alternative 2 and 64 acres for Alternative 3 (Alternative 3 quantities were not updated during feasibility level design). No impacts to Bayou aux Carpes Clean Water Act 404(c) area would occur. The proposed actions are anticipated to have significant impacts to wetland resources.</p> <p>See Sections 7.4.2 and 7.4.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Uplands	Past construction of levees and risk reduction structures have resulted in highly disturbed areas along the levee reaches. Upland habitats have been adversely impacted due to uplands being used for borrow areas for construction activities.	Continued use of upland habitats for borrow areas for construction activities. Existing levees would continue to be maintained as grass turf with routine maintenance of mowing along the levee as necessary.	Continued use of upland habitats for borrow areas for construction activities. Existing levees would continue to be maintained as grass turf with routine maintenance of mowing along the levee as necessary.	Actions by others on uplands would continue. Maintenance of existing WBV levee system would continue. Existing borrow areas would continue to be operated and actions by others would continue.	<p>Existing levees would be cleared of turf during construction and then re-vegetated with turf. Uplands associated with the levee footprints would stabilize following construction. Upland habitat associated with borrow areas would likely come from upland areas. Impacts to uplands within the proposed footprint of the levee lifts and floodwall raises would be less than significant, but uplands associated with required borrow would likely be significantly impacted. Exact impacts would be analyzed upon selection of borrow sites in the future.</p> <p>See Sections 7.5.2 and 7.5.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Fisheries and Essential Fish Habitat	Institutional recognition of decline in EFH quality; passage of Magnuson-Stevens Fishery Conservation and Management Act, as amended, formation of NMFS, and Louisiana Department of Wildlife and Fisheries (LDWF); Fish and Wildlife Coordination Act; Marine Mammal Protection Act; decline in fish and EFH due to overharvest and loss of habitat from natural conditions and human induced changes.	Institutional recognition of natural resources and fish resources and its habitats. Continued loss of habitat due to conversion and subsidence. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Continued loss of fish and EFH resources due to habitat loss. Sea level rise and subsidence expected to continue. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Actions by others would continue to affect fisheries and EFH. Sea level rise will likely increase saltwater intrusion and exacerbate ongoing conversion of wetlands to shallow open water resulting in loss of existing fish habitats. The existing levee maintenance would not impact existing fisheries or EFH.	Less than significant construction-related impacts on fisheries and EFH are anticipated to occur at discrete levee lift and floodwall raise construction sites. The placement of foreshore protection would lead to direct burial of immobile species. Despite some adverse impacts to fisheries and EFH, the proposed action is expected to result in only minor, less than significant short-term effects. See Section 7.6.2, 7.6.3, 7.7.2, and 7.7.3 for further details.
Wildlife	Institutional recognition through formation of LDWF; Endangered Species Act, Fish and Wildlife Coordination Act; Bald and Golden Eagle Protection Act; Marine Mammal Protection Act; Migratory Bird Treaty Act; decline in wildlife due to overharvest and loss of habitat from natural conditions and human induced changes.	Institutional recognition of natural resources and wildlife resources and its habitats. Continued loss of habitat due to conversion and subsidence. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Continued loss of wildlife resources due to habitat loss. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Existing maintenance of the WBV levees would continue. Wildlife that currently use the levees would continue to do so with negligible, temporary, less than significant impacts. Continued loss of wildlife resources due to habitat loss and sea level rise. Actions by others would continue.	Wildlife would be directly impacted during construction and due to loss of BLH-Wet habitat adjacent to the MRL. During construction, mobile wildlife likely to avoid the area. Significant impacts to wildlife are expected due to loss of BLH-Wet habitat along the MRL. Wildlife habitat associated with required borrow sites would likely be impacted. Exact impacts would be analyzed upon selection of borrow sites in the future. See Sections 7.8.2 and 7.8.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Threatened & Endangered Species	Institutional recognition through Endangered Species Act; decline in listed and protected species due to overharvest and loss of habitat from natural conditions and human-induced changes.	Continued impacts to listed and protected species habitat by natural conditions such as hurricane storm surge, saltwater intrusion and subsidence, and man-made conditions such as agriculture, human development, and industrialization.	Continued impacts to listed and protected species habitat by natural conditions such as hurricane storm surge, saltwater intrusion and subsidence, and man-made conditions such as agriculture, human development, and industrialization.	Degradation and loss of habitat would continue and adversely impact the listed species in and near the vicinity of the study area. Recovery plans for the listed species would offset, to some degree, the adverse cumulative impacts on listed species. Continued maintenance of the WBV levees is not likely to adversely affect listed species.	<p>The proposed action would have no effect on Gulf sturgeon and would not likely adversely affect West Indian Manatee and Pallid sturgeon, during construction and future operation of the proposed actions. These effects are considered to be temporary and less than significant.</p> <p>See Sections 7.9.2 and 7.9.3, and Appendix G for more details.</p>
Invasive Species	Introduction and spread of invasive species degraded native habitats. Institutional recognition through EO 13112 and EO 13751	Continued threat of invasive species. Invasive species management and eradication programs conducted by other entities offset some damage to native habitats.	Continued threat of invasive species. Invasive species management and eradication programs conducted by other entities would offset some damage to native habitats. New invasive species likely to expand into study area.	Continued threats of invasive species would continue. Existing invasive species would persist.	<p>Existing invasive species would persist in the study area. Implementation of BMPs to reduce the spread of invasive species would be followed during construction. Less than significant impacts on invasive species are expected. See Section 7.10.2 and 7.10.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Cultural & Historical Resources	Institutional recognition through National Historic Preservation Act, EO 13007, EO 11593, Native American Graves Protection and Repatriation Act, National Register of Historic Places.	Construction of levee and risk reduction structures would continue to disturb ground and unknown archaeological sites may be uncovered. Erosion and ground deposits during hurricane and tropical storm events would continue to damage known sites.	Continued construction activities would occur and unknown sites may be uncovered. Erosion and ground deposits during hurricane and tropical storm events would continue and could damage/destroy known sites.	Existing levees and floodwalls would continue to be maintained and would have no effect on cultural resources. With LORR reduced, known and unknown sites within the protected side of the WBV system may have higher risk of damage/destruction during hurricane and tropical storm events.	<p>The proposed action of levee lifts and floodwall raises are not expected to impact cultural resources due to previous surveys already being performed. If any unrecorded cultural resources are determined to exist, then no work will proceed in the area until final coordination with SHPO and THPO has been completed. Added level of flood risk reduction to known and unknown archaeological sites within the protected side of the WBV system, reducing damage caused by flood events. Less than significant impacts are anticipated.</p> <p>See Sections 7.11.2 and 7.11.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Aesthetics & Recreational Resources	Technical recognition via 1988 Visual Resources Assessment Procedure. Institutional recognition via Wild and Scenic Rivers Act, Louisiana Scenic River Act, Scenic Byways and others. Aesthetic and recreational resources negatively impacted by past hurricanes.	Continued institutional recognition. Visual resources destroyed, enhanced, or preserved by human activities and natural processes. Continued wetland loss and damages from hurricanes may have an adverse effect on the visual complexity and recreational resources within SE Louisiana.	Continued institutional recognition. Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve aesthetic and recreational resources.	Continued institutional recognition. Aesthetic and recreational resources would not change from existing conditions.	<p>Aesthetics and recreational resources would be temporarily impacted by construction activities. However, the proposed action impacts on aesthetics and recreational resources would be less than significant.</p> <p>See Section 7.12.2., 7.12.3, 7.13.2, and 7.13.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Air Quality	Institutional recognition through the Clean Air Act; General Conformity Rule; industrialization, urbanization, and human development.	Continued human development, industrialization, and urbanization have the potential to adversely impact air quality; Continued regulation enforcement and societal recognition help reduce air quality degradation.	Continued human development, industrialization, and urbanization have the potential to adversely impact air quality; Continued regulation enforcement and societal recognition help reduce air quality degradation.	Continued maintenance of the existing WBV system would continue. No changes to the attainment area status for the study area are anticipated. Continued human development, industrialization, and urbanization have the potential to adversely impact air quality. Continued regulation enforcement and societal recognition help reduce air quality degradation.	<p>During construction probable direct impacts to air quality would include temporary diesel and gasoline emissions. Air emissions from the proposed action would be temporary and less than significant. No violation of federal or state ambient air quality standards are expected. Less than significant impacts to air quality are expected.</p> <p>See Section 7.14.2 and 7.14.3 for further details.</p>
Noise	Institutional recognition through the Noise Control Act and local noise ordinances. Human development, urbanization, and industrialization.	Continued human development, industrialization, and urbanization have the potential to adversely impact noise quality; Continued regulation enforcement and societal recognition help reduce noise.	Continued human development, industrialization, and urbanization have the potential to adversely impact noise quality; Continued regulation enforcement and societal recognition help reduce noise.	Noise impacts would be similar to existing conditions. Continued maintenance of the WBV system would have minor noise related to mowing of existing levees. Local and temporary noise related to human activities would continue.	<p>Noise levels associated with construction activities would have the potential to temporarily impact noise. Future maintenance activities could result in slight increase in noise levels from equipment and associated activities; however, these increases are expected to be temporary. The noise impacts associated with the proposed action alternatives would be less than significant.</p> <p>See Sections 7.15.2 and 7.15.3 for further details.</p>

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Transportation	The transportation infrastructure includes major roads, highways, railroads, and navigable water ways that have developed historically to meet the needs of the public. Interstate 10 (I-10), an east-west bicoastal thoroughfare that connects Houston to Baton Rouge, is a primary route for hurricane evacuation and post-storm emergency response	The transportation infrastructure continues to meet the needs of the public. I-10 is the primary route for hurricane evacuation and post-storm emergency response.	Portions of highways and roads would continue to be periodically damaged by hurricane storm surge.	The routine maintenance of public roads around the study area would continue. Major transportation corridors within the study area likely would become more vulnerable to storm damage in the future. Transportation associated with existing borrow areas would continue.	Use of the area's roads would increase during construction. Truck hauling of borrow would temporarily impede vehicle traffic, increase local congestion, and adversely impact roads. These impacts would be significant. See Sections 7.16.2 and 7.16.3 for further details.
Human Environment & Environmental Justice	Institutional recognition of Environmental Justice (EO 12898) and the Department of Defense's Strategy on EJ of 1995.	High poverty rates negatively impact the social welfare of residents and resource limitations undermine the community's ability to provide assistance to residents in times of need.	Institutional recognition of EJ would continue.	Institutional recognition of EJ would continue. WBV system would not provide hurricane and storm damage risk reduction for a 1% AEP storm; the perceived and actual risks to minority and/or low-income population groups would increase resulting in a significant impact to low income and minority communities. Potential for residents to re-locate to areas with higher levels of flood risk reduction.	The proposed actions would not adversely impact socioeconomic or EJ resources within the study area. Flood side shifts of the MRL would spare impacts to the human environment. No permanent disproportionate impacts are expected to occur on any minority or low-income community. Less than significant impacts to the human environment and EJ are expected. See Sections 7.17.2, 7.17.3, 7.18.2, and 7.18.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
HTRW	Institutional recognition thru Resource Conservation and Recovery Act; CERCLA; Solid Waste Disposal Act; Industrialization and urbanization	Continued human population growth and industrialization with the potential of new HTRW impacts. Continued cleanup efforts to offset past HTRW impacts.	Continued human population growth and industrialization with the potential of new HTRW impacts	Continued maintenance of the WBV system would have low risk of encountering RECs. Should HTRW concerns or RECs arise at any time during future maintenance, USACE would coordinate with the appropriate federal and state authorities to implement an approved response action.	<p>Phase 1 ESA will be completed during feasibility. New Phase 1 would be required within a 6-month period prior to start of construction to ensure that no RECs are present. Less than significant impacts to HTRW are expected.</p> <p>See Section 7.19.2 and 7.19.3 for further details.</p>

7.1.4 GENERALIZED BORROW AREA IMPACT ANALYSIS

Extended construction windows throughout the 50-year period of analysis would be required for implementation of the multiple levee lifts associated with the project. Borrow areas available for use now may not be available when future levee lifts are needed. Accordingly, an analysis of borrow area impacts has been conducted on a “typical” borrow pit that could be chosen for use. Anticipated impacts of excavation and use of such “typical” borrow areas for the action alternatives were evaluated using the below assumptions. The assumptions are based on extensive borrow area impact assessments performed for HSDRRS implementation. During HSDRRS construction post-Hurricane Katrina (2005), over 229 million cubic yards of borrow material was cleared for use by USACE and only 93 million cubic yards was used for construction (as of June 2012, which constituted the majority of levee construction). As such, it is reasonable to assume that sufficient borrow is known to be available within the identified area. The quantities of borrow that would be needed for each lift are estimates. Specific borrow areas would be identified during pre-construction engineering and design for each segment of project construction. Borrow area acquisition requirements will continue to be evaluated to determine whether temporary or permanent easements are most advantageous to the Government. Additional NEPA documentation and associated public review would be conducted, as necessary, to address impacts associated with those borrow areas. Additionally, if a proposed borrow area contains upland bottomland hardwood forests or another significant resource that requires mitigation, a mitigation plan would be prepared in compliance with WRDA 1986, Section 906, as amended (33 U.S.C. §2283). See Appendix A for construction schedule and estimated borrow quantity for each levee lift.

Table 7-4. Borrow Area Assumptions and Requirements Incorporated into Borrow Area Analysis

Resource	Assumptions and Requirements
Locations	Borrow sites would be located within the following parishes: <ul style="list-style-type: none"> • Orleans Parish • Plaquemines Parish • Jefferson Parish • St. Charles Parish • Lafourche Parish • St. John the Baptist Parish
Socioeconomics	Borrow sites with potential EJ impacts or potential impacts to sensitive receptors would be avoided.

Resource	Assumptions and Requirements
Soils	<p>Based on an estimated 3.1 million cubic yards of material needed for construction and based on assumed 20-ft depth of borrow areas, Alternative 2 would require approximately 120 acres of borrow area. Based on the estimated 5.086 million cubic yards of material needed for construction, Alternative 3 would require approximately 197 acres of borrow area (Alternative 3 quantities were not updated during feasibility level design).</p> <p>Suitable clay material meeting the following requirements will be available:</p> <ul style="list-style-type: none"> • Soils classified as fat or lean clays are allowed • Soils with organic content greater than 9% are NOT allowed • Soils with plasticity indices less than 10 are NOT allowed • Soils classified as silts are NOT allowed • Clays will NOT have more than 35% sand content <p>Significant impacts to prime farmland soils would be anticipated given the strong correlation between suitable borrow soils and prime farmland soils.</p>
Transportation	<p>The same transportation corridors used during HSDRRS would be used, as described in <i>Transportation Report for the Construction of the 100-year Hurricane and Storm Damage Risk Reduction System</i> prepared in 2009 and incorporated by reference Invalid source specified.⁶ Moderate to major impacts to transportation would be anticipated.</p>
Jurisdictional Wetlands	<p>Suitable borrow areas that avoid jurisdictional wetland impacts would be utilized. No impacts to wetlands would be anticipated.</p>
Non-Jurisdictional (i.e., upland) Bottomland Hardwoods	<p>Suitable borrow areas that avoid non-jurisdictional bottomland hardwoods (BLH-dry) would be used. No impacts to bottomland hardwoods would be anticipated.</p>
Water Quality	<p>Water quality impacts would be minimized through the use of Best Management Practices (BMPs). Minor impacts to water quality would be anticipated during construction, dissipating upon completion.</p>
Fisheries/Essential Fish Habitat	<p>No impacts to fisheries or EFH would be anticipated due to the use of inland sites.</p>
Wildlife	<p>Some permanent impacts to wildlife would be anticipated due to permanent removal of habitat.</p>

⁶ Available online in Appendix F at <https://www.mvn.usace.army.mil/Portals/56/Users/194/42/2242/CED%20Volume%20II%20Compiled.pdf>; accessed 4 December 2019

Resource	Assumptions and Requirements
Threatened and Endangered Species	No impacts to T&E species would be anticipated as no T&E species are present in the upland areas in the target parishes.
Cultural Resources	Cultural resource surveys would be conducted on potential borrow sites; sites with cultural resources would be avoided; no impacts to cultural resources would be anticipated.
Recreational Resources	No impacts to recreational resources would be anticipated as borrow sites would likely be located on private property away from recreational areas.
Aesthetics	Minor impacts to aesthetics would be anticipated due to conversion of habitat.
Air Quality	Minor impacts during construction would be anticipated, dissipating upon completion; borrow areas would avoid non-attainment areas.
Noise	Minor impacts during construction would be anticipated and minimized through compliance with local noise ordinances; temporary impacts to wildlife in adjacent habitat would be anticipated during construction; avoidance of construction areas may cause carrying capacity of adjacent habitats to be temporarily exceeded.
HTRW	HTRW surveys would be conducted on potential borrow sites; sites with HTRW would be avoided; no impacts would be anticipated.

During scoping, the USFWS provided a recommended protocol for identifying borrow sources. The recommendations in descending order of priority are:

1. *Permitted commercial sources, authorized borrow sources for which environmental clearance and mitigation have been completed, or non-functional levees after newly constructed adjacent levees are providing equal protection.*
2. *Areas under forced drainage that are protected from flooding by levees, and that are:*
 - *non-forested (e.g., pastures, fallow fields, abandoned orchards, former urban areas) and non-wetlands;*
 - *wetland forests dominated by exotic tree species (i.e., Chinese tallow-trees) or non-forested wetlands (e.g., wet pastures), excluding marshes;*
 - *disturbed wetlands (e.g., hydrologically altered, artificially impounded).*
3. *Sites that are outside a forced drainage system and levees, and that are:*
 - *non-forested (e.g., pastures fallow fields, abandoned orchards, former urban areas) and non-wetlands;*
 - *wetland forests dominated by exotic tree species (i.e., Chinese tallow-trees) or non-forested wetlands (e.g., wet pastures), excluding marshes;*
 - *disturbed wetlands (e.g., hydrologically altered, artificially impounded).*

Notwithstanding this protocol, the location, size, and configuration of borrow sites within the landscape is also critically important. Coastal ridges, natural levee flanks, and other geographic features that provide forested/wetland habitats and/or potential barriers to hurricane surges

should not be utilized as borrow sources, especially where such uses would diminish the natural functions and values of those landscape features.

USACE would follow this recommended protocol to the extent practicable during borrow area selection. In addition, USACE will select borrow areas in the parishes listed in Table 7-4 that fall within the types of areas provided by USFWS that contain suitable soils and that do not contain significant resources to avoid a need for potential mitigation (see Figure 7-2). USACE would utilize information on suitable soils in conjunction with information on existing borrow areas to select parcels that likely meet the geotechnical and environmental requirements for borrow. Additional factors to be considered would be whether the parcels are likely to contain sufficient borrow quantity to be economically viable and whether the location minimizes the time/distance travelled between the source and the project site, and NFS preferences or information on willing landowners. USACE would then request right-of-entry for investigations from the NFS, perform borings and HTRW/cultural investigations, and validate assumptions about the material. If the location is determined to be suitable, appropriate NEPA documentation and coordination would be conducted with the goal of covering the next 5-10 years of borrow needs for the project. Upon completion of all environmental compliance requirements, USACE would request acquisition of the parcel by the NFS, which bears responsibility for acquisition of necessary lands and easements under the Project Partnership Agreement.

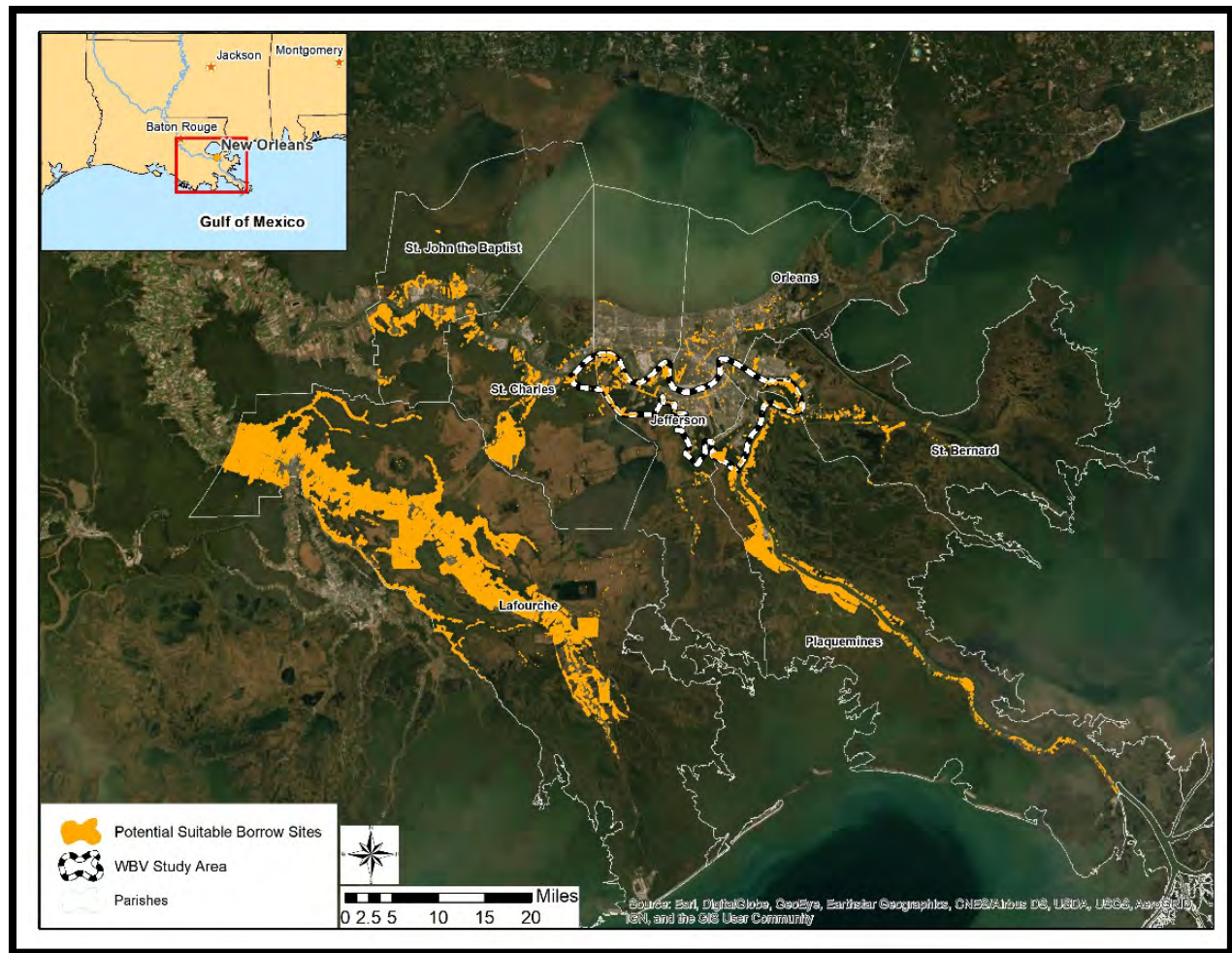


Figure 7-2. Potential Suitable Borrow Sites Based on Soil Types and Avoidance of Potential Mitigation

(data provided by USFWS, 2019; based on 2016 National Land Cover Database and National Resources Conservation Service (NRCS) soil surveys)

7.2 GEOLOGY & SOILS

7.2.1 REGULATORY FRAMEWORK

This soils resources section addresses compliance for the following applicable environmental laws and regulations:

- Farmland Protection Policy Act of 1981 (7 USC 4201 *et seq.*) 7 CFR 657-658
- 7 USC 4201, Prime and Unique Farmland
- Soil Conservation Act (16 USC 590(a) *et seq.*)
- Section 402 Clean Water Act

Impacts to soils would be considered significant if an alternative resulted in substantial conversion or loss of prime farmland soils.

7.2.2 IMPACTS OF CONSIDERED ALTERNATIVES

Soil impacts are generally defined as the change in land use of an area such that the soils in the area are no longer suitable for their best use, or the construction of facilities or structures on soils that cannot support the facilities or structures due to soil instability. The urban areas affected by the proposed actions contain soils that have previously been impacted by development, constructed levees, and other risk reduction structures.

NO ACTION ALTERNATIVE – Soils in the study area are expected to continue to be impacted from previous development, constructed levees, and other risk reduction structures. The 2011 HSDRRS projects resulted in significant impacts on prime farmland soils, which were relatively undisturbed. Impacts were both adverse due to a permanent loss of the soils and beneficial due to a reduction in risk of future flooding. Under the no action alternative, the area within HSDRRS would have increased overtopping flood risk resulting in prime farmlands and soils within the HSDRRS being more prone to flooding into the future, leading to continued significant impacts to soils. Soils located along the flood-side of the MRL would continue to be flooded and receive nutrients and sediment from the Mississippi River. Under the no action alternative, any existing borrow areas would continue to be used by private individuals, non-federal, and federal agencies for other construction activities. Prime farmland soils within these borrow areas would continue to be adversely impacted under the No Action Alternative.

PROPOSED ACTION ALTERNATIVES – For soil resources, the proposed action alternatives have similar impacts; they only differ in the amount of fill material needed for construction:

- **ALTERNATIVE 2** would require approximately 3.1 million cubic yards of fill material for construction activities. Assuming a 20-foot average depth of borrow areas this would require approximately 120 acres of borrow.
- **ALTERNATIVE 3** would require approximately 5.086 million cubic yards of fill material for construction activities. Assuming a 20-foot average depth of borrow areas this would require approximately 197 acres of borrow. (Alternative 3 quantities were not updated during feasibility level design.)

Direct Effects – Short-term construction-related impacts due to future levee lifts, armoring, and soil stabilization would include soil loss through water and wind erosion, compaction, and loss of biological productivity. Exposed soil during construction would be unstable and susceptible to wind and water erosion. After construction, the disturbed soils would stabilize and re-vegetate. Soils would also be impacted by compaction at the construction sites and loss of biological productivity. Structurally, levee soils must be compacted to provide adequate support against the pressure produced by high floodwaters. Compacted soils are less productive than aerated, loamy soils, and woody vegetation is not allowed on the levees or within a 15-foot vegetation-free zone past the levee toe. No significant impacts to prime farmland soils in the levee footprints are anticipated with implementation of the proposed alternatives since these soils have already been impacted by previous HSDRRS construction projects. Beneficial effects would be realized due to reduction in risk of future flooding.

Indirect Effects – Eroded soils from construction sites are likely to damage adjacent vegetation by coating leaf surfaces and limiting transpiration and photosynthesis and disturbing adjacent wetland communities through increased suspended solids in the water column, which reduces light penetration and decreases overall water quality.

GENERALIZED BORROW AREAS—Specific borrow areas to be used for construction of levee lifts have not been identified. USACE compared suitable borrow areas (*i.e.*, suitable soil types in areas with no sensitive ecological resources) provided by USFWS to areas designated as prime farmland (USDA, 2019) and determined that the majority of suitable fill material occurs in areas of prime farmland. Accordingly, there is a high likelihood that borrow areas would be located in areas with prime farmland soils. Alternative 2 could lead to the loss of 120 acres of prime farmland soils and Alternative 3 could lead to the loss of 197 acres of prime farmland soils (Alternative 3 quantities were not updated during feasibility level design). This is a worst-case scenario that assumes that all potential borrow acres would be excavated, and that all soils in those borrow areas would be designated as prime farmland. The use of the excavated prime farmland soils from borrow sites for WBV construction provides a benefit to the greater New Orleans area and provides a reduction in risk of flooding undisturbed farmland within the HSDRRS. However, because the loss of these prime farmland soils is permanent and would result in a substantial reduction in the available productive farmland regionally, and because of the volume of prime farmland soils already removed from production in the region since 2005 due to construction and improvement of the WBV HSDRRS features, the Lake Pontchartrain and Vicinity HSDRRS features and other construction activities, the additional loss of prime farmland soils is anticipated to have a significant impact. No mitigation measures can be implemented that would reduce the level of impact.

Therefore, Alternatives 2, 3, and associated borrow areas would have major, significant impacts on soils.

7.2.3 CUMULATIVE IMPACTS

Other regional past, present, and future actions would also continue to change the land use patterns and would contribute to the cumulative loss of prime farmland soils in southeastern Louisiana. The CED Phase 1, Volume I (USACE, 2013) provides additional detail and is incorporated by reference here and only briefly summarized here.

Beneficial cumulative impacts on soils would occur from coastal and wetlands restoration projects as healthier marsh and forested wetlands are created and protected and to some degree are better able to trap sediments, sustain vegetation, and build rich organic soils. Additionally, healthier marshes would act as a buffer for storm surge and could provide beneficial impacts on prime farmland soils further inland. Flood risk reduction projects would also provide beneficial impacts due to the reduction of storm surge.

Long-term cumulative beneficial impacts on soils would result from the implementation of levee lifts and maintenance of WBV levees in addition to the HSDRRS construction. All soils within the WBV would have a lower risk of inundation from storm events, including prime farmland soils, which could continue to be used for agricultural production during storm events. Further, with reduced risk of storm surge, it would be less likely for crop destruction to occur from flooding or brackish water inundation.

There would be adverse permanent, major cumulative impacts on soils from the construction of risk reduction efforts since Hurricane Katrina and removal of borrow materials associated with the proposed action alternatives, primarily due to the permanent loss of acres of prime farmland soils used for borrow. The magnitude of cumulative impacts on soils would be greater for the borrow sites than for construction of WBV levee lift components. Soil removed from borrow sites for WBV construction and future maintenance would occur primarily in rural areas and result in

120 acres for Alternative 2 or 197 acres for Alternative 3 that would no longer be suitable for pasture or farmland uses. (Alternative 3 quantities were not updated during feasibility level design.)

The WBV could also have a minor adverse cumulative impact on soils due to the potential for induced development in the study area as flooding risk of properties is reduced. Development pressures often result in encroachment into rural agricultural lands and with more development comes an increase in the use of impervious surfaces such as roads, homes, and parking areas. Impervious surfaces increase the flow of rainwater and erosion of exposed soils. Increased development in the study area would remove soils from biological productivity, and permanently remove prime farmland soils from agricultural production.

Collectively, the cumulative impacts due to construction risk reduction structures and levee raises in urban areas within WBV would have little adverse effect on previously disturbed soils. Areas within the HSDRRS that are designated prime farmland soils are beneficially impacted by the risk reduction system, as the land used as farmland, forestland, and wildlife habitat has a reduced risk of flooding.

Borrow material has been used by USACE for the construction of the HSDRRS and other projects in southeastern Louisiana. Over 17 million cubic yards of borrow material is estimated to have been obtained for the HSDRRS construction effort. Cumulatively, past, ongoing, and future projects in the region would result in the cumulative loss of biological productivity of soils and the potential for cumulative indirect impacts on soils through erosion and stormwater runoff as the area of impermeable surfaces increases. Due to the volume of prime farmland soils already removed for HSDRRS construction, the anticipated removal of prime farmland soils from borrow areas regionally for WBV construction would be a major impact and would be a significant loss of prime farmland soils.

Therefore, Alternatives 2, 3, and associated borrow would have major, significant cumulative impact on soils.

7.2.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to soil resources, the following environmental commitments shall be implemented:

- 1) BMPs as described by Stormwater Pollution Prevention Plans (SWPPP) would be used at levee lift construction sites to reduce erosion.
- 2) Environmentally acceptable construction practices would be used to avoid excessive disturbance of soils present in the project area.
- 3) Silt fencing and hay bales would be installed around the perimeter of the borrow areas to control runoff.
- 4) Post-construction earthen levees would be re-vegetated to reduce erosion and scour.
- 5) All fill material used for levee lift construction would be free from contamination and certified by physical testing, chemical analysis, and/or manufacturer's certification.
- 6) To make optimal use of available borrow material, excavation would begin at one end of the borrow area and be made continuous across the width of the areas to the required borrow depths, to provide surface drainage to the low side of the borrow pit as excavation proceeds.

- 7) Excavation for semi-compacted fill would not be permitted in water, nor should excavated material be scraped, dragged, or otherwise moved through water. In some cases, the borrow areas may need to be drained with the use of a sump pump.
- 8) Upon abandonment of a borrow area, site restoration would include placing the stockpiled overburden back into the pit and grading the slopes to the specified cross-section figures.
- 9) At borrow sites, all proper local, state, and federal permits would be required for potential impacts to water quality.

7.3 WATER RESOURCES

7.3.1 REGULATORY FRAMEWORK

This water resources section addresses compliance for the following applicable environmental laws and regulations:

- Clean Water Act Section 401: Water quality certification pursuant to Section 401 of the Clean Water Act would be achieved prior to construction.
- Clean Water Act Section 402: Prior to construction, the National Pollutant Discharge Elimination System permit process would be completed and a General Stormwater Permit would be required. Contractors would need a site-specific Spill Prevention, Control and Countermeasure Plan in place prior to the start of construction.
- Clean Water Act Section 404: Specific impacts to water quality due to displacement of water bodies by fill materials, stockpiling, and hydro-modifications will be described in the 404(b)1 evaluation and included prior to final report approval.
- EO 11988, Floodplains
- Coastal Zone Management Act Compliance (see Appendix G for full compliance details)

Impacts to water resources would be considered significant if an alternative:

- Caused long-term or permanent violation of state water quality standards or otherwise substantially degraded water quality.
- Caused the study area to no longer meet state of Louisiana water quality attainment status.

7.3.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Without the proposed action, the USACE expects the water quality in and near the study area to continue in a fashion similar to current conditions. Natural and human-influenced activities affecting water quality would have both potentially beneficial and detrimental effects into the future. The existing levees and floodwalls would continue to be operated and maintained into the future. Some water bodies in and adjacent to the study area would likely continue to violate LDEQ pollution criteria for their designated uses due to natural and human-influenced causes. Those with known or suspected sources of impairment may show improvement through time as controls are put in place to address the impairment.

PROPOSED ACTION ALTERNATIVES – For water resources, Alternatives 2 and 3 have similar impacts unless called out otherwise.

Direct Effects – Construction-related impacts would have direct effects to canals, drainage waterways, and open water due to increased sedimentation and nutrient loading of waterways from stormwater runoff during rain events notwithstanding use of BMPs during construction and prior to establishment of vegetated cover in newly raised levees. Direct, minor, short-term, construction-related impacts on water quality from the levee lift construction would include decreased DO levels in the waters immediately surrounding the construction site, excessive turbidity due to construction runoff and sedimentation, and increased water body temperature due to the increased suspended solids produced during construction that could absorb incident solar radiation (USACE, 2013). Where the base of the earthen levee was expanded into open water of a bayou or lake, these actions would directly impact water quality through increased sedimentation during construction activities, but impacts on water quality are expected to cease once levee material stabilized and was armored. The foreshore protection in WBV-12 and WBV-90 would impact approximately 5.6 acres of shoreline within the GIWW and Hero Canal, which would have direct short-term less than significant impacts on water quality from increased turbidity.

Indirect Effects – Earth-moving activities during construction disturb soils and can create indirect water quality effects in the event of uncontrolled runoff or poor sediment control practices during construction. Temporary, minor water quality impacts would occur due to increased nutrient loading, miscellaneous debris, and accidental spills from construction equipment. Indirect impacts could include alterations to hydrology, which could result in water column impacts, alteration of patterns, water circulation, and normal water fluctuations, in addition to changes to salinity and nutrient loads in the water. After construction, the conditions would be expected to stabilize, allowing for suspended sediments to settle and vegetation to recolonize the area.

Bayou Aux Carpes 404(C) Area – Water-based construction would be required to construct the foreshore protection in reaches WBV-90 and WBV-12. Approximately 244,000 square feet (5.6 acres) of foreshore protection would be constructed within the GIWW on the opposing bank to the Bayou aux Carpes 404(c) area (Figure 7-3). The foreshore protection is not anticipated to alter the existing hydrologic conditions within the 404(c) area. Therefore, impacts to water resources within the Bayou aux Carpes 404(c) area would be less than significant.

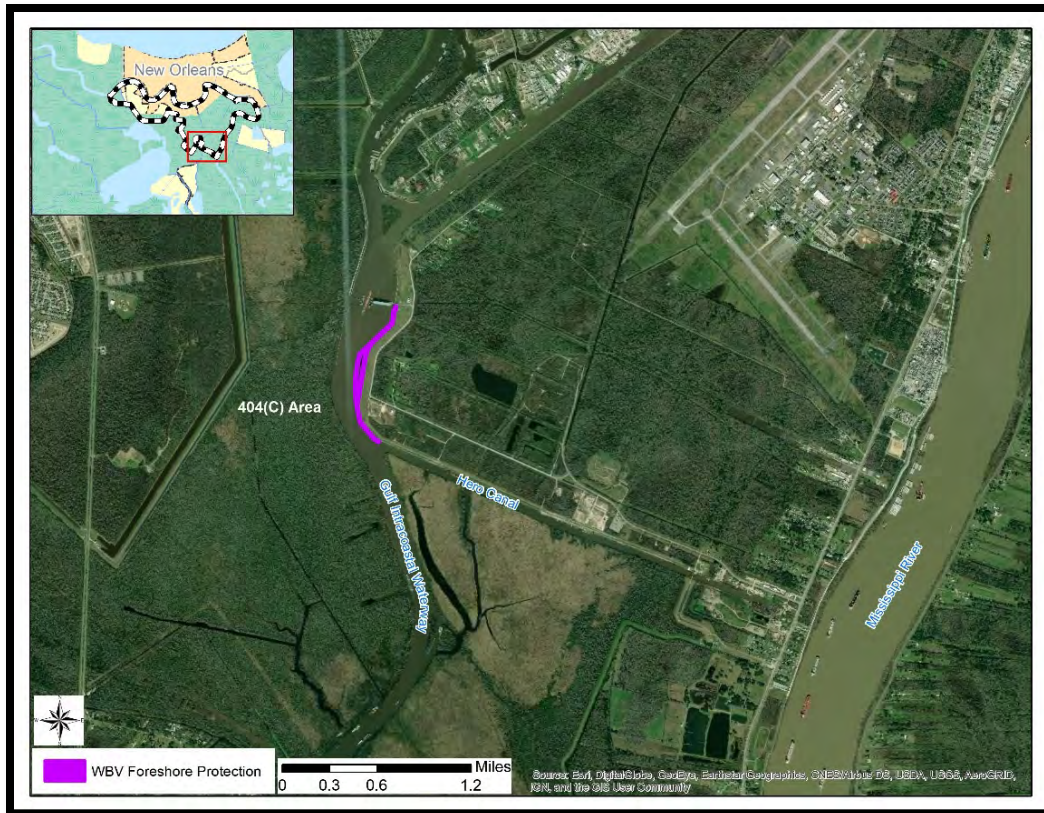


Figure 7-3. Location of Proposed Foreshore Protection Required for Alternatives 2 and 3

Hero Canal and GIWW – Any direct or indirect impacts on water in adjacent waterways such as Hero Canal and the GIWW would be temporary and minor and minimized using BMPs.

Mississippi River – In the MRL locations requiring levee expansion to the flood side, filling of BLH-wet habitat would permanently eliminate the affected wetlands' ability to perform water quality functions, causing a major, permanent significant impact to water quality. These impacts would be offset by BLH –wet compensatory mitigation (See Appendix K, *Mitigation Plan*).

Therefore, impacts to water resources from proposed action alternatives would be less than significant.

GENERALIZED BORROW AREAS – Dewatering activities during borrow site excavation is expected to increase suspended sediment concentration in waterways and wetlands near discharge points. No permanent impacts on water quality from borrow site construction and use are expected. Borrow sites are expected to be constructed in upland environments, and the beds and banks of open water bodies created from borrow site construction are expected to quickly stabilize and not contribute to sedimentation and turbidity of nearby waterways during storm events. The new water bodies in abandoned borrow pits would remain isolated and would not contribute to any degradation of existing water bodies in the regions. Disturbance of water quality would be temporary and confined to the borrow pit. **Therefore, impacts to water resources associated with borrow areas would be less than significant.**

7.3.3 CUMULATIVE IMPACTS

Past HSDRRS construction activities modified the surface hydrology, increased turbidity, decreased DO, increased suspended sediments, and potentially caused a slight increase in water temperature. Specific impacts of the HSDRRS are documented in the CED Phase I, Chapter 4, and are only summarized here (USACE, 2013). The HSDRRS construction activities did result in short-term moderate impacts to water quality for some of the sub-basins related to construction and maintenance activities. However, following the completion of construction activities and stabilization of material, there would be no further impacts on water quality.

Collectively, other present and future levee construction projects, storm damage reconstruction, redevelopment, and transportation projects would have cumulative short-term moderate adverse impacts on water quality in the region due to stormwater runoff from construction sites, dredging, and hydro-modification. However, the incremental cumulative effect of the proposed action would be less than significant.

The direct cumulative WBV impacts on water quality would be associated with the actual construction and maintenance activities. This would likely cause sedimentation and nutrient loading of waterways from stormwater runoff during rain events. These minor, short-term, less than significant impacts would include localized changes in turbidity, water temperature, salinity, temperature, DO, hydrology, and water velocity.

In general, there would be less than significant cumulative impacts on water quality from the proposed action.

7.3.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to water resources, the following environmental commitments shall be implemented:

- 1) All appropriate and practicable steps would be taken, through application of the recommendations of 40 CFR Part 230, subpart H, 230.70-230.77, to minimize adverse effects of the discharge for all proposed construction activities.
- 2) Prior to construction a SWPPP would be prepared to address potential impacts to water quality from construction equipment, construction crews, and construction practices. The SWPPP would include required BMPs to reduce run-off, prevent accidental spills, and otherwise minimize the potential for impacts to water quality.
- 3) Construction BMPs (e.g., sediment curtain) would be in place during construction.
- 4) Dust suppression methods such as watering of construction sites would be in place during construction.
- 5) Containment of fuel and construction-required chemicals would be in place during construction.
- 6) For foreshore protection construction, use of turbidity control measures is required.

7.4 WETLAND AND FOREST RESOURCES

7.4.1 REGULATORY FRAMEWORK

This section addresses compliance for the following applicable environmental laws and regulations:

- Section 906(d) of WRDA 1986

- Fish and Wildlife Coordination Act
- Clean Water Act Section 401
- Clean Water Act Section 402
- Clean Water Act Section 404
- Executive Order (EO) 11990, Protection of Wetlands
- EO 11988, Floodplain Management

Impacts to wetlands and forest resources would be considered significant if substantial conversion or loss of wetlands would occur due to proposed actions.

7.4.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Wetland loss in coastal Louisiana is expected to continue due to subsidence and development of human infrastructure (USACE, 2013; Boesch, 1994). Future major hurricane events are expected to convert marsh into open water similar to the conversion that occurred from Hurricanes Rita and Katrina (Barras, Bernier, & Morton, 2008). The historic balance between wetland loss and formation along the deltaic plain would continue to be interrupted due to changes to the Mississippi River. The maintenance of the Mississippi River in its current course and subsequent changes to the deltaic cycle would continue as today, resulting in the majority of the sediment deposition and fresh water to be discharged off the continental shelf. The problem of saltwater intrusion into historically less saline marshes is expected to continue. Continued loss of cypress-tupelo swamps and BLH forests due to wind, storm surge damage, and saltwater intrusion would continue to impact the regional habitat and biological resources in the study area. CPRA 2017 Master Plan data indicate that large expanses of coastal marsh may be lost over the next 50 years, even with implementation of the Master Plan (Figure 7-4).

Without implementation of the proposed action, there would be no actions taken to lift the WBV levee reaches or raise existing floodwalls. However, maintenance activities would continue to occur. As no vegetated wetlands exist in the project footprints, no wetlands would be impacted by such continued maintenance. No impacts to the Bayou aux Carpes Clean Water Act Section 404(c) area would occur.

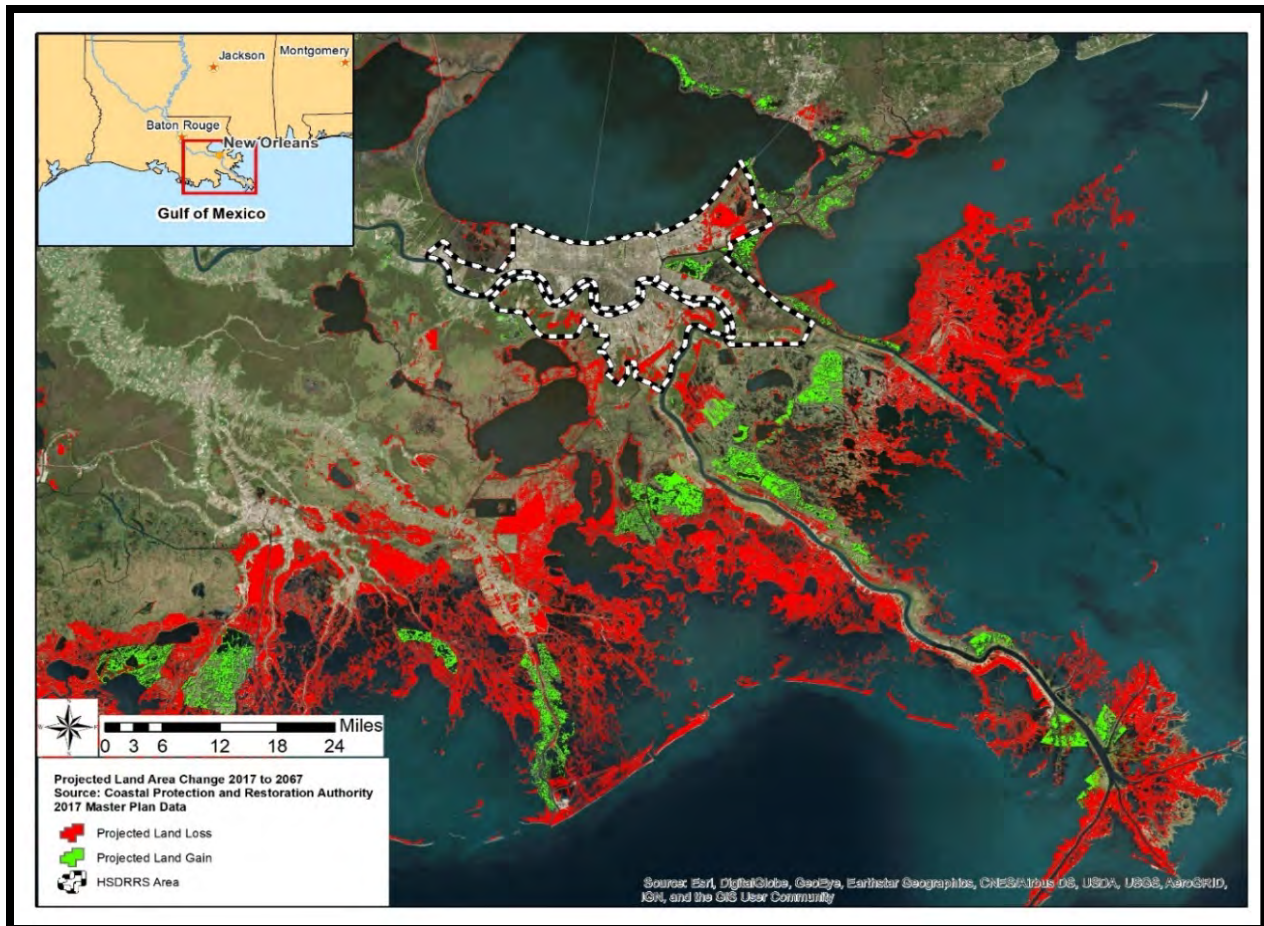


Figure 7-4. Projected Land Area Change from 2017 to 2067 based on CPRA 2017 Master Plan Data (medium scenario, with Master Plan implementation)

PROPOSED ACTION ALTERNATIVES – For wetland and forest resources, Alternatives 2 and 3 have identical impacts unless called out otherwise.

Direct Effects – No permanent impacts to marsh, SAV, or Cypress-Tupelo swamp habitats are anticipated with implementation of the Proposed Action Alternatives. However, potential wetland impacts would occur with levee lifts associated with the MRL due to the necessity to expand the levees to the flood side, thereby impacting BLH-wet habitat. These impacts would be avoided to the maximum extent practicable but would be unavoidable in some locations due to avoidance of existing infrastructure on the protected side of the levees. Initial design estimates indicate an additional 25 feet would be required on the flood side of the existing levees for construction in various reaches. These flood side shifts would impact approximately 60 acres of BLH-wet habitat with Alternative 2 and approximately 64 acres for Alternative 3. (Alternative 3 quantities were not updated during feasibility level design.) Existing rights of way would be used in all other cases. Placement of foreshore protection (approximately 5.6 acres) on existing foreshore protection within the GIWW and Hero Canal would result in no new impacts to wetland resources, including SAV.

Indirect Effects – Temporary increases in suspended sediment and turbidity of marshes adjacent to construction sites and staging areas could occur from stormwater runoff, but these impacts are anticipated to be minor and short-term in nature. Indirect effects of construction

(e.g., increased turbidity, noise, vibrations, fugitive dust, etc.) would have temporary effects to the wetland habitats. Overall, the adjacent wetlands would stabilize following construction, allowing sediment to settle and vegetation to stabilize the area.

Bayou Aux Carpes 404(C) Area – Approximately 244,000 square feet (5.6 acres) of foreshore protection would be constructed within the GIWW on the opposing bank to the Bayou aux Carpes 404(c) area (Figure 7-3). No direct impacts to 404(c) would occur and BMPs would be used to decrease/minimize any impacts occurring near the 404(c) area. Therefore, the Proposed Action Alternatives would have less than significant impacts to wetland resources within the 404(c) area.

GENERALIZED BORROW AREAS – Borrow areas would be selected so as to avoid any impacts to wetland or bottomland hardwood resources. The potential for indirect impacts on jurisdictional wetlands from borrow site excavation exists; however, measures implemented to protect jurisdictional wetlands from borrow site excavation during HSDRRS construction (upland buffers) were successful in preventing indirect impacts.

The Proposed Action Alternatives are anticipated to have a significant impact on wetland and forest resources, requiring compensatory mitigation (see Appendix K, *Mitigation Plan*). Approximately 37.21 AAHUs of BLH-Wet habitat are required for Alternative 2 and 39.55 AAHUs for Alternative 3 to offset BLH-Wet impacts resulting from proposed actions. (Alternative 3 quantities were not updated during feasibility level design.)

7.4.3 CUMULATIVE IMPACTS

Cumulative impacts to jurisdictional wetlands throughout the greater New Orleans area would continue with or without the proposed action. Impacts to wetlands, including mitigation projects from HSDRRS would continue. Past, ongoing, and future 404 permitted actions are expected to continue which would impact wetland resources. Historical and present wetland loss and gain in southeastern Louisiana has been caused by a multitude of natural and anthropogenic actions (Barras, Bernier, & Morton, 2008). Coastal wetland loss has occurred for thousands of years in Louisiana and has until the 20th century been balanced by various natural wetland building processes (LACOAST, 1997). Multiple factors have been associated with coastal land loss, including the inhibition of sediment movement into coastal systems due to levee systems along the Mississippi River; man-made canals and their associated hydrologic changes (i.e., saltwater intrusion); a decline of suspended sediments coming from the Mississippi River due to upriver dams and other projects; erosion caused by wave action and boating activity; geologic compaction and faulting; storm events, including hurricanes; and relative sea level rise (Boesch et al., 1994). Public and private wetland creation and restoration projects have contributed to wetland gain in southeastern Louisiana. Major programs and initiatives include the Coastal Wetlands Planning, Protection and Restoration Act program; the Beneficial Use of Dredged Material program; WRDA restoration projects (e.g., Davis Pond Freshwater Diversion); vegetation restoration projects (e.g., National Resources Conservation Service Plant Materials Center); Louisiana state restoration projects; the Louisiana Parish Coastal Wetland Restoration Program; FEMA restoration projects; public and private parties' initiatives, including those of nongovernmental organizations and corporations; and private mitigation banks. It is expected that the trend of wetland loss would continue, the rate of which would be slowed by the previously mentioned wetland creation and restoration initiatives.

Indirect cumulative impacts include alterations to habitats and hydrology, which could result in changes to salinity and nutrient loads in local wetlands, leading to additional wetlands loss. Flood risk reduction projects and other regional projects occurring near wetlands would cause damage to adjacent wetlands vegetation (including SAV) and increase turbidity and sedimentation in the adjacent wetlands habitat and drainage canals.

The Proposed Action Alternatives are anticipated to have significant cumulative impacts on wetland and forest resources, requiring compensatory mitigation.

7.4.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to wetland and forest resources, the following environmental commitments shall be implemented:

- 1) Compensatory mitigation required to offset impacts to Bottomland Hardwood – Wet will be implemented (See Appendix K, *Mitigation Plan* for details)
- 2) Avoidance methods and the use of buffer and “no-work” zones for the minimization of impacts on wetlands and non-jurisdictional BLH would be used.
- 3) No borrow excavation or work areas will be permitted in the areas designated as wetlands. Wetlands would be protected through implementation of BMPs. These practices include Installation of a silt fence around areas of excavation and maintaining a 100-foot buffer between the fence and wetlands areas in order to prevent surface runoff discharge into the wetlands.
- 4) A SWPPP and daily inspections by borrow personnel and other BMPs designed to protect wetlands as necessary would be used.
- 5) BMPs would be implemented to ensure adjacent wetlands and waters of the United States are not impacted by runoff during construction. Construction-related run-off into the wetlands would be managed through BMPs, which would minimize the potential indirect adverse impacts from considered action alternatives on wetlands. BMPs are effective, practical, structural or nonstructural methods which prevent or reduce movement of sediment, nutrients, pesticides, and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of construction activities. BMPs would be used to minimize construction related impacts along the entire study area.
- 6) Because of the sensitivity and significance of the Bayou aux Carpes 404(c) area, every effort would be made to minimize impacts during construction and the following measures would be required:
 - a. Training of all construction supervisors and workers would be undertaken by the contractor before work begins. This training would include an explanation of the importance of Bayou aux Carpes area and the regulatory authority for its protection; identification of the boundaries of protected and regulated areas; and the ecological and legal ramifications of encroachment, spills, and other violations of the laws and measures that protect this USEPA-designated area. Employees would be trained prior to working on site. The contractor would be required to supply 404(c) hard hat stickers which will serve as recognition that training has been completed.
 - b. Continue coordination with the National Park Service and USEPA regarding any proposed project feature that may impact this area.

- 7) Borrow areas would be selected that avoid impacts to wetlands and non-jurisdictional BLH.
- 8) All fill material used for levee lift construction would be free from contaminants.
- 9) All fill material would be placed by qualified contractors using the appropriate equipment to minimize impacts on wetland areas and equipment would be properly maintained.

7.5 UPLANDS

7.5.1 REGULATORY FRAMEWORK

This uplands resources section addresses compliance for the following applicable environmental laws and regulations:

- Fish and Wildlife Coordination Act
- Section 906(d) of WRDA 1986

Impacts to uplands would be considered significant if an alternative resulted in substantial loss and conversion of upland habitats.

7.5.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – The habitat within all of the levee footprints is grass turf. The project areas of all reaches have been highly disturbed as a result of HSDRRS construction. The levee reaches were replanted with grass turf following completion of HSDRRS levee construction and are maintained by periodic mowing. Herbaceous woody vegetation is not allowed to take root within the levee footprint or the “vegetation-free zone” which extends 15 feet past the toe of each levee reach. It was assumed that the existing levee would be maintained to keep turf grass growing and woody species from establishing. The existing levee would be mowed routinely as necessary. In general, upland resources would remain similar to existing conditions; however, some uplands in the vicinity of the study area may become more saturated due to relative sea level rise and regional subsidence. There would be less than significant direct or indirect impacts to uplands within the project area if the levee lifts were not constructed.

ALTERNATIVES 2 AND 3 – Alternatives 2 and 3 would have similar impacts unless otherwise noted below.

Direct Effects – Direct impacts would result from the clearing of approximately 1,634 acres of the existing levee turf grass and associated organic material for both proposed action alternatives. The waste material would be disposed of in compliance with all applicable federal, state and local laws. Following the completion of construction, the levee slopes would be re-vegetated and turf grasses maintained similar to pre-construction conditions.

Indirect Effects – Indirect effects of construction (e.g., increased turbidity, noise, vibrations, fugitive dust, etc.) would have temporary effects to the upland habitats. Overall, the uplands would stabilize following construction, allowing sediment to settle and vegetation to stabilize the area.

Therefore, impacts to uplands within the proposed footprint of the levee lifts and floodwall raises would be less than significant.

GENERALIZED BORROW AREAS – Excavation of borrow areas would affect upland habitat. In general, borrow areas would likely consist of primarily of agricultural lands (e.g., sugarcane

fields, pasture), fallow agricultural lands, pine plantations, existing borrow sites, or formerly developed land. Any new upland borrow areas used for proposed action would be cleared of existing vegetation, excavated, and would most likely convert to open water habitat, reducing forage and breeding habitat for upland wildlife. Alternative 2 would require approximately 120 acres of borrow area to supply fill for construction. Alternative 3 would require approximately 197 acres of borrow area to supply fill for construction. (Alternative 3 quantities were not updated during feasibility level design.) Borrow areas will be located in uplands. Borrow areas would meet the assumptions outlined in Section 7.1.4, including avoiding impacts to BLH-Dry habitat.

Therefore, borrow areas would have moderate, significant impacts to uplands.

7.5.3 CUMULATIVE IMPACTS

Even though minimal in size when compared to the regional extent of forested and grassland habitats directly and indirectly affected by previous development activities, the excavation and use of borrow material in the study area, in combination with the past, present, and future large-scale construction projects, would cumulatively lead to the loss of upland habitats within southeast Louisiana. Based on historical human activities and land use trends in the area, it is reasonable to anticipate that future activities would further contribute to cumulative degradation of the land resources, and ultimately, upland habitats. In southeast Louisiana, most development occurs in the upland areas, which compose a relatively small portion of the surface area of the region. Most of southeast Louisiana is composed of wetlands, open water, and estuarine habitats, and undeveloped and undisturbed upland areas are relatively rare.

Therefore, the cumulative loss of upland area that functions as habitat for wildlife provides forested resources is a long-term, moderate cumulative impact.

7.5.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to upland resources, the following environmental commitments shall be implemented:

- USFWS recommendations for identification of borrow areas will be followed to the greatest extent practicable
- Applicable, mitigation measures, as described in Section 5.3.1.8. in the Comprehensive Environmental Document, Phase 1 (USACE, 2013) would be followed, including:
 - Tree protection measures
 - Pre-construction surveys for nesting birds
 - Limit removal of trees in forested wetlands to the fall or winter

7.6 FISHERIES

7.6.1 REGULATORY FRAMEWORK

This fisheries resources section addresses compliance for the following applicable environmental laws and regulations:

- Fish and Wildlife Coordination Act
- Coastal Zone Management Act (See Appendix G, *Environmental Compliance*, Section 4, for full compliance details)
- Marine Mammal Protection Act

- Magnuson-Stevens Fishery Conservation and Management Act

Impacts to fisheries would be considered significant if an alternative resulted in substantial loss of desired aquatic habitat for native species or the direct loss of fishes within the study area as a result of implementing the proposed actions.

7.6.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – RLSC would likely increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water resulting in loss of existing estuarine fish habitats. RLSC could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there would likely be a corresponding reduction in overall species diversity and abundance as well as a loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats.

Although fisheries productivity has remained high (Caffey & Schexnayder, 2002) as Louisiana has experienced tremendous marsh loss, this level of productivity may be unsustainable. As marsh loss occurs, a maximum marsh to water interface (i.e., edge) is reached (Browder, Bartley, & Davis, 1985). A decline in this interface would follow if marsh loss continues and the overall value of the area as fisheries habitat would decrease (Minello T. , Able, Weinstein, & Hays, 2003). Because fishery productivity is related to the extent of the marsh to water interface (Faller K. , 1979; Dow D. D., Herke, Knudsen, Marotz, & Swenson, 1985; Zimmerman, Minello, & Zamora, 1984), it is reasonable to expect fishery productivity to decline as the amount of this interface decreases.

PROPOSED ACTION ALTERNATIVES – For Alternatives 2 and 3, impacts on fisheries are identical. In addition, similar impacts to fisheries productivity as described in the No Action Alternative would be anticipated.

Direct Effects – Negligible long-term direct construction-related impacts on fisheries and aquatic habitat are anticipated to occur at discrete levee lift and floodwall raise construction sites. Construction activities associated with the removal of emergent and overhead vegetation cover (shading aquatic areas) would likely degrade fish habitat by increasing flow rate and water temperatures and exposing species to predation. Potential direct effect on fisheries would be associated with the placement of 5.6 acres of foreshore protection in reaches WBV-90 and WBV-12. Foreshore protection would be placed along the GIWW and Hero Canal to bring existing foreshore protection back up to the proper elevation for levee protection and would permanently recover approximately 5.6 acres of shoreline. The placement of rock on top of existing rock is not expected to impact any wetland vegetation, including SAV. It is assumed that resident motile organisms would avoid the area during construction. Non-motile organisms would be directly impacted due to burial. Bottom-dwelling fishes and sessile invertebrates that utilize edge habitat for foraging and/or spawning would have most of the impacts associated with the foreshore protection placement. However, rock fill may result in beneficial impacts on fisheries by providing protection to larval and juvenile fishes as a nursery habitat and/or providing additional edge habitat for foraging larger fish. The hard substrate also would provide habitat for sessile filter feeders. In addition, an increase in rock material has been shown to benefit local assemblages of nekton that are important for sustaining local fisheries, especially blue crab (USACE, 2013).

Since proposed actions occur on the flood side of the existing levee, no impacts on fish habitat of the Bayou aux Carpes CWA Section 404(c) wetlands (protected side) would occur. Fisheries and fish habitat within the GIWW and Hero Canal, however, would be temporarily impacted during rock placement; however, the construction is occurring in the same footprint previously disturbed due to HSDRRS construction and therefore no new impacts to wetland or SAV are anticipated.

Indirect Effects – Less than significant, indirect, minor, short-term, construction-related impacts on fisheries and adjacent water bodies may include decreased DO levels in the waters immediately surrounding the construction site, increased turbidity due to construction runoff and sedimentation, and increased water body temperature due to increased suspended solids produced during construction that could absorb incident solar radiation. Temporary, minor water quality impacts could occur due to increased nutrient loading, miscellaneous debris, and accidental spills from construction equipment. Any of these localized changes in water quality could cause fish to temporarily avoid impacted areas and seek refuge in nearby suitable habitat. After construction, conditions would be expected to stabilize and return to conditions similar to pre-construction.

Overall, impacts on fisheries and fish habitat as result of the proposed action are anticipated to be less than significant.

GENERALIZED BORROW AREAS – Borrow areas are anticipated to be located in uplands so no direct or indirect impacts to fisheries habitat are anticipated. If borrow areas are identified near aquatic habitat, then potential impacts would be evaluated, as necessary, in a site-specific NEPA document. A borrow area once no longer in production is converted to open water habitat and fish are introduced, then abandoned borrow pits may provide fish habitat in the future.

7.6.3 CUMULATIVE IMPACTS

Direct cumulative impacts on fisheries and fish habitat in the study area are associated with the actual construction activities (water body displacement from foreshore protection, levee lifts, and floodwall raises). These impacts would be primarily during the construction period. The total area within the study area potentially affected would be small and most areas would be affected only temporarily. The study area would be modified very slightly relative to the magnitude of historical changes within the study area.

Rain events during past and on-going risk reduction construction activities have caused sedimentation and contamination of waterways from storm water runoff (USACE, 2013). Alterations in water quality from sediment loading adversely impacted fisheries by lowering DO and increasing water temperatures. Additional adverse impacts on fish and other aquatic organisms from sediment suspension and siltation in water adjacent to risk reduction construction activities included clogged gills, reduced growth rates, and disruption of egg and larval development (USACE, 2013).

Indirect cumulative adverse impacts on fisheries and their habitats occur from alterations to fish migratory movements, active/passive transport of fish eggs and larvae, nursery habitat, recruitment of fish larvae and juveniles, water characteristics and organism access to abiotic water quality habitats (e.g., temperature, salinity, turbidity, and DO), organism access to biotic water quality habitats (e.g., protection from predators and food availability), and hydrology and water velocity. Past, present, and future human-induced changes to aquatic and wetland

habitats in the vicinity of the study area would have adverse impacts to fisheries related to loss of habitat and overall productivity.

Storm damage reconstruction and transportation projects in the region are anticipated to result in less than significant cumulative impacts on fisheries or fish habitat, since most of the projects proposed are either limited to upland construction or occur in previously disturbed areas.

Hurricane and coastal storm risk reduction projects and flood risk reduction projects often alter existing nearshore habitats and impact interior marshes by impacting the natural processes of hydrology, erosion, subsidence, and saltwater intrusion. Water flow and important fish habitats between the protected side and the flood side of levees often become further fragmented.

Hurricane and coastal storm risk reduction projects and flood risk reduction projects, combined with other regional coastal and marsh restoration projects, would result in fish habitat with greater heterogeneity and interspersed and lower salinity levels. Hurricane and coastal storm risk reduction projects and flood risk reduction projects would also provide beneficial impacts on fish habitat through the reduction of storm surge inundation via increased hurricane and coastal storm damage reduction. Future regional projects also provide opportunities for dredged material from access channels to be used for marsh rebuilding and thus fish habitat creation or nourishment.

The cumulative direct and indirect impacts from regional projects that result in the temporary degradation of water quality or the permanent loss of wetlands that serve as quality fish habitat, combined with the current trend of water quality and habitat degradation in southeastern Louisiana, would result in cumulative minor impacts on fisheries and fish habitat regionally.

As water quality and structural habitat improve as a result of habitat restoration and a reduction in discharge of urban flood waters from better operational procedures, fisheries production would increase. Restoration of wetlands would also lead to improved nursery habitat for important finfish. In addition, the rock utilized for shoreline protection and stabilization would, over time, cumulatively benefit fisheries by providing protection for juvenile and larval species and enhancing foraging potential of aquatic prey species. Providing rocky shoreline habitat to otherwise sand and mud benthic communities would expand the surface area for motile and sessile aquatic organisms to inhabit and thrive.

Therefore, less than significant cumulative impacts to fisheries and fish habitat are anticipated.

7.6.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to fisheries resources, the following environmental commitments shall be implemented:

- 1) Direct and indirect impacts associated with foreshore protection would be minimized by the use of BMPs to control sediment transport.
- 2) Potential mitigation for impacts to open water habitats is currently being evaluated by USFWS, NMFS, and USACE.
- 3) Continued coordination with natural resources agencies to ensure final design of features enhance fish habitat to the fullest extent practicable.

7.7 ESSENTIAL FISH HABITAT

7.7.1 REGULATORY FRAMEWORK

- Magnuson-Stevens Fishery Conservation and Management Act

Mandatory Contents of EFH Assessment

Per 50 CFR 600.920(e)(3), all EFH assessments must include the following information:

- Description of the action
- Analysis of the potential adverse effects of the action on EFH and the managed species
- Federal agency's conclusions regarding the effects of the action on EFH
- Proposed mitigation, if applicable

Mandatory contents of the EFH Assessment for the WBV GRR can be found in the following locations within this document:

1. **Description of the action.** A description of each of the proposed Alternatives, a description of each considered alternatives is provided in Section 6.5, above.
2. **Analysis of the potential adverse effects of the action on EFH and the managed species.** An analysis of the direct, indirect, and cumulative impacts of the Alternatives on EFH and managed species can be found below in this section. Impacts to EFH would be considered significant if an alternative resulted in substantial loss of EFH in the study area. A description of historic and existing conditions of EFH in the project area can be found in Section 4 above. An analysis of the direct, indirect, and cumulative impacts of the Alternatives on fisheries in general can be found in Section 7.6 above.
3. **Federal agency's conclusions regarding the effects of the action on EFH.** Despite some adverse impacts to EFH, the project is expected to result in only minor short-term adverse effects on EFH when compared to the No Action Alternative. Specific conclusions regarding the effects on EFH can be found within the analysis of direct, indirect, and cumulative impacts of each Alternative can be found in Section 7.7.2 and 7.7.3 below.
4. **Proposed mitigation, if applicable.** No mitigation is proposed. To minimize impacts, environmental commitments are listed in Section 7.7.4.

7.7.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – RSLC (as described above in Section 2.2.2 and Section 5.2.1) will likely increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water resulting in loss of existing EFH. RSLC could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there will likely be a corresponding reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats. The study team assumed that the degradation or loss of important EFH would continue and impact species in and near the vicinity of the study area.

Without implementation of the proposed action, there would be no actions taken to lift the WBV levees. However, maintenance activities would continue to occur.

PROPOSED ACTION ALTERNATIVES – Impacts of Alternative 2 and 3 are expected to be identical for EFH.

Direct Effects – Placement of the stone foreshore protection along the shoreline of the GIWW and Hero Canal would result in placement of 5.6 acres of rock on top of existing rock. No new impacts to vegetated wetlands, including SAV, are expected. The stone would be placed on the existing foreshore protection footprint to bring it back up to the required elevation. This area has been designated as EFH (reaches WBV-12 and WBV-90), but no new impacts are expected. A temporary loss of invertebrates could also occur with construction activities, causing a temporary loss of forage habitat for finfish and shrimp. Overall, the temporary impacts and placement of rock on existing rock represents a proportionately very small area (approximately 5.6 acres) within the expanse of the GIWW and Hero Canal.

Indirect Effects – Indirect, minor, short-term, construction-related impacts on EFH may include decreased DO levels in the waters immediately surrounding the construction site, increased turbidity due to construction runoff and sedimentation, and increased water body temperature due to increased suspended solids produced during construction that could absorb incident solar radiation. Temporary, minor water quality impacts could occur due to increased nutrient loading, miscellaneous debris, and accidental spills from construction equipment. Any of these localized changes in water quality could cause mobile aquatic species to temporarily avoid impacted areas and seek refuge in nearby suitable habitat. After construction, conditions would be expected to stabilize and return to conditions similar to pre-construction. No conversion of aquatic habitat to upland habitat is anticipated in the footprint of the levees so no permanent loss of EFH is anticipated with construction of levee lifts or floodwall raises.

GENERALIZED BORROW AREAS – Impacts on EFH or managed species would not occur with use of existing borrow areas known to be used from within and outside the study area because they are not located in intertidal or estuarine areas (USACE, 2013). Borrow areas are anticipated to be located in uplands so no direct impacts to EFH are anticipated. Indirect impacts on EFH from future borrow area excavation could occur if borrow areas are located near aquatic habitat. If necessary, specific impacts on EFH would be identified in site-specific NEPA documents prepared after borrow areas have been identified.

Due to the localized impacts related to foreshore protection construction, it was determined that Alternatives 2, 3 and potential borrow areas would have less than significant impacts to EFH.

7.7.3 CUMULATIVE IMPACTS

The combination of past and ongoing regional work would contribute to cumulative loss of EFH in the vicinity of the study area. Regional projects would adversely impact EFH by causing direct habitat loss through the filling of waterways and marshes and dredging of water ways. Indirect cumulative effects include alterations of habitats and hydrology, which could result in changes in salinity and nutrient loads in EFH leading to further degradation of EFH. Past, present, and future flood risk reduction projects and other regional projects occurring near EFH would cause damage to EFH and adjacent wetlands vegetation, disturbance of fisheries and sediments, and would increase turbidity and sedimentation in the adjacent aquatic habitat and drainage canals.

Risk reduction projects directly alter existing shoreline habitat and hydrologically impact marshes by impacting the natural process of erosion, subsidence, and saltwater intrusion. The historic construction of flood risk reduction projects in southeast Louisiana is responsible for

limiting water flow between the protected side of the levee and the flood side of the levee, altering freshwater and sediment input into estuaries, and contributing to wetland fragmentation and loss. Future flood and storm risk reduction projects cumulatively add to these impacts on EFH. Large-scale coastal and wetlands restoration projects are anticipated to restore these habitats in the future, and will offset some of these historic losses of EFH.

The incremental cumulative effect of the Proposed Actions were determined to be less than significant.

7.7.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to EFH, the following environmental commitments shall be implemented:

- BMPs to reduce sedimentation and erosion into adjacent water bodies during construction.
- Continued coordination with natural resources agencies to ensure final design of features enhance fish habitat to the fullest extent practicable.

Per letter dated 7 Feb 2020 (See Appendix G, *Environmental Compliance*), NOAA's National Marine Fisheries Service (NMFS) reviewed the draft EIS and the Recommended Plan for WBV. The NMFS concurs with the CEMVN's determination of no substantial impact to EFH in the GIWW or Hero Canal. NMFS does not object to the maintenance projects as proposed and concludes that CEMVN's responsibilities to meet the requirements of 50 CFR 600.920(k) have been satisfied. NMFS did not provide any Conservation Recommendations.

7.8 WILDLIFE

7.8.1 REGULATORY FRAMEWORK

This wildlife resources section addresses compliance for the following applicable environmental laws and regulations:

- Fish and Wildlife Coordination Act
- Bald and Golden Eagle Protection Act of 1940, as amended
- Migratory Bird Treaty Act of 1918
- EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

Impacts to wildlife would be considered significant if an alternative resulted in substantial loss of native wildlife habitat or the direct loss of wildlife within the study area as a result of implementing the proposed actions.

7.8.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Without implementation of the proposed action, there would be no actions taken to lift the WBV levees or raise floodwalls. However, maintenance activities associated with HSDRRS would continue to occur. Wildlife that currently utilize the levees would continue to do so with negligible temporary disturbance from maintenance activities.

RSLR, human encroachment and development, and other factors would result in the continued loss of habitat. RSLR would increase saltwater intrusion and exacerbate ongoing conversion of marsh habitat to shallow open water. Figure 7-5 depicts the anticipated wildlife habitat landscape of the study area and vicinity in 2067 based on CPRA 2017 Master Plan data. As habitat loss continues, migratory bird species would have less suitable stopover habitat forcing

them to fly further distances to suitable habitat. Most mammalian, amphibian, and reptilian species would migrate to habitats that are more suitable. Wildlife would benefit from restoration activities implemented by other programs; however, these activities are not likely to be enough to keep up with the current trends in habitat loss and relative sea level rise (See Section 5.2.1 above).

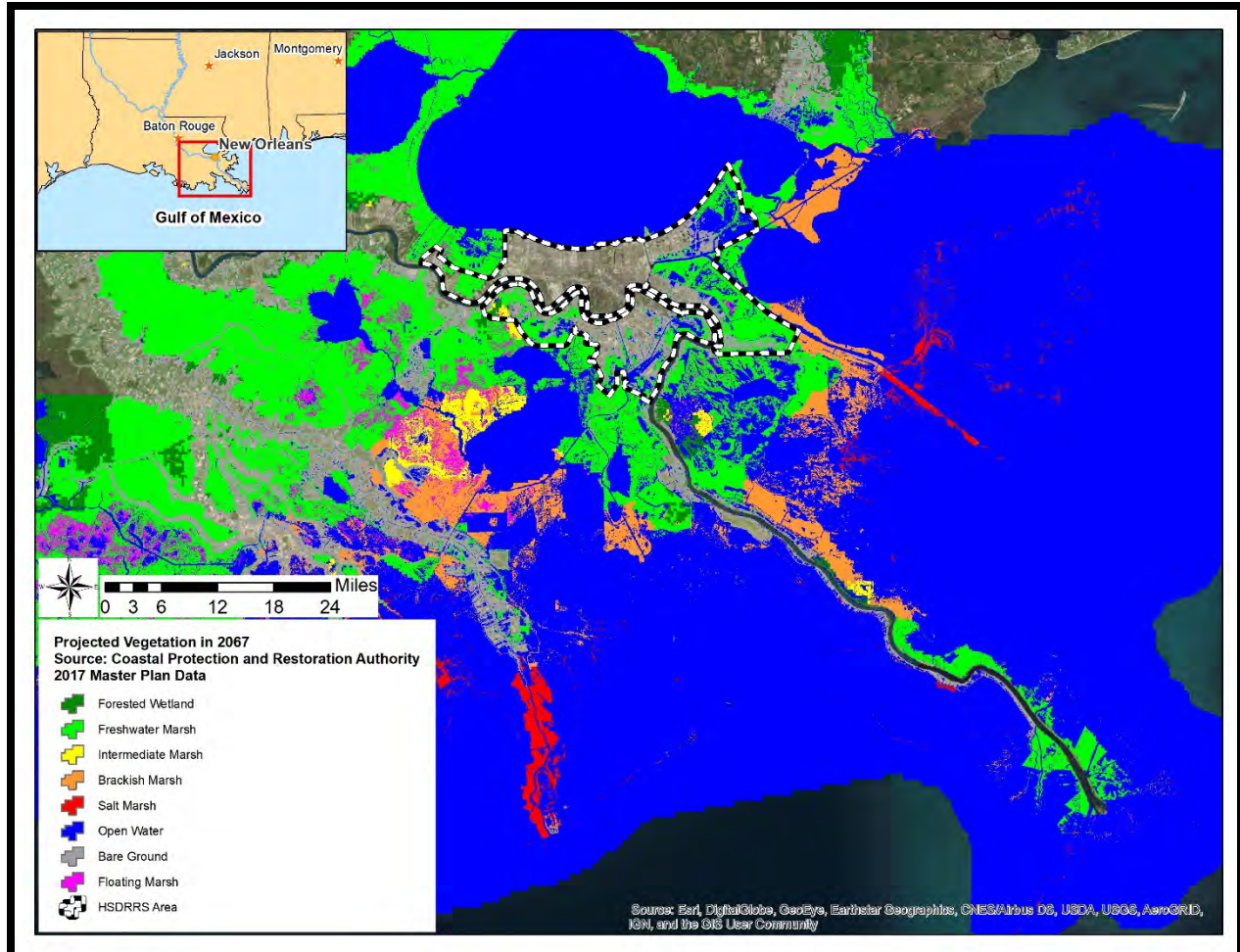


Figure 7-5. Projected Habitats in Year 2067 Based on CPRA 2017 Master Plan Data (medium scenario, with Master Plan implementation)

Under the No Action Alternative, no borrow areas would be utilized for the improvement of WBV levees. However, because known borrow sites are existing operating businesses, these borrow sites may continue to be used for activities by others. As the sites are excavated, wildlife would be temporarily displaced. Once the sites have been fully excavated, they may be converted to ponds and small lakes which may provide some wildlife habitat. Any excavated borrow pits that remain dry would be expected to be colonized by vegetation and woody plants. As vegetation density increases, the pit could attract a variety of wildlife including birds, reptiles, amphibians, and small mammals.

PROPOSED ACTION ALTERNATIVES – Impacts of Alternative 2 and 3 are expected to be identical.

Direct Effects – Wildlife in the vicinity of the study area (see Section 4.8 for common species in the study area impacted) may be temporarily stressed as a result of construction from increases in noise and traffic. Wildlife would be directly impacted by the loss of habitat in bottomland hardwoods areas adjacent to Mississippi River levees. Mobile wildlife species, such as rodents and birds, would be expected to leave the area during construction activities. Mortality rates for smaller, less mobile wildlife species such as amphibians and reptiles may increase during turf removal and grading activities on the levees. Following completion of construction, occasional direct and indirect impacts to less mobile species would continue to occur during routine maintenance. Most species of mobile organisms would likely relocate to nearby extensive wetlands and shoreline habitats. The habitat value of the maintained levees is limited, and large wildlife species, predominantly birds and small mammals that hunt and forage in the levee turf grass and adjacent vegetation, do not generally shelter or nest there. These species would be expected to move to nearby habitat for these activities during construction. Given the extent of similar or higher quality habitats in the vicinity of the levee lifts, wildlife movement would not result in impacts to the carrying capacity of nearby environments. Re-vegetating the area with turf grass would restore this temporarily lost terrestrial habitat, and wildlife species would return once construction activities are complete.

Protected species that may occur in the coastal parishes of this study area may include colonial nesting water/wading birds including the formerly listed brown pelican (*Pelecanus occidentalis*) and various raptors including the formerly listed bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrines*). A bald eagle nest has been documented in the past in the nearby Bayou aux Carpes 404(c) area and other nests may exist in the study area.

The flood-side levee shift required along the MRL would result in a loss of BLH-Wet habitat, which is important to wildlife resources and is currently limited in coastal Louisiana. Alternative 2 would result in 60 acres converted and Alternative 3 would require 64 acres converted. (Alternative 3 quantities were not updated during feasibility level design.) These impacts to BLH-Wet would be offset through mitigation (See Appendix K, *Mitigation Plan*), but the loss of this habitat along the Mississippi River would still be significant to wildlife, including wetland game and non-game species.

Alternatives 2 and 3 are anticipated to have moderate, significant impacts to wildlife resources due to the loss of BLH-Wet habitat adjacent to Mississippi River levees.

Indirect Effects – The presence of construction-related activities, machinery, and noise would be expected to cause wildlife to avoid the area during construction; therefore indirect impacts would occur on wildlife currently inhabiting the study area, and wildlife would migrate to other adjacent habitats.

GENERALIZED BORROW AREA – As borrow sites are excavated, wildlife would be displaced. Once the material is excavated, however, the areas would be converted to aquatic habitat or scrub/shrub communities, which would offer habitat to some terrestrial and aquatic species. The lands surrounding potential borrow areas likely contain a variety of mammals, birds, reptiles, and amphibians. Species likely inhabiting the area include nutria, muskrat, raccoon, white-tailed deer, rabbits, squirrels, and a variety of smaller mammals. If borrow areas hold water and water quality is adequate then herons, egrets, wood ducks, and migratory waterfowl may use these waters. Lands surrounding open waters and borrow pits may offer habitat to mammals, birds, reptiles, and amphibians; however, wildlife habitat within an active borrow area is limited. Any potential borrow site used for the proposed action would require environmental clearance and

coordination with state and federal agencies. **Therefore, impacts to wildlife associated with borrow areas would be less than significant.**

7.8.3 CUMULATIVE IMPACTS

The work on the WBV reaches discussed in this EIS, combined with previous HSDRRS construction, ongoing development and work on the additional reaches in the vicinity, could impact similar wildlife species. Loss of wetlands and BLH habitat from activities would affect local and regional wildlife species through a loss of foraging, nesting, and rookery habitat and fragmentation of habitat. Aquatic species (e.g., marine mammals) could experience temporary adverse effects from decreased water quality, noise, and other disturbances. The displacement of wildlife from turf grass habitat would be temporary during the construction period, and the displaced individuals likely would return following project completion. Secondly, this habitat is similar to that which covers extensive areas in the New Orleans region, such as residential lawns and parks, and is not expected to exceed the carrying capacity of this adjacent habitat, so cumulative impacts to wildlife are expected to be minimal. Lastly, the reaches discussed in this EIS are not in close enough proximity to the majority of the other reasonably foreseeable levee lifts, so they are not likely to impact the same local populations of wildlife utilizing the levees in those other areas.

Thus, the potential cumulative impact on wildlife from the proposed action in conjunction with other construction projects in the region would be a moderate, significant impact due to loss of BLH-Wet habitat.

7.8.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to wildlife resources, the following environmental commitments shall be implemented:

- 1) Biological monitoring during construction activities
- 2) Use of dust suppression methods such as watering of construction sites
- 3) Pre-construction nesting bird surveys conducted by USFWS and USACE and avoidance of active nests
- 4) Prevention of colonial nesting birds from establishing active nests within the project construction right-of-way to prevent nesting close to the noise and disturbance caused by the construction activities. If birds were allowed to establish nests in these areas, they could ultimately abandon eggs or hatchlings.
- 5) Close coordination with USFWS and LDWF is necessary in order to avoid disturbance of the existing rookery adjacent to WBV 09a.
- 6) Recommendations to minimize potential project impacts to eagles and their nests are provided by LDWF in Appendix L and USFWS in their National Bald Eagle Management Guidelines and these recommendations would be followed during construction of the proposed actions. Pre-construction surveys, buffer areas, and construction seasons may be required.
- 7) USFWS recommends that a qualified biologist inspect the proposed work sites for the presence of undocumented nesting colonies during the nesting season (e.g. February through September depending on the species). If colonies exist, work should not be conducted within 1,000 feet of the colony during the nesting season.

7.9 THREATENED & ENDANGERED SPECIES

7.9.1 REGULATORY FRAMEWORK

This Threatened and Endangered Species section addresses compliance for the following applicable environmental laws and regulations:

- Endangered Species Act Section 7 (See Appendix G, *Environmental Compliance*, Section 2 for full compliance details)

Significant Impacts to Threatened and Endangered Species are:

- A direct, adverse effect on a species protected under the ESA, or an unmitigated loss of critical habitat that diminishes regional population
- An unmitigated net loss of habitat value or sensitive habitat of special biological significance
- A substantial loss to the population of any protected species.

7.9.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Degradation and loss of important fish and wildlife habitats would continue due to human development and natural forces. Many different fish and wildlife species use these habitats for shelter, nesting, feeding, roosting, cover, nursery, and other life history requirements. The loss and deterioration of transitional wetland habitats would continue to adversely impact all listed species in and near the vicinity of the study area. It is assumed the positive impacts of federal, state, local, and private restoration and recovery projects and programs would offset, to some degree, the adverse cumulative impacts on listed species.

It was assumed the degradation and loss of important essential fish and wildlife habitats would continue. Many different fish and wildlife species use these habitats for shelter, nesting, feeding, roosting, cover, nursery, and other life history requirements. The loss and deterioration of transitional wetland habitats would continue to adversely impact all listed species in and near the vicinity of the study area. It is assumed that the positive impacts of federal, state, local, and private restoration and recovery projects and programs would offset, to some degree, the adverse cumulative impacts on listed species.

PROPOSED ACTION ALTERNATIVES AND GENERAL BORROW AREAS – Alternatives 2 and 3 are expected to have identical impacts to Threatened and Endangered Species. USACE has made a “no effect” determination for Gulf Sturgeon, and a “not likely to adversely affect” determination for Pallid sturgeon and the West Indian manatee. Appendix G, *Environmental Compliance*, Section 2 provides additional details on direct and indirect impacts to Threatened and Endangered Species. **Table 7-5** summarizes the impacts for proposed action alternatives and generalized borrow areas.

- 1) *West Indian Manatee*: USACE determined that the potential for a manatee to be in the project area during construction was unlikely, and the proposed action was determined *not likely to adversely impact this species*. USACE committed to implement BMPs to further reduce the potential effects. These measures include, but are not limited to reducing vessel traffic speed, posting signs of the potential presence of manatees, and halting construction activities in the event a manatee is observed in the area.
- 2) *Gulf Sturgeon*: Gulf sturgeon is listed in Plaquemines Parish; however, its range does not extend west of the Mississippi River. Therefore, it is not likely to occur in the

proposed construction area. USACE determined that proposed action would have *no effect* to this species.

- 3) *Pallid Sturgeon*: During construction of the flood-side levee shifts along the Mississippi River and placement of rock on existing foreshore protection within the GIWW and Hero Canal, potential temporary less than significant impacts could include increased turbidity, noise, and vessel traffic. USACE determined that proposed action was *not likely to adversely impact this species*.

Overall, the Proposed Actions, including borrow areas, would be less than significant for Threatened and Endangered Species.

Table 7-5 West Bank and Vicinity Summary of Threatened and Endangered Species ESA Determination

Common Name	Species Name	Alternative		Generalized Borrow Areas
		2	3	
West Indian Manatee	<i>Trichechus manatus</i>	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect	No effect
Gulf Sturgeon	<i>Acipenser oxyrinchus desotoi</i>	No effect	No effect	No effect
Pallid Sturgeon	<i>Scaphirhynchus albus</i>	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect	No effect

By letter dated 10 December 2019, USFWS concurred with the not likely to adversely affect determination. No effect determinations do not require an agency response.

7.9.3 CUMULATIVE IMPACTS

Past, ongoing, and future construction of hurricane and storm damage reduction projects and flood risk reduction project and their associated excavation of borrow areas contribute to cumulative impacts on water quality of protected species habitat in the study area.

Direct impacts on protected species habitat occurred as a result of past filling of waterways and wetlands for ROW for the HSDRRS. The direct cumulative impacts on protected species habitat are associated with construction activities likely causing increased sedimentation of waterways from stormwater runoff during rain events. The direct impacts include changes in water temperature, salinity, turbidity, DO, hydrology, and water velocity (USACE, 2013). These water quality impacts would impact the protected species by degrading their aquatic habitat and potentially impacting their food sources, abilities to forage, and visibility for migration and escape from predators (USACE, 2013). Within much of the study area, no cumulative direct or indirect impacts on protected species would be expected to occur. Cumulative indirect, long-term impacts from the conversion of natural areas could increase marsh fragmentation, alter hydrology, and in turn, affect habitat quality, degrading habitat for some protected species.

Other projects proposed in southeastern Louisiana could potentially lessen impacts from implementation of WBV, including coastal and wetland restoration projects. Projects such as

these would provide cumulative long-term beneficial impacts on protected species. Some of these projects in southeastern Louisiana would include restoration projects which create numerous acres of marsh through the beneficial placement of dredged sediments from the Mississippi River. Enhancement of habitat through wetlands and coastal restoration projects would provide long-term benefits to the area and would be beneficial to protected species.

The work on the WBV reaches discussed in this EIS, combined with work on the additional reaches in the vicinity, may affect but is not likely to adversely affect the West Indian manatee and Pallid sturgeon, and has no expected effect for Gulf sturgeon, resulting in less than significant cumulative impacts for threatened and endangered species.

7.9.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to threatened and endangered species, the following environmental commitments shall be implemented:

- 1) Use specific construction times to avoid threatened and endangered species
- 2) BMPs to reduce sedimentation and erosion into adjacent water bodies during construction
- 3) During construction, standard listed species protection measures as outlined in Appendix G, *Environmental Compliance*, would be implemented to minimize potential impacts to listed species that may be in the area during construction.

7.10 INVASIVE SPECIES

7.10.1 REGULATORY FRAMEWORK

This invasive species section addresses compliance for the following applicable environmental laws and regulations:

- EO 13112, Invasive Species
- Executive Order 13751, Safeguarding the Nation from the Impacts of Invasive Species

Impacts to invasive species would be considered significant if an alternative resulted in a substantial spread or introduction of invasive species into the study area a result of implementing the proposed actions.

7.10.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Invasive species would likely continue to pose a threat in and near the study area. Landscape disturbances and deteriorations would be expected to continue into the future allowing for continued and expanded invasions by non-native species. Existing native vegetative communities would be expected to degrade and become vulnerable to infestation. Invasive species would replace native vegetation, forming monoculture stands of dense vegetation. Habitats may realize some benefit from establishment of invasive species in some areas. For example, the robust above and belowground production of cogongrass (*Imperata cylindrical*) may provide substrate stabilization and biomass contributions; or water hyacinth (*Eichhornia crassipes*) may provide potential water quality improvement through nutrient uptake and retention. However, it is expected that the overall adverse impacts of invasive species spread and abundance into the future outweigh the potential benefits. Expected adverse impacts may include reduced vegetative biodiversity, alteration of soil

properties and ecosystem processes, and reduction in wildlife food and habitats. The existing invasive species found in the study area would likely continue and new invasive species, not yet identified, may become established in the future. Federal, state, and local laws, programs, and regulations aimed at invasive species management and control would be expected to continue.

PROPOSED ACTION ALTERNATIVES AND GENERALIZED BORROW AREAS –

Alternatives 2 and 3 are expected to have identical impacts to invasive species. It is expected that the existing invasive species found in the study area would not be effected by the proposed actions. Invasive species are expected to persist with or without any of the proposed actions. The indirect adverse effect documented post HSDRRS construction was the potential for unchecked growth of Chinese tallow and other invasive plant species in borrow areas, and this indirect effect may also occur with WBV construction.

Therefore, the Proposed Action Alternatives and potential borrow areas would have less than significant impacts on invasive species.

7.10.3 CUMULATIVE IMPACTS

Past and ongoing construction projects have contributed to the introduction and spread of invasive species in the study area. The cumulative adverse impacts to the region include reduced biodiversity and altered ecosystem processes. Periodic eradication of invasive/nuisance plant species within the study area are expected to continue by private, non-federal, and federal entities. Ongoing mitigation enhancement projects and coastal and wetland restoration projects target eradicating of invasive and nuisance plants followed by plantings of native species. These efforts would lessen the adverse impacts locally; regionally, however, invasive species are expected to continue to have adverse impacts to the environment.

The proposed action, when considering the past, ongoing, and future actions would have negligible, less than significant cumulative impacts on invasive species.

7.10.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to invasive species, the following environmental commitments shall be implemented:

- 1) During construction, steps would be taken to prevent the introduction and spread of invasive species to stay in compliance with EO 13751 (*Safeguarding the Nation from the Impacts of Invasive Species*) and EO 13112 (*Invasive Species*).

7.11 CULTURAL & HISTORICAL RESOURCES

7.11.1 REGULATORY FRAMEWORK

This cultural and historic resources section addresses compliance for the following applicable environmental laws and regulations:

- National Historic Preservation Act, Section 106
- Cultural Resources Management Presidential Memorandum regarding Government to Government Relations (April 29, 1994)
- EO 13007, Indian Sacred Sites
- EO 11593, Protection and Enhancement of the Cultural Environment
- Native American Graves Protection and Repatriation Act 43 CFR 10

- Archaeological resources Protection Act of 1989

Impacts to cultural resources would be considered significant if an alternative resulted in a substantial adverse effect to a historic property such that implementation of the alternative would result in the destruction of the property or the loss of the property's eligibility for listing in the National Register of Historic Places.

7.11.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Without implementation of the proposed action the existing levees and floodwalls would not be modified. Routine maintenance of the existing levee would have no effect on cultural resources. Without the increased level of risk reduction from the implementation of the proposed action, cultural and historic resources that may exist within the study area would be at higher risk for adverse impacts associated with hurricane storm surge, flood events, and land loss. Erosion damage from flood events could expose previously buried archaeological deposits and remove the data potential the sites may possess.

The CEMVN identified historic built resources listed in the NRHP within the WBV study area that could be impacted if there is levee failure or if overtopping occurs as a result of the 1% AEP storm event. Resources identified were based on a review of the *Louisiana Cultural Resources Map* and the *Standing Structures and Districts Map* provided by the Louisiana State Historic Preservation Officer (SHPO). The review revealed a total of four (4) individual buildings listed in the NRHP that could be impacted if there is levee failure or if overtopping occurs as a result of the 1% AEP storm event. The four (4) buildings are located along Sala Avenue in Westwego, Jefferson Parish, and include: the Conrad A. Buchler House, the L.J. Bernard Hardware Store, the Ed Martin Seafood Company Factory and House, and the Vic Pitre House. All four (4) buildings are within the Harvey-Westwego sub-basin.

The Conrad A. Buchler House was listed in the NRHP in 1999. The ca. 1911 Craftsman bungalow is locally significant under Criterion B in the area of politics/government for its association with Conrad Buchler, the first mayor of Westwego. The Conrad A. Buchler House is located at 236 Sala Avenue, Westwego, Jefferson Parish. The L. J. Bernard Hardware Store was listed in the NRHP in 2000 under Criterion B in the area of commerce at the local level. The frame commercial building, constructed in 1907, is located at 275 Sala Avenue, Westwego, Jefferson Parish. The L. J. Bernard Hardware Store is one of the few commercial resources extant in Westwego. Ed Martin Seafood Company Factory and House is located at 300-06 Sala Avenue in Westwego, Jefferson Parish. The ca. 1943 factory is locally significant under Criterion A in the area of industry for its association with the Westwego seafood industry in the late 1920s through the 1950s. The Ed Martin Seafood Company Factory and House were listed in the NRHP in 2000. The Vic Pitre House is located at 476 Sala Avenue, Westwego, Jefferson Parish. The ca. 1925 bungalow is locally significant under Criterion B in the area of politics/government for its association with Victorin A. Pitre, the longest serving mayor in Westwego's history. The Vic Pitre House was listed in the NRHP in 1998.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts to cultural and historic resources.

Direct Effects – Less significant direct impacts on cultural and historical resources are expected from implementation of the proposed actions within the existing WBV footprint. The proposed levee shifts of the Mississippi River Levee outside of the existing right of way, yet-to-be identified borrow areas, and other project features outside of the existing footprint have the

potential to impact known and unknown cultural resources. To comply with Section 106 of the NHPA for the work that is co-located with the Mississippi River levee, the USACE would utilize the programmatic agreement developed for the Mississippi River Levee Supplemental EIS pursuant to 36 CFR 800.14(b) in consultation with the SHPOs, Tribes, Advisory Council on Historic Preservation (ACHP), and other interested parties. USACE consulted with SHPO, Tribes, and the ACHP on the utilization of HSSDRS mitigation methods and the programmatic agreement to address potential impacts for the WBV co-located work. If any unrecorded cultural resources are determined to exist within the proposed project boundaries, then no work would proceed in the area containing these cultural resources until a USACE archaeologist has been notified and final coordination with the SHPO and THPO has been completed.

Indirect Effects – Implementing the proposed action would have beneficial indirect impacts to cultural and historical resources by providing an added level of storm damage risk reduction to known and unknown archaeological sites in the project vicinity on the protected side of the levees, thereby reducing the damage caused by storm events. Erosion of ground deposits during storm events can result in severe damage and destruction of archaeological sites.

Alternatives 2 and 3 could include the introduction of new visual elements (levee lifts and floodwall modifications and replacements) to the study area's viewshed that have the potential to indirectly impact known and previously undocumented cultural resources that may be listed or eligible for listing in the NRHP. The introduction of new visual elements that are inconsistent with the historic or cultural character of these resources could indirectly diminish the integrity of the property's setting, feeling, or association and/or cause changes to the integrity of feeling or character associated with a historic resource or Traditional Cultural Property (TCP). USACE will continue to coordinate with stakeholders to ensure impacts to cultural resources are avoided to the greatest extent practicable.

All proposed actions for WBV are committed to minimizing any potential for cultural resources impacts by USACE through the Section 106 process. **Therefore, impacts of Proposed Actions would be less than significant for cultural and historic resources.**

GENERALIZED BORROW AREAS – With implementation of the proposed action, borrow material would be removed from the borrow locations identified in the future. Any undiscovered cultural resources could be impacted by borrow activities. All new borrow areas would require Section 106 compliance, including evaluation to determine the existence of known cultural resources eligible for the National Record of Historic Properties. If borrow areas have not been surveyed for cultural resources, Phase I or Phase II cultural investigations would be necessary. If needed, cultural resources surveys would be conducted within the borrow locations and any identified potentially significant cultural resources will be avoided or mitigated through the Section 106 process. Compliance with NHPA Section 106 would be achieved during the NEPA and environmental compliance process for the new borrow sites. **The potential impacts would be negligible and less than significant as all impacts on cultural resources would be avoided or minimized through the Section 106 process.**

7.11.3 CUMULATIVE IMPACTS

Projects controlled by, and projects that acquire their funds from, federal sources are subject to Section 106 guidelines and processes under the National Historic Preservation Act. Under these laws, the federal entity is required to consider the effects of their projects upon cultural resources. Cultural resources or historic properties include any prehistoric or historic district,

archaeological site, structure, or object included or eligible for listing on the NRHP. All federal hurricane and coastal storm risk reduction, flood risk reduction, coastal and wetland restoration, and transportation projects are subject to these guidelines and processes, and therefore such federal projects should not cumulatively adversely affect cultural resources.

While many cultural resources surveys have been conducted within the vicinity of the proposed action, future and concurrent regional projects still have the potential to adversely affect cultural resources by the destruction of all or part of eligible archaeological sites, modification of historic structures, or alteration of the view-shed of historic districts. However, for federal projects, if any unrecorded cultural resources are determined to exist within a project's boundaries, then no work will proceed in the area containing these cultural resources until the SHPO and Federally recognized Tribes have been notified. **As such, other federal current and future regional projects would potentially have minor, less than significant, direct and indirect cumulative adverse impacts on cultural resources.**

7.11.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to cultural and historic resources, the following environmental commitments shall be implemented:

- 1) General cultural resources mitigation measures as outlined in Section 5.2.1.12.1 of the CED, Phase 1 (USACE, 2013) would be followed.
- 2) USACE developed a Programmatic Agreement pursuant to 36 CFR 800.14(b) in consultation with the SHPOs, Tribes, ACHP, and other interested parties for the portion of Recommended Plan that is co-located with the Mississippi River levee. The stipulations of the Programmatic Agreement would be followed during project implementation of the co-located work.
- 3) If new borrow sites are selected, USACE would be required to fully investigate the proposed borrow areas for the presence of cultural resources and consult with the SHPO and Tribes pursuant to Section 106 of the NHPA and complete additional NEPA documentation.
- 4) If new borrow sites are selected, USACE would be required to fully investigate the proposed borrow areas for the presence of cultural resources and consult with the SHPO and Tribes pursuant to Section 106 of the NHPA and complete additional NEPA documentation.

7.12 AESTHETICS (VISUAL)

7.12.1 REGULATORY FRAMEWORK

This aesthetic resources section addresses compliance for the following applicable environmental laws and regulations:

- National Environmental Policy Act, 42 USC Section 4321, *et seq.*
- 1988 Visual Resources Assessment Procedure
- Wild and Scenic Rivers Act
- Scenic Byways
- Louisiana Scenic Rivers Act

Impacts to aesthetics would be considered significant if an alternative substantially degraded the existing visual character or quality of the site and its surroundings.

7.12.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE –

Under the No Action Alternative, the proposed action would not be constructed. The visual environment attributed to cultural landscapes and historic structures existing within the study area would be at risk for adverse impacts associated with storm events and land loss.

Physical and ecological changes, including vegetative succession occurring in the study area, determine the future of the study area's visual landscape in the absence of new projects. Additionally, recreation and land use trends contribute to determine the landscape's visual future. Future forecasts for the ecological, recreation, and land use resources can be found elsewhere in this document.

Existing borrow sites are actively used by private individuals, non-federal, and federal entities seeking borrow and are visually unappealing. Once abandoned, those sites may convert to lake or ponds. No change to aesthetic or visual resources values from the No Action Alternative would be expected.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct Effects – The visual attributes of the study area would be temporarily impacted by construction activities at the project site and by transport activities needed to move equipment and materials to and from the site. Temporary impacts on visual resources would occur during actual implementation of the proposed actions when the area would contain construction equipment and staging areas. The levees and floodwalls would be similar in design and scale to the existing conditions, except slightly higher in elevation where levee lifts are proposed, and therefore permanent impacts would be less than significant. However, it is noted that with slightly higher levees, the views may be impacted, but the impact was deemed less than significant. Turf grass would be re-established on the levees after construction, and the appearance of the levees would remain similar to the existing conditions.

Indirect Effects – Maintaining the earthen levees and floodwalls would provide a continued benefit to aesthetic quality due to a reduction in properties damaged by both storm surge and flood events. The visual environmental surrounding would also indirectly affect the surrounding recreational and cultural and historic resources which are further discussed in Sections 7.11 and 7.13 of this document.

Therefore, the proposed action impacts on aesthetics would be less than significant.

GENERALIZED BORROW AREAS – The majority of the existing borrow areas are remote and inaccessible to the public. New borrow sites would be expected to further reduce the study area's aesthetic quality through the introduction of more disturbed borrow sites. Currently, the number and location of potential new borrow sites are unknown. If necessary, site-specific impacts will be discussed in site-specific NEPA documentation once specific sites have been identified.

7.12.3 CUMULATIVE IMPACTS

Short-term adverse cumulative impacts on visual resources has occurred and would continue to occur during all construction activities. Direct cumulative long-term impacts on visual resources from improvements to the risk reduction measures would be minor, as most of the proposed actions remain similar to what previously existed, only at a higher elevation. Additionally, the cumulative impact of the reduction of threat to property posed from flooding would be beneficial to the regional aesthetic resources.

The use of borrow sites for proposed actions would have a cumulative minor impact on visual resources, because the borrow sites would be used are located on private land with limited to no public access, and where borrow sites are not backfilled, open water habitats would remain and in many cases are also aesthetically pleasing.

Cumulative long-term impacts on visual resources are still evident from Hurricanes Katrina and Rita in some parts of the study area and include degraded, damaged, or destroyed homes, facilities, and recreational parks in some areas. In general, all regional projects would have short-term moderate construction impacts on aesthetic resources. Most storm damage and redevelopment projects in the region would have beneficial cumulative impacts on visual quality after the post-construction phase. Hurricane and storm damage reduction projects, flood risk reduction projects, and coastal restoration projects would beneficially impact aesthetic resources and the overall visual view sheds within the study area, as the risk of tropical storm damage and flooding would be reduced and marshes are created or restored. New and restored infrastructure redevelopment projects would also benefit the aesthetic resources in the study area by upgrading aging or failing infrastructure, which often contributes to a blighted visual quality within the area.

The proposed action for construction and use of borrow sites would contribute to the permanent cumulative impacts on visual resources, but regionally, the cumulative impacts on aesthetics would be negligible and less than significant.

7.12.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to aesthetic resources, the following environmental commitments shall be implemented:

- Soil borrow sites for levee building material needed to construct the proposed levees are not specifically identified in this study; therefore, if the visual impacts caused by borrow areas differ from the generalized impacts documented here, further evaluation will be conducted during additional NEPA, as necessary.
- Architectural design concepts for floodwalls and other hard structure hurricane and storm damage risk reduction features are not identified in this study; therefore, the visual impacts caused by hard structure hurricane and storm damage risk reduction features will be evaluated during PED.
- If new borrow sites are selected, USACE would be required to fully investigate the proposed borrow area's setting and any impacts on the aesthetic quality of the surrounding area per the NEPA.

7.13 RECREATIONAL RESOURCES

7.13.1 REGULATORY FRAMEWORK

This recreational resources section addresses compliance for the following applicable environmental laws and regulations:

- CEQ 40 CFR 1508.27(b)(3) (NEPA evaluation of intensity of impacts)
- Wild and Scenic Rivers Act
- Louisiana Scenic Rivers Act

Impacts to recreation would be considered significant if an alternative resulted in a substantial effect to the long-term provision of, or access to, recreational uses in the area.

7.13.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Under the No Action Alternative, the WBV and MRL levee lifts and floodwall raises would not occur. Recreational resources within the WBV study area will continue to be protected from storm surge inundation by the HSDRRS, but less so for the 1% AEP event in the without project condition. The study area lies in a region of active subsidence and sea level rise (see Section 5.2.1). Routine maintenance would continue causing negligible interference with recreational activities in the vicinity of the WBV project area. Borrow operations would continue at the existing various sites in the vicinity of the study area.

As levees subside, they provide a lower level of overtopping flood risk reduction. Land-based recreational resources, including camps, park structures, and recreation facilities would be susceptible to a higher risk of inundation in the future without-project condition. Water-based recreational resources, such as fishing and hunting, would also be affected from deposits of salt laden waters into interior estuaries thereby affecting fishing opportunities, especially in the short-term. Over time, water-based recreational resource opportunities would return to baseline conditions.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts. Under the proposed action, the levee lifts and floodwall raises would be confined to the existing levee right-of-way except along the MRL where flood-side shifts to levee alignment are anticipated.

Direct Effects – No direct impacts to state or locally-operated recreational facilities are expected because they are far enough from the work areas to avoid impacts. Walking, jogging, biking, dog-walking, and recreating on levee reaches could be prohibited temporarily during construction and access for bank fishing might be limited. No impacts to Louisiana Scenic Rivers are anticipated.

Indirect Effects – There could be minimal, indirect, construction-related impacts to recreational resources in the study area, including temporary congestion of traffic corridors. Additionally, noise from construction activities could cause minimal impact to recreational use within the Jean Lafitte National Historical Park and Preserve. The MRL levees just north of Crescent City Connection Bridge would impact use of the green space/batture during low-water on the Mississippi River. This area is used by many for passive and active recreation. The conditions would restore to normal after the construction activity is completed.

Adverse impacts on recreational resources from levee lifts and floodwall raises would be negligible and would be limited to short-term recreational access closures during the actual construction activities. No permanent adverse impacts on recreational resources are anticipated from the proposed actions.

Therefore, impacts from the Proposed Action Alternatives to recreational resources would be less than significant.

GENERALIZED BORROW AREAS – With implementation of the proposed action, borrow material would be removed from the borrow locations to be identified in the future. Existing borrow areas are actively used by private individuals, non-federal, and federal entities seeking borrow and are heavily impacted. Upon depletion of a given borrow area, depending how the end site is left, the habitat may be suitable to support some recreation activities (e.g., wildlife viewing and fishing). These benefits are expected to be minimal and sites would remain private, restricting their recreational value to the public. Therefore, there would be no direct, indirect, or cumulative impacts to recreational resources in the region related to existing borrow areas. If new borrow sites are required, then these new areas would need to be investigated and evaluated under NEPA.

7.13.3 CUMULATIVE IMPACTS

Present and future actions by USACE, other agencies, businesses, or the public would likely contribute to cumulative improvement to recreational resources, as many projects in the area include ecosystem and recreational infrastructure improvement. The CED, Phase I (USACE, 2013) discusses the cumulative impacts of present and future regional storm damage reconstruction, redevelopment, coastal, and wetland restoration, and transportation actions on recreational resources and is incorporated by reference here.

Temporary cumulative adverse impacts on recreational resources have occurred in the study area; temporary impacts primarily associated with access closures are expected to occur for the life of the project. Access and navigation to land- and marine-based recreational opportunities and resources have been affected by past and ongoing actions. Noise and water quality issues from past and ongoing storm risk reduction construction activities cumulatively reduce fishing and hunting opportunities within the study area. In addition, the displacement of wildlife due to construction impacts would limit outdoor nature activities such as bird watching, hiking, and photography.

Cumulative impacts from construction might be noticeable to individuals who use the levees for walking or access to bank fishing, but park, field, and trail users would only be affected if a major event generating a lot of traffic were held at the same time that construction traffic is on the roads.

The proposed action in association with past and ongoing storm risk reduction projects provides cumulative benefits for recreational resources in the study area by reducing flood and storm damage risk to recreation facilities, museums, sporting arenas, recreational paths, park infrastructure, and green space.

Cumulatively, the proposed action construction and future borrow site excavation would have negligible permanent impacts on recreational resources. Where construction projects cross recreational areas, temporary closures of access can occur. Some green space and other recreational areas may be permanently lost or impacted, but cumulatively, improvements offered through these regional projects would provide beneficial effects on recreational resources in the study area. **Regionally, the permanent cumulative impacts on recreational resources would be negligible and less than significant.**

7.13.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to recreational resources, the following environmental commitments shall be implemented:

- Continued coordination with LDWF, Scenic Rivers Program regarding minimization of impacts to affected Louisiana Scenic Rivers, if any.
- The CEMVN would ensure that impacts and encroachments onto public lands are avoided.
- USFWS recommends USACE should avoid impacts to public lands, if feasible. If not feasible, USACE should establish and continue coordination with agencies managing public lands that may be impacted by a project feature until construction of that feature is complete and prior to any subsequent maintenance.

7.14 AIR QUALITY

7.14.1 REGULATORY FRAMEWORK

This air quality resources section addresses compliance for the following applicable environmental laws and regulations:

- Clean Air Act
- General Conformity Rule

Impacts to air quality would be considered significant if an alternative resulted in emissions that exceeded the General Conformity de minimis thresholds associated with the Clean Air Act.

7.14.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE –

Air quality would continue to be subject to institutional recognition and regulation into the future. However, air quality in the study area would likely decline for the following reasons: continued population growth, further commercialization and industrialization, increased numbers of motor vehicles, and increased emissions from various engines. These impacts would be coupled with the continued loss of coastal wetland vegetation that would no longer be available to remove gaseous pollutants. It was assumed respiratory ailments, such as asthma, would increase in the human population due to the reduced air quality.

Under the No Action Alternative, there would be no potential for direct, indirect, or cumulative effects to air quality because construction of the proposed action would not occur, and the attainment area status for the study area is not anticipated to change from current conditions.

Existing borrow areas are actively used by private individuals, non-federal, and federal entities seeking borrow. On-going air quality impacts from activities at the borrow sites would include temporary diesel and gasoline emissions from the operation of construction equipment and creation of particulate emissions generated by activities that disturb and suspend soils. However, the attainment area status of existing parishes is not anticipated to change from the current conditions.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct Effects – Probable direct impacts to air quality would include temporary diesel and gasoline emissions from the operation of construction equipment and temporary creation of

particulate emissions during project construction. Construction workers would temporarily increase the combustible emissions during their commute to and from work. The emissions from supply trucks and workers commuting to work would temporarily impact air quality in the vicinity of the project area. Operation of construction equipment and support vehicles would also generate Volatile Organic Compounds (VOCs), Particulate Matter (PM)₁₀, PM_{2.5}, Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Ozone (O₃) and Sulfur Oxides (SO_x) emissions from diesel engine combustion. During the construction of the proposed action, proper and routine maintenance of all vehicles and other construction equipment would be implemented to ensure that emissions are within the design standards of all construction equipment. St. Charles, Jefferson, Orleans, and Plaquemines parishes are in attainment of all NAAQS. Due to the short duration of the construction project, any increases or impacts on ambient air quality would be expected to be short-term and minor and would not be expected to cause or contribute to a violation of federal or state ambient air quality standards. Long term, there is no anticipated effect to air quality. Regional air quality standards would not be violated. The proposed project would be in conformance with NAAQS.

Indirect Effects – The indirect effects to air quality of implementing the proposed action would be related to the emissions from transportation of personnel and equipment to and from the job site on a daily basis until the completion of construction.

Conformity Determination. The General Conformity Rule (40 CFR Part 93) ensures that the actions taken by federal agencies in nonattainment and maintenance areas do not interfere with a state's plans to meet national standards for air quality. A conformity determination evaluates whether a federal action meets the requirements of the general conformity rule and must be performed when a federal action generates air pollutants that would exceed conformity threshold ("de minimis") levels in a region designated as a non-attainment or maintenance area for one or more NAAQS. If emissions would not exceed de minimis levels, a conformity determination is not required. Since the study area is in attainment, a conformity determination was not required.

GENERALIZED BORROW AREAS – For generalized borrow locations, impacts resulting from implementation of the proposed action would be expected to be similar to the FWOP conditions. There would be short-term impacts to air quality that would result from the operation equipment to excavate, move and transport borrow. Air emissions would be controlled by implementation of BMPs. Air quality impacts would be limited to those produced by heavy equipment and suspended dust particles generated by bulldozing, dumping, and grading. Operation of construction equipment and support vehicles would generate VOCs, PM₁₀, PM_{2.5}, NO_x, CO, O₃, and SO_x emissions from diesel engine combustion. The construction equipment should have the same emissions as local traffic in the areas. Duration of the impacts to air quality would depend upon the daily frequency of trucks, weather, and the amount of borrow available.

Air emissions from the proposed action would be temporary and would have less significant impacts to air quality in the region and are not expected to cause or contribute to a violation of federal or state ambient air quality standards.

7.14.3 CUMULATIVE IMPACTS

Cumulative effects to air quality may be noticeable if construction activities and borrow operates are conducted simultaneously. The limited temporal and quantitative contribution of emissions from the proposed action to cumulative air emissions from other area sources such as vehicles

and other potential levee lifts in Jefferson, Orleans, St. Charles or Plaquemines Parishes would not be expected to alter the attainment status of these parishes.

A number of construction projects are occurring or are planned for the study area that would produce air emissions, including ongoing hurricane storm damage risk reduction projects, flood risk reduction projects, Sections 404/10/408 permitted actions, several hotels and high-rise housing projects, and riverfront development⁷. These present and future regional actions, along with the proposed action, would increase the ambient air pollution levels in the New Orleans Metropolitan Area, and local citizens may experience an increased exposure to air pollution. Other storm and flood risk reduction construction projects could potentially increase and extend the time that local residents are exposed to an elevated air pollution level. However, most of these emissions would occur primarily during construction activities and therefore would cause only short-term cumulative impacts on air quality. **The ambient air quality should return to pre-construction conditions once completed, and permanent cumulative impacts on air quality would be negligible and less than significant.**

7.14.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to air quality, the following environmental commitments shall be implemented:

- 1) Dust suppression methods would be implemented to minimize fugitive dust emissions
- 2) Standard construction BMPs would be developed in coordination with LDEQ and be used during construction of the proposed action, including proper and routine maintenance of all vehicles and other construction equipment to ensure that emissions were within the design standards of all construction equipment.
- 3) Construction equipment and haul trucks will have catalytic converters and mufflers to reduce exhaust emissions.
- 4) Conformity analyses would be conducted for borrow areas located in non-attainment areas.

7.15 NOISE

7.15.1 REGULATORY FRAMEWORK

This noise section addresses compliance for the following applicable environmental laws and regulations:

- Noise Control Act of 1972, as amended by Quiet Communities of 1978
- National Environmental Policy Act

Impacts to noise would be considered significant if an alternative resulted in:

- Substantial permanent increase in ambient noise levels for adjacent sensitive receptors
- Exposure of persons to or generation of noise and vibration levels in excess of standards established by local/regional noise ordinances or applicable standards of other agencies.

7.15.2 IMPACTS OF CONSIDERED ALTERNATIVES

⁷ Available online at: <https://nola.curbed.com/maps/new-orleans-riverfront-development-construction-mapped>. Accessed 19 November 2019.

NO ACTION ALTERNATIVE – Noise impacts would be similar to those under existing conditions because there would be no direct or indirect impacts from construction equipment. Future maintenance activities could result in a slight increase in noise levels from equipment and activities associated with maintenance activities but any increase in noise levels is anticipated to be temporary.

Existing borrow sites would be actively used by private individuals, non-federal, and federal entities seeking borrow. Noise levels would be expected to be similar to existing conditions of continued operation of borrow areas. These noise impacts related to borrow operation would continue until the borrow area is depleted.

Local and temporary noise typically associated with human activities and habitations such as car and truck traffic, operation of commercial and recreational boats, water vessels, airboats, and other recreational vehicles; operation of machinery and motors; and human residential-related noise (air conditioners, lawn mowers, etc.) would likely continue to affect humans and animals in the study area in the future. Noise levels may increase slightly with increasing population and industrialization in the study area. Changes in local noise ordinances may also increase or decrease future noise levels.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct and Indirect Effects – Noise along the existing right-of-way would increase due to the temporary operation of equipment and vehicles used in the construction of the levee lifts and floodwall raises. While noise impacts may cause a temporary inconvenience to residents and facilities in the immediate area, noise levels associated with construction activities would be temporary and monitored to ensure acceptable standards are maintained. No permanent noise impacts as a result of the WBV construction is anticipated, and all noise emissions are expected to be short-term, lasting only as long as construction activities. The CED, Phase 1 (USACE, 2013) further describes the noise impacts that occurred during previous construction and these impacts are incorporated by reference and only briefly summarized here. No long-term indirect effects on noise are anticipated with implementation of proposed actions.

Noise levels associated with construction activities have the potential to temporarily impact wildlife that may be present in the area, but would not be significantly different from noise associated with other human activities that occur on a daily basis. After completion of the proposed action, noise levels would be expected to return to pre-action levels. Future maintenance activities could result in a slight increase in noise levels from equipment and activities associated, but any increase in noise levels associated with maintenance activities are anticipated to be lower and of shorter duration. Construction of foreshore protection in the vicinity of the 404(c) is occurring on the opposing bank and is expected to be temporary and have minim noise impact to this area.

Table 7-6 describes noise emission levels for construction equipment that would be expected to be used during the proposed construction activities. As can be seen from this table, the anticipated noise levels at 50 foot range from 76 dBA to 83 dBA based on data from the Federal Highway Administration (USDOT, Federal Highway Administration Construction Noise Handbook, 2006). All construction is anticipated during daytime hours. After completion of the proposed action, noise levels would be expected to return to pre-action levels. Future maintenance activities could result in a slight temporary increase in noise levels from

maintenance equipment such as mowers, but would be the same as the currently existing conditions.

Table 7-6. Sound Levels (dBA) of Construction Equipment and Modeled Attenuation at Various Distances

Noise Source	Distance from Source				
	50 feet	100 feet	200 feet	500 feet	1,000 feet
Dump Truck	76 dBA	70 dBA	64 dBA	56 dBA	50 dBA
Compactor/ Roller	83 dBA	77 dBA	71 dBA	63 dBA	57 dBA
Excavator	81 dBA	75 dBA	69 dBA	61 dBA	55 dBA
dBA at 50 feet is a measured noise emissions. The other distances are modeled estimates. Source: USDOT, 2006					

Table 7-7 summarizes the sensitive noise receptors located in the WBV sub-basins that would be exposed to noise emissions associated with the proposed WBV action. These noise receptors are located along the proposed levee raises and were previously identified by USACE (2013). Noise emissions would be expected throughout the construction period for each project feature. Construction periods may range from 1 to 2 years. Construction would only occur during times allowed by applicable noise ordinances (see Section 4.15.) While the noise emissions would create major impact to sensitive receptors during construction activities, they would be temporary and limited to active construction windows and sporadic (over 50 years), making long-term impacts from noise emissions negligible and less than significant.

Table 7-7. Number of Sensitive Noise Receptors Impacted from Proposed Action (USACE, 2013)

Sub-Basin	Number of Sensitive Noise Receptors				
	Single-Family Homes	Apartment Buildings	Churches	Schools	Hospitals
Belle Chasse	49	0	3	0	0
Gretna-Algiers	32	2	1	0	0
Harvey-Westwego	231	0	1	0	0
Lake Cataouatche	32	0	0	0	0
TOTAL	344	2	5	0	0

GENERALIZED BORROW AREAS – Temporary noise would occur during construction and hauling activities associated with equipment such as bulldozers, excavators, and dump trucks. It is assumed that excavation and hauling would be limited to daylight hours (10 – 14 hours per day) seven days a week. However, this may change due to construction schedules, weather conditions, and project borrow needs. Nearby residential areas may be impacted by elevated noise levels due to excavation and hauling. Actual noise impacts would depend on location of borrow sites to sensitive receptors, construction schedules, which are dependent on weather conditions and specific borrow area characteristics, which are not known at this time. Those factors would be addressed in future, borrow-site-specific NEPA.

Therefore, the noise impacts of the proposed action alternatives would be less than significant.

7.15.3 CUMULATIVE IMPACTS

Cumulative noise impacts associated with WBV construction activities would be periodically major due to the number of sensitive noise receptors adjacent to proposed action; however, these impacts would be short-term and would end when construction is completed. No permanent cumulative impacts would occur from WBV construction.

A number of construction projects are occurring or planned for the region that would produce noise emissions. The construction activities for these projects would potentially increase the ambient noise levels in the study area and extend the time that local residents are exposed to elevated noise levels.

Storm damage reconstruction and redevelopment projects would potentially cause temporary adverse impacts in the study area; should pile driving operations occur, those impacts could be major. If WBV construction projects coincide with other construction projects, then the short-term adverse cumulative impacts would occur on sensitive noise receptors in the region.

Overall, noise associated with WBV construction and other regional projects would be limited to specific locations of construction activities and would be temporary in nature. **Regional, long-term cumulative noise impacts would be negligible and less than significant.**

7.15.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to noise, the following environmental commitments shall be implemented:

- 1) Adherence to the local noise ordinances.
- 2) Construction equipment would be routinely checked to ensure that the equipment is operating properly.

7.16 TRANSPORTATION

7.16.1 REGULATORY FRAMEWORK

This transportation section addresses compliance for the following applicable environmental laws and regulations:

- Federal Aid Highway Act

Impacts to traffic would be considered significant if an alternative resulted in an increase in traffic which is substantial in relation to the existing traffic load and capacity of the local road network.

7.16.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Under the No Action Alternative, the levee lifts and floodwall raises would not occur. The routine maintenance of public roads around the project area would continue. It is assumed that major transportation and evacuation corridors within the vicinity of the study area would likely become more vulnerable to storm damage in the future without action resulting in significant adverse impacts. Some transportation and evacuation routes in the vicinity of the study area may also become more vulnerable due to future loss of coastal

marshes, which act as natural buffers to storm surge resulting from tropical storms and hurricanes.

Under the No Action Alternative, known borrow area sites are likely to continue to be used by private individuals, non-federal, and federal entities seeking borrow. The use of these borrow areas is anticipated to continue until they have exhausted the borrow supply, and the current impact of borrow pit use on area roads would continue until the pit is exhausted.

PROPOSED ACTION ALTERNATIVES – The impacts on transportation between Alternatives 2 and 3 are expected to be identical unless otherwise noted.

Direct Effects – Use of the area's roads would increase during construction due to the presence of construction related vehicles and activities. It is assumed the same transportation corridors would be used for construction of WBV as previously used during HSDRRS construction. The CED, Phase I describes the estimated transportation impacts and is incorporated by reference (USACE, 2013) and only briefly summarized here. Construction equipment such as bulldozers and graders would need to be delivered to construction sites. Haul trucks would be entering and exiting the areas on a daily basis during the period of construction. The truck hauling would temporarily impede vehicle traffic and result in minimal reduction of the level of service on some local road segments. Any increase in traffic would be moderate and temporary. After construction is complete, transportation would return to pre-construction levels.

Assuming a 14 cubic yard dump truck, Alternative 2 would require approximately 220,000 truck trips to haul approximately 3.1 million cubic yards of in-place borrow material to the project sites. For Alternative 3, approximately 363,000 truck trips would be required to haul approximately 5.086 million cubic yards of in-place borrow material to the project sites. (Alternative 3 quantities were not updated during feasibility level design.) The number of miles and the transportation route for each truck trip would depend upon the borrow pit selected by the contractor for each reach. The increase in truck traffic would have a short-term temporary impact on the direct travel routes to/from the borrow sites and would result in localized congestion at the construction site.

Indirect Effects – With implementation of the proposed action, indirect effects on transportation would include increased use of existing transportation corridors as a result of the reduced storm risk within the study area.

Overall, the impact on transportation from implementing the proposed action would be a moderate, significant impact.

GENERALIZED BORROW AREAS – With implementation of the proposed action, haul trucks would be entering and exiting the areas on a daily basis during the period of construction. The truck hauling would temporarily impede vehicle traffic and result in a minimal reduction of the level of service on some local road segments. Impacts on roads that are used near borrow areas would occur. Adverse short-term, congestion-related impacts and degradation of the roads would likely be moderate to major during construction period.

7.16.3 CUMULATIVE IMPACTS

The HSDRRS construction and associated excavation of borrow areas contributed directly and

indirectly to cumulative impacts on the transportation system throughout the study area. Cumulative moderate adverse impacts such as damage and degradation of infrastructure and roadway wear-and-tear due to increased truck traffic occurred in the study area. Likewise, lower hurricane and storm damage reduction to the portion of the greater New Orleans area upon completion of WBV is expected to cause additional economic and population growth in the region and thus increase the demand for transportation resources, which could lead to cumulative indirect long-term adverse impacts. Indirectly, traffic congestion caused by truck traffic on some roadways likely altered traffic patterns of commuters and residents, increasing traffic congestion on roads not directly used for WBV-related transportation.

The transportation analysis conducted by USACE (2009) to address the overall cumulative impacts of construction and future operation and maintenance of the HSDRRS describes and characterizes the environmental impacts of transporting materials necessary to construct the HSDRRS for New Orleans, Louisiana. The 2009 report was updated in 2016 using final transportation information. The analysis addressed the effects of using the public highways and waterways to supply earthen borrow, structural steel (e.g., sheet pile, pipe pile, H-pipe), ready-mix concrete, concrete pile, aggregate, and rock to over 150 different construction projects for the LPV and WBV projects. The database of projects used to analyze quantities, trips, and timing of trips contains 150 projects, which were analyzed in 19 previous IERs. Table 4-17 shows the quantities of the material used for the 150 projects. According to the transportation analysis, an estimated 1.5 million truck trips are estimated to have been needed to deliver the quantity of material presented in the table below to construct HSDRRS. In addition, 814 barge trips delivered some of the material, mainly rock. This past action, along with proposed action and other known construction activities, could contribute to cumulative impacts on transportation on major roads such as Interstate 10. However, this cumulative impact would be short term and is not considered significant given the existing high traffic volumes present on these major roads.

Table 4-8. HSDRRS Material Quantities

Material	Quantity	Units
Earthen Fill	17,319,700	Cubic yards
Concrete	1,559,500	Cubic yards
Aggregate	2,979,300	Tons
Sheet Pile	11,479,800	Square feet
H-Pile	10,368,800	Linear feet
Pipe Pile	845,500	Linear feet
Concrete Pile	1,592,200	Linear feet
Rock	3,043,500	tons

Short-term cumulative adverse impacts on transportation caused by increased construction traffic, congestion from transporting materials (primarily borrow material) to project construction locations, and temporary road closures resulting from the implementation of the proposed action. Damage to pavement from increased truck traffic may occur. Short-term cumulative impacts on residents from construction and traffic noise occurred during previous improvements and ongoing redevelopment construction activities and transportation improvement projects. Similar impacts are expected with the proposed actions.

If one or more of the levee lift projects in Jefferson, Orleans, St. Charles, or Plaquemines Parishes used the same borrow pit at the same time as the WBV reaches, local roads in the immediate vicinity of the borrow pit would see a cumulative impact of a further reduction in level of service or traffic congestion. This cumulative impact would be temporary and would return to pre-project conditions once the hauling of material for the levee lifts is complete.

Present and future actions by USACE and other agencies for project construction and maintenance would likely further contribute to cumulative degradation of roadway pavement and traffic congestion, since many projects require the use of heavy trucks and construction equipment. The CED, Phase I describes other present and future regional actions and is incorporated by reference (USACE, 2013), and only summarized here. The combination of WBV construction, excavation of borrow areas, and other regional projects (e.g., transportation, storm damage reconstruction, coastal and wetland restoration, and flood risk reduction projects) would contribute directly and indirectly to cumulative impacts on transportation in the study area.

Cumulative moderate adverse impacts such as increased traffic, damage and degradation of infrastructure, and roadway wear-and-tear due to increased truck traffic, in conjunction with concurrent regional construction projects, would be expected within the WBV study area. Likewise, lower flood and coastal storm damage risk in the greater New Orleans area upon completion of the WBV would cause additional economic and population growth in the region and thus would increase the demand for transportation resources, which could lead to cumulative indirect long-term adverse impacts. Construction of the WBV would also provide beneficial impacts on transportation resources in the region, as it reduces flood and coastal storm damage risk and future storm damage to these resources. The WBV construction has the long-term potential to save millions of dollars in repair costs for highways, roads, bridges, railroads, airports, and public transit systems (streetcar lines) that could otherwise be damaged by future flooding.

The cumulative impact on transportation would be a moderate, significant impact for implementation of the proposed action.

7.16.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to transportation resources, the following environmental commitments shall be implemented:

- 1) Use of flagmen, signage, cones, barricades, temporarily re-routing roads during construction, and installation of temporary turn lanes near construction areas
- 2) Appropriate measures to ensure safety and facilitate the movement of traffic would be implemented at all approved borrow areas
- 3) Use of dust suppression methods such as watering of construction sites
- 4) Traffic coordination meetings with local and state transportation departments would be held to discuss traffic situations, conditions, and traffic management strategies.

7.17 HUMAN ENVIRONMENT

7.17.1 REGULATORY FRAMEWORK

This section addresses compliance for the following applicable environmental laws and regulations:

- NEPA

Impacts to the human environment would be considered significant if:

- Socioeconomic impacts resulted in a substantial shift in population trends or adversely affected regional spending and earning patterns

7.17.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – Under the No Action Alternative, the existing WBV system would not provide hurricane and storm damage risk for a 1% AEP storm, leading to increased perceived and continuation of actual risks to the communities as described in the Future Without Project Condition. There would be no direct impact on the human environment under this alternative since construction of levee lifts would not occur. Any indirect or cumulative impacts of the No Action Alternative to socioeconomic resources would be a continuation of the Future Without Project and are anticipated to be less than significant and follow similar trends as described in Section 4.17 above.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct Effects – There are no direct impacts to socioeconomic resources from the WBV and MRL projects. No permanent adverse direct impacts on population and housing, business and industry, employment and income, community and regional growth, or community cohesion is expected to occur as a result of Alternatives 2 and 3. All of the WBV construction activities would take place in existing ROWs and within areas already environmentally assessed for NEPA (USACE, 2013) and would not directly impact the human environment. MRL improvements would take place on the flood-side of the system, sparing impacts to the human environment.

Indirect Effects – The socioeconomic indirect impacts from WBV and MRL projects would be primarily beneficial and include hurricane and storm damage risk reduction resulting from increasing the heights of the levees/floodwalls for the 1% AEP or 0.5% AEP storm events. Indirect impacts include temporary, minor inconveniences from construction activities to those living near the HSDRRS or Mississippi River levees, such as increases in traffic and noise, and inability to recreate in areas affected by construction.

In the short-term, construction activities related to proposed action directly provide jobs, benefit businesses through the purchases of materials and supplies, and provide sales tax revenue to local governments. In the long-term, providing a level of risk reduction to communities in southeast Louisiana would improve the confidence of residents and the business community in the long-term viability and resilience of the Greater New Orleans area and could generate further interest in redevelopment of storm-damaged neighborhoods.

Therefore, implementation of the proposed actions would have less than significant impacts to socioeconomics, and therefore the overall human environment, as related to the implementation of levee lifts and floodwall raises.

GENERALIZED BORROW AREAS – Impacts on socioeconomics may occur as a result of the additional borrow, but until borrow sites are selected, the total impacts cannot be estimated.

7.17.3 CUMULATIVE IMPACTS

The impacts of past, proposed action, and actions of others associated with raising levees, floodwalls, floodgates, and new construction collectively would continue to have a cumulative

beneficial impact on the socioeconomics of southeast Louisiana because these projects are tied directly to regional recovery projects, enhance storm risk reduction, or contribute to wetland and coastal restoration. The CED, Phase I discusses the cumulative socioeconomic and environmental justice impacts of present and future regional actions within the study area and is incorporated by reference (USACE, 2013), and only briefly described here.

The cumulative long-term benefits of the long-term confidence in risk reduction brings are not truly quantifiable, but providing greater safety for everyone with investment interests in southeast Louisiana is a beneficial cumulative economic benefit to Louisiana and the U.S.

Cumulatively, large construction projects have short-term socioeconomic impacts regionally on residents and businesses from increased noise, dust, and traffic congestion. Periodic lane and road closures that delay and idle traffic have indirect cumulative economic adverse impacts due to time lost from other economic-generating activities. Although there would be adverse cumulative impacts on socioeconomic resources within the study area, most of these impacts would be short-term and occur only during ongoing construction activities of the WBV and other regional projects.

Many federal agencies have authorized spending in the hurricane-affected areas. Short-term and long-term benefits on community and regional growth would result as local, state, and federal agencies and non-profits in the region continue to spend money in the region on storm damage reconstruction, redevelopment, coastal and wetland restoration, and other hurricane and storm damage risk reduction projects. These tens of billions of dollars of investments all have an economic multiplier benefit which, when combined with the proposed action, would result in long-term beneficial impacts in the region in jobs, sales of materials and supplies, housing values, and other expenditures. Additionally, the greater level of risk reduction provided by WBV and other risk reduction projects regionally would cumulatively improve economic conditions in the long-term through reduced insurance costs and greater investment (USACE, 2013). **Thus, the long-term regional cumulative impacts on socioeconomic resources would be predominately beneficial and are considered by the majority in the region and the nation as essential.**

7.17.4 ENVIRONMENTAL COMMITMENTS

Although there is no requirement through regulations to minimize socioeconomic impacts from construction of WBV, adverse impacts on socioeconomic resources were minimized primarily by designing the footprint of risk reduction work within existing ROWs, thereby reducing the need to acquire additional property or to “take” property.

To minimize impacts to socioeconomic, the following environmental commitments shall be implemented:

- 1) Minimize impact on the overall footprint
- 2) Temporary construction easements would be returned to pre-construction conditions and consistent with the 1% AEP level of risk reduction.
- 3) All project features would be designed so that the visual and human-cultural values associated with the project are protected, preserved, maintained, or enhanced to the maximum extent practicable.
- 4) Use best management practices to reduce or minimize construction impacts to the human environment.

7.18 ENVIRONMENTAL JUSTICE

7.18.1 REGULATORY FRAMEWORK

This section addresses compliance for the following applicable environmental laws and regulations:

- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations
- EO 13166, Improving Access to Services with Persons with Limited English Proficiency

Impacts to the human environment would be considered significant if:

- Environmental Justice impacts resulted in a disproportionately high and adverse impact to a minority or low-income population.

7.18.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – The No Action Alternative would not raise the levees to provide hurricane and storm damage risk reduction for a 1% AEP storm. There would be no direct impact on minority and/or low-income population groups under this alternative since construction of levee lifts would not occur. However, since this alternative fails to provide full overtopping flood risk reduction for a 1% AEP storm at year 2073, the actual and perceived risks to minority and/or low-income population groups under this alternative would be higher than under the with-project alternatives.

Minority and low-income residents would remain vulnerable to storm events and over time, may consider relocation. However, low-income populations may find it difficult to move to areas with lower flood risk because of the financial strain associated with moving. In those cases, residents would remain and continue to be impacted by storm events.

PROPOSED ACTION ALTERNATIVES – The impacts on environmental justice between Alternatives 2 and 3 are expected to be identical unless otherwise noted. Alternatives 2 and 3 are expected to have identical impacts.

The HSDRRS CED Phase I study identifies EJ communities and EJ resource impacts from construction of the HSDDRS for WBV and those findings are incorporated into this analysis. The link, <https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/> provides the IERs, the CED report and the EJ analysis for the five parish HSDRRS study area.

Direct Effects – There are no direct impacts to environmental justice resources from the WBV and MRL projects. All of the WBV construction activities would take place in existing ROWs and within areas already environmentally assessed for NEPA (USACE, 2013) and would not directly impact the EJ resources. MRL improvements would take place on the flood-side of the system, sparing impacts to the EJ resources. Additionally, no permanent disproportionate impacts are expected to occur on any minority or low-income community from WBV and MRL construction.

Indirect Effects – Indirect adverse impacts to EJ communities that are adjacent to the WBV levee and MRL projects may include short-term construction impacts, such as noise during daylight hours, dust, temporary road closures and increases in truck traffic. High, adverse short-term or permanent adverse impacts are not expected to occur as a result of the federal action. Best management practices will be utilized during construction activities that reduce and

minimize noise levels and dust and transportation routes for material delivery will be identified, before construction activities commence, to limit impacts to EJ communities. Short-term adverse impacts will be felt by communities adjacent to the levee lifts, but also to those in the general metropolitan area as trucks will be using roads to deliver levee material from borrow source sites. Residents in the study area, regardless of race or income level, could be impacted by short-term construction activities. Hurricane and storm damage risk reduction benefits will be conferred to all residents within the HSDDRS.

No disproportionate, high adverse impacts on low-income or minority communities is expected from the proposed action because all residents and businesses are provided an equal level of risk reduction and any adverse construction impacts are spread throughout the study area impacting EJ and non EJ communities alike. Additionally, there are no long-term high and adverse impacts from construction of Alternatives 2 and 3 and all residents regardless of income or race and including EJ and non EJ communities would receive flood risk benefits from the projects.

Therefore, implementation of the proposed actions would have less than significant impacts to environmental justice as related to the implementation of levee lifts and floodwall raises.

GENERALIZED BORROW AREAS – Impacts implicating environmental justice concerns may occur as a result of the additional borrow, but until borrow sites are selected, the total impacts cannot be estimated.

7.18.3 CUMULATIVE IMPACTS

Cumulative impacts under the No Action Alternative include the potential for a steady decline in minority and/or low-income population groups and other groups as residents move to areas with lower flood risks as well as continued financial and emotional strain placed on these groups as they prepare for and recover from flood events.

The CED, Phase I discusses the cumulative environmental justice impacts of present and future regional actions within the study area and is incorporated by reference (USACE, 2013), and only briefly described here. Cumulatively, large construction projects have the potential to disproportionately impact low-income and minority communities. However, although there would be adverse cumulative impacts on EJ resources within the study area, most of these impacts would be short-term and occur only during ongoing construction activities of the WBV and other regional projects. Upon completion of construction, the EJ communities would also receive by reducing flood risk. **Thus, the long-term regional cumulative impacts on EJ resources would be less than significant.**

7.18.4 ENVIRONMENTAL COMMITMENTS

Adverse impacts on environmental justices resources were minimized primarily by designing the footprint of risk reduction work within existing ROWs, thereby reducing the need to acquire additional property or to “take” property.

To minimize impacts with potential environmental justice concerns, the following environmental commitments shall be implemented:

- 1) Minimize the overall footprint to the extent practicable.

- 2) Temporary construction easements would be returned to pre-construction conditions and consistent with the 1% AEP level of risk reduction.
- 3) All project features would be designed so that the visual and human-cultural values associated with the project are protected, preserved, maintained, or enhanced to the maximum extent practicable.
- 4) Use best management practices to reduce or minimize construction impacts to the EJ communities.
- 5) If Limited English Proficiency (LEP) communities are present, then efforts to ensure meaningful access to project information, notifications, and other aspects of the proposed project would occur now and into the future.

7.19 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

7.19.1 REGULATORY FRAMEWORK

Under ER 1165-2-132 the type and extent of HTRW contamination within the vicinity of the proposed actions are assessed during the feasibility phase to inform the choice among alternative plans. USACE policy is to avoid the use of project funds for HTRW removal and remediation activities.

This HTRW section addresses compliance for the following applicable environmental laws and regulations:

- Resource Conservation and Recovery Act
- Comprehensive Environmental Response, Compensation, and Liability Act
- Solid Waste Disposal Act

Impacts associated with HTRW would be considered significant if an alternative resulted in:

- The creation of a public health hazard involving the use, production, dispersal, or disposal of a hazardous material posing a health risk to people, animal, or plant populations.
- The creation of a hazard to the public or environment through reasonably foreseeable upset or accident conditions involving the release of a hazardous material.

7.19.2 IMPACTS OF CONSIDERED ALTERNATIVES

NO ACTION ALTERNATIVE – The previous Phase I ESA investigations did identify existing or potential RECs near the project area, but it is unlikely that HTRW would alter the operation and maintenance of the flood risk reduction features, adversely affect the project area, personnel working on the project, or the public at large. The probability of encountering RECs during future levee and floodwall operations and maintenance would remain low. The NFS would be responsible for testing and investigations to determine the existence and extent of any hazardous substances regulated under CERCLA and to develop and implement any response plan required by the regulating agency, at no cost to the Government.

Indirect and cumulative impacts resulting from the No Action Alternative would potentially increase the risks of flooding in residential and commercial areas and may result in the mixing of surface waters with sewage, contamination of drinking water supplies, and mobilization of HTRW. As floodwaters recede, the constituents could enter surface waters and cause

temporary reductions in water quality. Soil and sediment contamination may also occur within the project area due to the floodwaters.

PROPOSED ACTION ALTERNATIVES – The impacts on HTRW between Alternatives 2 and 3 are expected to be identical unless otherwise noted.

The proposed action alternatives occur within existing ROWs, and any RECs previously identified in the Phase I ESAs for HSDRRS construction would be reflected in the project documents. As noted in Section 4, any previously identified RECs would have been remediated or avoided prior to HSDRRS construction and would be unlikely to affect future WBV work, personnel working on the project, or the public. The probability of encountering RECs during future levee and floodwall improvements would remain low. An abridged Phase 1 ESA did not identify any existing RECs. If this project is approved and funded, a full Phase 1 ESA would be conducted prior to construction. Should HTRW concerns or RECs be identified at any time during future project improvements, USACE would undertake the appropriate evaluation and would follow applicable laws, regulations and procedures, including those contained in the Project Partnership Agreement and its provisions regarding NFS HTRW remediation.

If the Record of Decision is signed and funding allocated, then a full Phase I ESA will be conducted on the project features prior to construction. Additionally, new Phase I ESAs would be required within a 6 month period prior to the start of any of the levee lifts to ensure that no RECs are present. The probability of encountering HTRW in the study area would be low and RECs would be avoided or remediated; **therefore, no direct or indirect impacts would be expected.**

GENERALIZED BORROW AREAS – Should new borrow site excavation be needed, these sites would need environmental compliance to ensure that no RECs or HTRW issues would be encountered at these borrow sites. Therefore, although the location and number of new borrow sites are unknown, no direct or indirect impacts would be expected from HTRW (USACE, 2013).

For both borrow site excavation and levee lift construction, spills and the potential to produce HTRW are a possibility. Storage, fueling, and lubrication of equipment and motor vehicles associated with construction activities would be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants, and oil would be managed and stored in accordance with all federal, state, and local laws and regulations. Used lubricants and used oil would be stored in marked, corrosion-resistant containers and recycled or disposed in accordance with appropriate requirements. Construction contractors would be required to develop a Spill Prevention Control and Countermeasures Plan.

7.19.3 CUMULATIVE IMPACTS

Ongoing and future regional projects would likely contribute to cumulative beneficial impacts on HTRW, since many projects in the area, which include ecosystem restoration, infrastructure improvements, and a large storm rebuilding and reconstruction effort, would identify, evaluate, and potentially remediate existing HTRW issues. However, storm reconstruction, redevelopment, and transportation projects could also temporarily adversely impact natural resources, such as water quality in surface waters, because of the mobilization of HTRW due to stormwater runoff from construction. The cumulative effects of these projects on HTRW problems would be temporary and minor. Coastal and wetland restoration, as well as flood and storm risk reduction projects, could potentially cause contaminated sediment suspension, which would result in adverse effect and indirect HTRW impacts during construction. However, a

reduced risk of flooding and storm damage afforded by the proposed action would offer long-term beneficial HTRW impacts by lessening risk of storm surge devastation in the region.

The cumulative effects of all types of regional projects on HTRW would be temporary and minor and primarily during construction activities. Implementation of federal, state, and local laws and regulations would minimize any potential HTRW impacts. **Therefore, no long-term HTRW direct or indirect cumulative impacts would be expected within the WBV study area.**

7.19.4 ENVIRONMENTAL COMMITMENTS

- 1) A full Phase I ESA will be completed for each of the future levee lifts.
- 2) Containment of fuel and construction-required chemicals
- 3) For borrow areas, the contractor will be required to collect, characterize, label, store, transport, and dispose of all non-recyclable hazardous and regulated wastes, as regulated by the USEPA, and to comply with RCRA and other applicable laws and regulations.
- 4) Solid waste receptacles will be maintained at all staging areas. Non-hazardous solid waste (trash and waste construction materials) will be collected and deposited in on-site receptacles.

7.20 PROBABLE UNAVOIDABLE ADVERSE IMPACTS (ON ALL RESOURCES)

During construction of the proposed action, there would be temporary unavoidable adverse impacts on the existing flora and fauna, soil, and traffic in those locations where construction would occur adjacent to an existing roadway or would be along the transportation corridor between borrow areas and construction sites. Some of these impacts may occur, on a lesser scale, during maintenance of the proposed the action. Temporary, unavoidable adverse impacts including increased turbidity and noise would result from construction activities. These impacts would return to normal when construction is completed. Longer-term, non-temporary adverse impacts related to operation and maintenance of the proposed action includes loss of prime farmland within the borrow areas and loss of soil and habitat from borrow areas. However, benefits from an improved hurricane and storm damage risk reduction system for the New Orleans Metropolitan Area would outweigh these unavoidable adverse impacts.

Where unavoidable construction impacts (including borrow areas) to the environment occur, mitigation would occur to replace loss of wetland habitats (*i.e.*, BLH-wet, fresh and intermediate marsh, and brackish marsh). At this time, Alternative 2 would require 37.21 AAHUs of BLH-Wet mitigation to offset impacts while Alternative 3 would require 39.55 AAHUs. (Alternative 3 quantities were not updated during feasibility level design.) If unavoidable impacts happen to non-wetland habitat (such as dry bottomland hardwood forest), in accordance with WRDA 1986, Section 906 (as amended), compensatory mitigation may also be required.

7.21 RELATIONSHIP TO SHORT-TERM USES AND LONG-TERM PRODUCTIVITY (ON ALL RESOURCES)

This section discusses the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. This section discusses whether construction and operation of the proposed project could cause short-term uses of the environment that would affect, either positively or negatively, the long-term productivity of the

environment. “Short-term” generally refers to more immediate period of time during which the proposed action would be constructed, whereas, “long-term” refers to an indefinite period beyond this timeframe.

Short-term uses of the environment associated with the proposed actions are generally the same as the environmental impacts described in the previous sections (Section 7.2-7.18) of this EIS. These impacts include both temporary and permanent “use” of the physical environment as a result of developing the proposed action and energy and resource use during project construction and maintenance. In considering the effect of these uses on long-term productivity, four main types of long-term productivity are considered: soil productivity, hydrological productivity, biological productivity, and economic productivity.

7.21.1 SOIL PRODUCTIVITY

While maintenance of long-term soil productivity is mainly a concern in areas that are in agricultural use, this concern also can arise anywhere that soils provide an economic or ecological benefit. Construction of the proposed action would affect soil productivity by borrow excavation, clearing, and grading. At borrow areas, long-term negative effects on soil productivity would be expected since these soils would be taken out of use. However, long-term positive effects on soil productivity for soils within the protected levee system are expected due to reduced risk of storm surge and flooding.

7.21.2 HYDROLOGICAL PRODUCTIVITY

Wetlands, groundwater resources, and floodplains contribute to long-term hydrological productivity by providing filtration, habitat for sensitive species, and essential recharge for agricultural and municipal use. Wetlands would lose productivity in those areas requiring mitigation, but productivity would be replaced through compensatory mitigation. Water bodies and floodplain would lose some productivity in the short-term from increased sedimentation from erosion during construction and increased amounts of potential pollutants that could enter construction sites from construction equipment and soil-disturbing activities.

7.21.3 BIOLOGICAL PRODUCTIVITY

Plant communities, fish, and wildlife contribute to the biological productivity; their long-term productivity provides an ecological and recreational benefit in sensitive or remote areas. Proposed construction would affect biological resources through land clearing, grading, and borrow area excavation.

During construction, clearing and grubbing along existing levees would occur. After construction, levee vegetation would be restored. Excavation of borrow areas would permanently remove vegetation. After the borrow area is depleted, natural cover and/or vegetation restoration could take place. Borrow area excavation would also impact wildlife. Substantial habitat could be permanently lost, altered, and fragmented. The noise and increased human activity related to construction could decrease some wildlife species' breeding success and in some cases cause direct mortality. At the same time, habitat alteration can encourage the increase of species that can best adapt to the altered habitats. Over the long-term, species that are highly adaptable or avoid areas during short-term construction activities are expected to return once construction is complete.

7.21.4 ECONOMIC PRODUCTIVITY

Agriculture, urban and suburban development, and industrial uses can contribute to economic productivity. Risk reduction measure construction and maintenance could affect the economic productivity of some resources by limiting their long-term revenue potential but could contribute to long-term revenue potential in sectors that benefit from an improved hurricane and coastal storm damage risk reduction system. Proposed construction would affect economic productivity through borrow area excavation, construction of levee lifts, and raising of flood walls. At borrow areas, there would be long-term negative effects on land used for agriculture since these areas may be taken out of agricultural production. The proposed project is expected to create a long-term increase in economic productivity by providing a more reliable hurricane and coastal storm damage risk reduction system for a portion of the greater New Orleans area. Increased reliability could create a long-term economic benefit to existing businesses that rely on reduced flooding for production. An improved hurricane and coastal storm damage risk reduction could also attract new industrial and commercial business to the study area, which would provide a long-term increase in economic productivity through increased revenue and jobs.

7.22 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT TO RESOURCES

This section discusses likely irreversible and irretrievable commitments of resources for the project. The impact of the proposed actions on resources that will be forever lost or altered also is discussed. No mitigation specific to the irreversible and irretrievable commitment of resources discussed below has been identified to date for the proposed actions.

Irreversible commitments are those that cannot be reversed, except perhaps in the extreme long run (Shipley, 2010). Simply stated, once the resource is removed it can never be replaced. For the action alternatives considered, there are no irreversible commitments to natural resources. This study is in the planning stage. Money has been expended to complete this planning document and pre-project data collection and modeling. No construction dollars, which are considered irreversible, have been expended for the study. Fossil fuels consumed during construction of proposed actions would be irreversibly expended since their use cannot be reversed or resources replenished. Lastly, human power and funding used to construct the proposed action would result in irreversible fiscal resource commitments. When time and money are dedicated to the project and used, these expenditures cannot be restored or dedicated to another project.

Irretrievable commitments are those that are lost for a period of time (Shipley, 2010). The proposed action alternatives require a vast commitment of construction materials, fuel, energy, land, funding, and labor. Construction materials used to build the proposed action, such as aggregate, steel, and petroleum would be irretrievably committed to the project. These materials cannot be retrieved until they are removed, recycled, and used elsewhere. In addition, water used directly in concrete mixtures or through dust abatement would effectively be an irreversible expenditure. Although concrete can be retrieved through recycling and reuse, the water used to make it is irreversibly locked in solid form. Water quality in adjacent water bodies may be degraded by the proposed actions. This degradation would constitute an irretrievable commitment of water resources because water quality improvements could conceivably be retrieved if future restoration strategies would be implemented.

7.23 COMPLIANCE WITH ENVIRONMENTAL STATUTES

There are many federal and state laws pertaining to the enhancement, management, and protection of the environment. Federal projects must comply with environmental laws, regulations, policies, rules, and guidance.

Public review of the draft report occurred from 13 Dec 2019 to 7 February 2020. Public meetings occurred in January 2020. Comments received during the public review period are documented in Appendix L, *Coordination*. Appendix G, *Environmental Compliance*, provides additional environmental compliance documentation. Environmental compliance will be achieved prior to potential approval of a Record of Decision.

Table 7-8 provides a list of the relevant laws and regulations, including the agency tasked with the jurisdiction for each and the respective permit, license and compliance, or other review.

Table 7-9. Relevant Laws and Regulations

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
Sound/Noise			
Noise Control Act of 1972 (42 USC 4901 <i>et seq.</i>) as amended by Quiet Communities of 1978 (PL 95-609)	USEPA	Compliance with surface carrier noise emissions	Construction and operations
Air			
Clean Air Act and amendments of 1990 (42 USC 7401(q)) 40 CFR 50, 52, 93.153(b)	USEPA	Compliance with NAAQS and emission limits and/or reduction measures	Construction and operations
Water			
Clean Water Act of 1977 (33 USC 1341 <i>et seq.</i>) 40 CFR 121	LDEQ	Section 401 Water Quality Certification	Potential discharge into waters of the state (including wetlands and washes)
Clean Water Act of 1977 (33 USC 1342) 40 CFR 122	USEPA	Section 402(b) National Pollutant Discharge Elimination System General Permit for Stormwater Discharges for Construction Activities	Construction sites with greater than 1 acre of land disturbed
Clean Water Act of 1977 (33 USC 1344) 40 CFR 230	USACE	Section 404(b)1 Evaluation - Compliance	Discharge of dredge or fill material to a watercourse

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
Clean Water Act of 1977 (33 USC 1344) 40 CF 230	USEPA	Section 404(c)	USEPA may exercise a veto over the specification by USACE or by a state of a site for the discharge of dredged or fill material
Coastal Zone Management Act of 1972 (16 USC 1456(c)) Section 307	Administered by LDNR	Consistency Determination - Compliance	Consistency with the Louisiana Coastal Management Program
EO 11988 (Floodplain Management), as amended by EO 12608	Water Resources Council, FEMA, and CEQ	Compliance	Construction in or modification of floodplain
EO 11990 (Protection of Wetlands), as amended by EO 12608	USACE and USFWS	Compliance	Construction in or modification of wetlands
Soils			
Resource Conservation and Recovery Act of 1976 (42 USC 6901(k)), as amended by Hazardous and Solid Waste Amendments of 1984 (PL 98-616; 98 Statute 3221)	USEPA	Proper management, and in some cases, permit for remediation	Current operation involving hazardous waste and/or remediation of contamination site
Comprehensive, Environmental Response, Compensation, Liability Act of 1980 (42 USC 9601), as amended by Emergency Planning and Community Right-To-Know-Act of 1986 (42 USC 1101 <i>et seq.</i>)	USEPA	Development of emergency response plans, notification, and cleanup	Release or threatened release of a hazardous substance
Farmland Protection Policy Act of 1981 (7 USC 4201 <i>et seq.</i>) 7 CFR 657-658	NRCS	NRCS Determination via form AD-1006	Prime and unique farmlands
Soil Conservation Act (16 USC 590(a) <i>et seq.</i>)	NRCS	Compliance	Soil conservation of federal lands
Natural Resources			
Endangered Species Act of 1973, as amended (16 USC 1531) Sections 7 and 9 50 CFR 17.11-17.12	USFWS, NMFS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, develop mitigation measures	Protection of threatened and endangered species and their critical habitats

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
Wild and Scenic Rivers of 1968 (P.L. 90-542; 16 USC 1271 et seq.)	Bureau of Land Management, National Park Service, USFWS, and U.S. Forest Service	Compliance	Preserve certain rivers with outstanding natural, cultural and recreational values in a free-flowing condition for the enjoyment of present and future generations.
Migratory Bird Treaty Act of 1918 (16 USC 703) 50 CFR Chapter 1	USFWS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, develop mitigation measures	Protection of migratory birds
Bald and Golden Eagle Protection Act of 1940, as amended (16 USC 688(d)) 50 CFR 22.3	USFWS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, obtain permit	Protection of bald and golden eagles
Fish and Wildlife Coordination Act (16 USC 2901)	USFWS, NMFS	Compliance	Conserve and promote conservation of fish and wildlife and their habitats
Marine Mammal Protection Act of 1972 (16 USC 1361)	NMFS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, develop mitigation measures	Protection of marine mammals
EO 13112 (Invasive Species)	USACE and Port of New Orleans	Compliance	Requires agencies to restrict the introduction of exotic organisms into natural ecosystems
Magnuson-Stevens Fishery Conservation and Management Act (P.L. 104-297)	NMFS	Compliance	Conserve and enhance Essential Fish Habitat.
Health and Safety			
Occupational Safety and Health Act of 1970 (29 USC 651) 29 CFR 1975	OSHA	Compliance with guidelines, including Material Safety Data Sheets	Health and safety standards
Cultural/Archaeological			

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
NHPA (16 USC 470 <i>et seq.</i>) 36 CFR 800, Army Regulation 200-4, Cultural Resources Management, Presidential Memorandum regarding Government to Government Relations (April 29, 1994) EO 13007 (Indian Sacred Sites)	USACE, SHPO, ACHP, and Tribes	Section 106 Consultation	Assessment of cultural resources and avoidance of disturbance of historic properties
Native American Graves Protection and Repatriation Act 43 CFR 10	USACE, SHPO, ACHP, and Tribes	Compliance	Protection of Native American sites, graves, and sacred objects
Archaeological Resources Protections Act of 1989 (16 USC 470(a)(a)-470(ii)) 43 CFR 7	Affected land-managing agency	Permits to survey and excavate/remove archaeological resources on federal lands; Native American tribes with interests in resources must be consulted prior to issue of permits	Investigations and excavation on federal lands
Socioeconomics			
EO 14045 (Protection of Children from Environmental Health Risks and Safety Risks)	USEPA	Compliance	Identify and assess environmental health risks and safety risk that may disproportionately affect children
EO 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations)	USEPA	Compliance	Identify and address disproportionately high and adverse human health or environmental effects on minority and low-income populations
EO 13166 (Improving Access to Services for Persons with Limited English Proficiency)	Department of Justice	Compliance	If Limited English Proficiency communities are present, ensure meaningful access to project information, notifications, etc.

7.23.1 FISH AND WILDLIFE COORDINATION ACT

The following fish and wildlife conservation recommendations were provided by the U.S. Fish and Wildlife Service as part of their final Fish and Wildlife Coordination Act Report (Appendix G, *Environmental Compliance*).

We do not oppose the Corps' plan to implement alternative 2 for the WBV HSDRRS provided that the following fish and wildlife conservation recommendations are incorporated into ongoing and future project planning and implementation efforts:

- 1. Impacts to Essential Fish Habitat (EFH) shall be avoided and minimized to the greatest extent possible. Because impacts to designated EFH habitat may need to be mitigated the Corps shall coordinate with the NMFS regarding this need.*
- 2. To the greatest extent possible, situate final flood protection features so that impacts to wetlands and non-wet bottomland hardwoods are avoided or minimized.*
- 3. Avoid adverse impacts of bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. Forest clearing associated with project features shall be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.*
- 4. The Service recommends that the USACE contact the Service for additional consultation if: 1) the scope or location of the proposed project is changed significantly, 2) new information reveals that the action may affect listed species or designated critical habitat; 3) the action is modified in a manner that causes effects to listed species or designated critical habitat; or 4) a new species is listed or critical habitat designated. Additional consultation as a result of any of the above conditions or for changes not covered in this consultation should occur before changes are made and or finalized.*
- 5. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, Water Control Plans, or other similar documents) shall be coordinated with the Service, NMFS, LDWF, EPA and Louisiana Department of Natural Resources (LDNR). The Service shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.*
- 6. The Corps shall avoid impacts to public lands, if feasible. If not feasible the Corps should establish and continue coordination with agencies managing public lands that may be impacted by a project feature until construction of that feature is complete and prior to any subsequent maintenance. In addition all mitigation proposed to occur on public lands should be coordinated with the respective land managing agency. Points of contacts for the agencies potentially impacted by project features are: Office of State Parks contact Mr. Brent Evans at 1-888-677-1400, National Park Service (NPS), contact Superintendent Chuck Hunt, (504) 589-3882 extension 137 (Charles_Hunt@nps.gov) or Chief of Resource Management Guy Hughes (504) 589-3882 extension 128, (Guy_Hughes@nps.gov) and for the 404(c) area contact the previously mentioned NPS personnel and Mr. Raul Gutierrez (214) 665-6697 with the EPA.*
- 7. If applicable, a General Plan for mitigation shall be developed by the Corps, the Service, and the managing natural resource agency in accordance with Section 3(b) of the FWCA for mitigation lands.*
- 8. The Corps in cooperation with the natural resource agencies is still evaluating alternative enhancement measures for the EPA Bayou aux Carpes 404(c) designated wetlands. Enhancement measures, which would ensure the integrity of the 404(c) area is maintained, are a condition of the 404(c) modification. The Service encourages the Corps to select and implement the preferred alternative(s).*

9. *The Corps shall maintain full responsibility for all mitigation projects until the projects are found to be fully compliant with success and performance requirements.*
10. *The Corps shall fully compensate for any unavoidable losses of wetland habitat or non-wet bottomland hardwoods caused by project features.*
11. *Borrow sites shall be designed to avoid and minimize impacts to fish and wildlife habitat; in the event new borrow sites are identified, guidelines for borrow site selection found in Appendix B should be followed.*
12. *Identified impacts should have a fully defined mitigation plan that is included in the integrated National Environmental Policy Act document. The mitigation plan should be developed including locations and AAHUs vetted through the natural resource agencies. Only existing mitigation banks and existing credits released by Corps Regulatory Branch may be considered.*
13. *If the local project-sponsor is unable to fulfill the financial mitigation requirements for operation and/or maintenance of mitigation lands, then the Corps shall provide the necessary funding to ensure mitigation obligations are met on behalf of the public interest.*
14. *Any proposed change in mitigation features or plans shall be coordinated in advance with the Service, NMFS, LDWF, EPA and LDNR.*
15. *The Corps shall finalize mitigation plans and proceed to mitigation concurrent with project construction. If construction is not concurrent with mitigation implementation then revising the impact and mitigation period-of-analysis to reflect additional temporal losses will be required*

USACE Responses to USFWS Conservation Recommendations

1. Concur. USACE has coordinated with NMFS on EFH (see Appendix G – Environmental Compliance).
2. Concur. Impacts to wetlands and non-wet bottomland hardwood habitat have been and will continue to be avoided and minimized to the greatest extent possible.
3. Concur. USACE will avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. Forest clearing will be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.
4. Concur. USACE will continue to coordinate with the Service and will contact the Service for additional consultation as the need arises.
5. Concur. USACE will continue to coordinate with the Service and other resource agency partners and will provide all applicable documents for review.
6. Concur. USACE will avoid impacts to public lands to the extent practicable and will continue to coordinate with land managers.

7. Concur. If applicable, a General Plan for mitigation will be developed by the Corps, the Service, and the managing natural resource agency.
8. USACE will continue to coordinate with natural resource agency partners on the Bayou aux Carpes 404(c) designated wetlands.
9. Concur. USACE will maintain full responsibility for all mitigation projects until the projects are found to be fully compliant with success and performance requirements.
10. Concur. Compensatory mitigation is proposed for unavoidable impacts to bottomland hardwood-wet habitat (see Appendix K – Mitigation Plan).
11. Concur. Borrow sites will be designed to avoid and minimize impacts to fish and wildlife resources to the maximum extent practicable. Guidelines for borrow site selection will be followed to the maximum extent practicable.
12. Concur. A Mitigation Plan has been developed and is included as Appendix K. The purchase of mitigation bank credits is the recommended mitigation method as detailed in Appendix K.
13. The purchase of mitigation bank credits is the recommended mitigation method, which would not require any operation or maintenance on the part of USACE or the project sponsor. If USACE-constructed mitigation were required, all operations and maintenance obligations would be met by the NFS on behalf of the public interest.
14. Concur. Any proposed changes to mitigation features will be coordinated with all appropriate resource agency partners.
15. Concur. Mitigation will occur prior to or concurrent with project construction.

8 EVALUATE & COMPARE ALTERNATIVE PLANS*

This section evaluates and compares the final array of alternatives. While the authorizing language does not allow for the 0.5% AEP plan (Alternative 3) to be recommended for implementation by this study, it was found to be an economically viable plan and is presented for comparison to the 1% AEP plan as part of a reasonable array of alternatives for evaluation.

Evaluation and comparison of alternatives is based on preliminary modeling, design, cost estimates, and evaluation of effects. The results of those preliminary analyses are presented in this chapter. Once an alternative has been selected for recommendation, additional detailed analyses are conducted for the recommended plan, which results in refinements to the plan's features, outputs and effects. This more detailed analysis is described in Section 8.8, following identification of the recommended plan, and the revised details of the recommended plan are presented in Chapter 9.

Four accounts have been established to facilitate evaluation and display the effects of alternative plans:

- a) The **NED** account displays changes in the economic value of the national output of goods and services.
- b) The **EQ** account displays non-monetary effects on significant natural and cultural resources.
- c) The **RED** account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
- d) The **OSE** account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

Evaluation and comparison of alternatives is based on the four Principles and Guidelines criteria: completeness, acceptability, efficiency, and effectiveness. Resilience, redundancy, robustness, and sustainability contribute to completeness, efficiency, and effectiveness of plans and are accounted for in the evaluation of alternatives. In some cases, the evaluation may be qualitative.

The alternatives are evaluated based on the following decision criteria:

- **Economic costs and benefits** – quantitative estimates of the costs of each alternative and the NED benefits, resulting in display of Benefit-to-Cost Ratios (BCRs) and net economic benefits.
- **Environmental effects** – quantitative estimates of mitigation requirements and costs.
- **Life safety risk reduction** – quantitative estimates of 1) reduction in the annual probability of failure due to overtopping, and 2) reduction in the average annual life loss due to overtopping ..
- **Contributions to addressing USACE Tolerable Risk Guidelines 1 and 4** – qualitative or semi-quantitative assessment of the degree to which each TRG is achieved by each alternative (met, partially met, or not met).

This evaluation and comparison step was based on a conceptual level of design and associated cost estimates. A summary of the evaluation and comparison of the final array of alternatives is presented in Section 8.6.

8.1 ALTERNATIVES DESIGN

For purposes of developing the initial cost estimate and evaluating potential environmental impacts, the study team made the following levee and floodwall design assumptions:

- HSDRRS design criteria were applied to both alternatives for determining the design elevations of levees and floodwalls. This includes excluding still-water (also known as “surge”) overtopping and limiting the expected wave overtopping rate to 0.1 cfs/ft at 90% confidence and 0.01 to 0.03 cfs/ft at 50% confidence at each design segment. Additionally, the design elevations will be checked for resiliency by comparing top of levee/structure elevations to the 0.2% AEP still-water elevations.
- Floodwall design used the draft guidance for Engineering Manual 1110-2-2502.
- Due to the size and scope of the study area, levee design was based on representative reaches.
- Multiple levee lifts would be constructed over time to incrementally address the combined effects of levee settlement, rising sea levels, and regional subsidence. These lifts would be “straddle lifts” wherever possible. The use of straddle levee lifts reduces the need for additional real estate acquisition and potential environmental impacts. Figure 8-1 illustrates the concept of levee lifts performed over time. A detailed listing of analysis and levee lifts are presented in Appendix B and Appendix A, respectively.
- Some levee reaches have concrete paved transitions from levee to floodwall. It is assumed that with each lift, the slope paving would need to be removed, lifted and replaced to match the required design elevation.
- It is assumed that all previously placed armoring for each reach would need to be removed before each lift and then replaced after construction of each lift. All MRL levees have concrete slope paving on the flood side slope. It is assumed that the slope paving will need to be removed and replaced with any expansion of the levee footprint.
- New co-located levee reaches are assumed to include armoring.
- Floodwalls falling below target design elevations were assumed to be modified if the deficiency was less than 2 feet and replaced if the deficiency was greater than two feet.
- For the initial design, the study assumed no changes to interior ponding or pumping capacity. The inclusion of additional interior ponding or pumping features would be reconsidered during the refined design of the recommended plan. However, due to the authorizing language, addition of these features would be limited to cases where project features were found to cause induced flooding.
- Assume no additional utility relocations are required. All potential relocations would likely have been performed during construction of HSDDRS (2006-2011) when the system was completely rebuilt after Hurricane Katrina. During this time, land owners would have signed acts of subordination to the project in order to receive reimbursement and are responsible for any future relocation costs. As such, it is reasonable to assume that no (or only limited) utility relocations are required, and this is a low-risk assumption based on likely impact to overall cost.
- No increased resiliency or robustness actions were considered at this time. The current project levees all have landside armoring and some have foreshore protection. Floodwalls have landside splash pads. All of these features contribute to a relatively resilient and robust system. The inclusion of additional features to further increase

resiliency and robustness would be reconsidered during the refined design of the recommended plan.

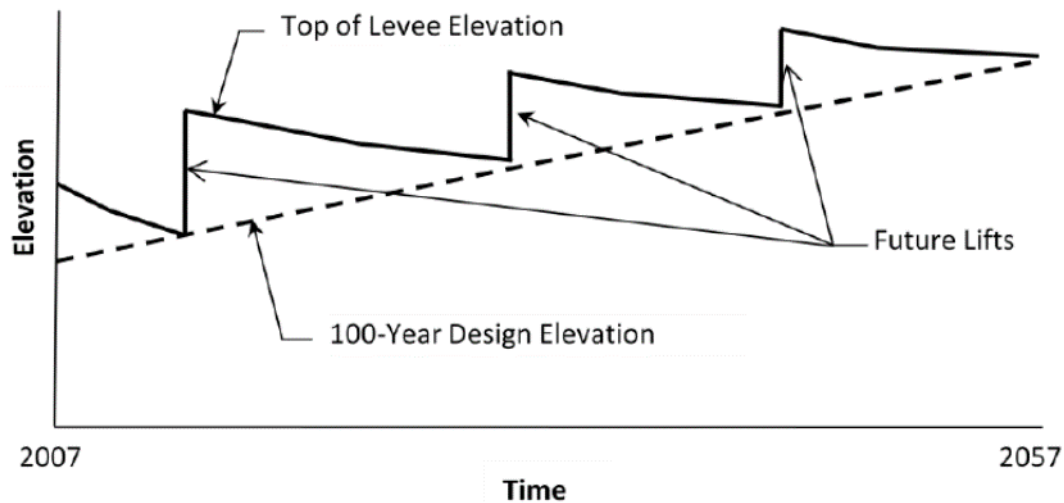


Figure 8-1. Conceptual Levee Lifts

8.2 ECONOMIC COSTS AND BENEFITS OF ALTERNATIVES

The HEC-FDA Version 1.4 USACE-certified model was used to calculate expected annual damages and benefits over the period of analysis. The economic and engineering inputs necessary for the model to calculate damages include structure inventory, content-to-structure value ratios, vehicles, first-floor elevations, depth-damage relationships, ground elevations, and stage-probability relationships. More information about these economic and engineering inputs are described in Appendix J, *Economics*.

8.2.1 FIRST COSTS OF ALTERNATIVES

Table 8-1 identifies the first costs of the final alternatives array by account and includes contingencies. Contingencies were determined by performing an abbreviated cost risk assessment for each action alternative, which considered uncertainties related to each input to the cost estimate.

Table 8-1. First Costs of Final Array of Alternatives (October 2019 Price Level)*

Account	WBV No Action	WBV ALTERNATIVE 2	WBV ALTERNATIVE 3
01 Lands and Damages	\$0	\$15,900,000	\$16,300,000
06 Fish and Wildlife Facilities	\$0	\$8,500,000	\$8,800,000
11 Levees and Floodwalls	\$0	\$488,800,000	\$577,200,000
30 Planning, Engineering and Design	\$0	\$59,700,000	\$70,300,000
31 Construction Management	\$0	\$39,800,000	\$46,900,000
Total	\$0	\$613,000,000	\$719,000,000

*All numbers have been individually rounded and, therefore, may not appear to add correctly to the total.

8.2.2 ECONOMIC BENEFITS

As discussed in Section 3.4 (Existing Economic Damages), the estimate of economic benefits assumes that there is no system failure (non-performance) prior to overtopping. Additionally, the benefits do not include any potential increases to the structure inventory (see Section 5.4 – Future Economic Damages). Table 8-2 displays the economic costs and benefits of the final array of alternatives.

Table 8-2. Economic Costs and Benefits of the Final Array of Alternatives (October 2019 Price Level)

	WBV No Action	WBV ALTERNATIVE 2	WBV ALTERNATIVE 3
Costs			
Total Project First Cost	\$0	\$613,000,000	\$719,000,000
Average Annual Investment Cost	\$0	\$14,000,000	\$18,000,000
Average Annual O&M Costs*	\$0	\$15,000,000	\$16,000,000
Total Average Annualized Costs	\$0	\$29,000,000	\$34,000,000
Economic Benefits - NED			
Without Project Damages	\$77,000,000	\$77,000,000	\$77,000,000
With Project (Residual) Damages	\$77,000,000	\$8,000,000	\$3,000,000
Damages Reduced (Benefits)	\$0	\$69,000,000	\$74,000,000
Net Benefits	\$0	\$40,000,000	\$39,000,000
Benefit-to-Cost Ratio (BCR)	N/A	2.4	2.2

*OMRR&R estimates at this stage of the study were incorrectly calculated but did not impact the comparison and selection of the recommended plan. See Section 9.3 for the correct estimate of OMRR&R costs for the recommended plan.

8.3 LIFE RISK REDUCTION OF THE ALTERNATIVES

Table 8-3 summarizes the levee performance (APF) and consequences (AALL) for both the No Action Plan and both designs that were evaluated.

Table 8-3. Levee Performance and Consequences

Alternative	APF	AALL
No Action	3E-04 to 3E-03	1E-01
With Project Alternative 2 (1% AEP design at 1.8 ft. RSLR)	3E-05 to 3E-04	3E-03
With Project Alternative 3 (0.5% AEP design at 1.8 ft. RSLR)	1E-07 to 1E-06	1E-05

The results of the risk assessment at this stage of the study show that both alternatives reduce the risk due to overtopping below the societal tolerable risk line associated with TRG-1 and TRG-1 is considered fully addressed for overtopping by each alternative, with Alternative 3

providing the greater level of risk reduction. In consideration of TRG-4, the study team considered whether additional actions were warranted to further reduce life safety risk. Although there are already robust emergency action plans in place, given the large urban population, there may be opportunities for improvements to the evacuation plans and better communication of those plans would be actions to further reduce risk.

The likelihood of critical infrastructure inundation due to overtopping is also reduced for both alternatives. Table 8-4 compares the effects of each plan regarding critical infrastructure. Critical infrastructure data was obtained from the Homeland Security Infrastructure Program (HSIP) Gold 2015 database, which is a data inventory assembled by the National Geospatial-Intelligence Agency in partnership with the Department of Homeland Security.

Table 8-4. Comparison of Critical Infrastructure at Risk

	Without Project	Alt 2 1% AEP	Alt 3 0.5% AEP
Category	Number	Number	Number
Agriculture	1	0	0
Chemicals	2	2	2
Communications	2	0	0
Education	49	4	3
Emergency Services	17	2	2
Energy	7	1	1
Law Enforcement	2	0	0
Manufacturing	4	2	2
National Symbols	0	0	0
Public Venues	16	5	4
Transportation-Air	4	4	4
Transportation-Ground	1	0	0
Transportation-Water	79	70	66
Water Supply	1	0	0
Total	185	90	84

8.4 ALTERNATIVES SENSITIVITY TO RELATIVE SEA LEVEL RISE SCENARIOS

As discussed in Section 5.2.1, three relative sea level rise scenarios were estimated for the study's period of analysis (2023 to 2073) and the study team chose to design and evaluate the alternatives using the intermediate RSLR scenario. USACE policy also requires that the evaluation consider each alternative's performance over a 100-year adaptation horizon (in this case, through 2123) for all three scenarios, identify any critical thresholds, and identify any adaptability differences between the alternatives.

8.4.1 RSLR DIFFERENCES IN LOADING AND ALTERNATIVES' PERFORMANCE OVER TIME

An evaluation was performed to estimate the performance of each project alternative up to and after year 2073, which is the end of the study's period of evaluation. Additionally, Corps policy demands a performance evaluation of major infrastructure related to sea level change for a time period of 100 years, which would be the year 2123. The performance of the project through time depends on the RSLC projection (low, intermediate, or high), the level of risk reduction of each alternative, and an understanding of how the exterior stage-frequency changes through time for the various RSLC amounts.

Using the same methodology described in Section 5.2.1, the three RSLC scenarios were extended out to the 100-year performance horizon and the results are displayed in Table 8-5. Figure 8-2 displays the same information in graphical form, with the black lines tracking the intermediate RSLC estimate in 2073 (1.8 feet) horizontally to the low and high scenarios. The plot shows how the project performance of a system designed and built to intermediate RSLC conditions (1.8ft in 2073) would begin to decrease near 2053 for a high RSLC scenario or be extended to 2091 for the low RSLC projection.

Table 8-5. USACE Relative Sea Level Rise (feet) from 2023 to 2123. Average of 7 gages

	Low	Int	High
2023	0.0	0.0	0.0
2028	0.1	0.2	0.3
2033	0.3	0.3	0.5
2038	0.4	0.5	0.8
2043	0.5	0.6	1.1
2048	0.6	0.8	1.4
2053	0.8	1.0	1.8
2058	0.9	1.2	2.2
2063	1.0	1.4	2.6
2068	1.2	1.6	3.0
2073	1.3	1.8	3.4
2078	1.4	2.0	3.8
2083	1.5	2.2	4.3
2088	1.7	2.4	4.7
2093	1.8	2.6	5.2
2098	1.9	2.8	5.7
2103	2.1	3.1	6.3
2108	2.2	3.3	6.9
2113	2.3	3.5	7.4
2118	2.4	3.8	8.0
2123	2.6	4.0	8.6

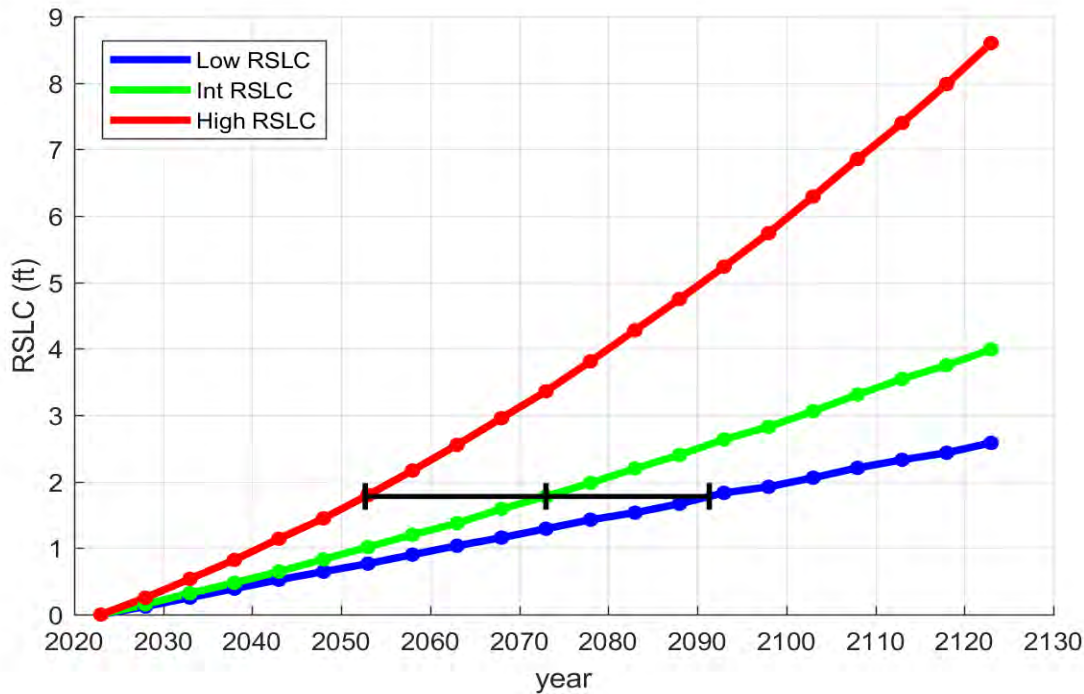


Figure 8-2. Low, Intermediate and High Relative Sea Level Rise Projections from 2023 to 2123

The effects of RSLR vary around both the LPV and WBV systems. For illustrative purposes, the RSLR elevations for a range of AEP events at the Lake Borgne Surge Barrier (in the LPV system) is shown in Figure 8-3. In this figure, vertical lines are drawn from the 1% and 0.5% events to intersect the RSLR curves, showing the RSLR stillwater elevations for those events. Horizontal lines show how the intermediate scenario compares to the low and high scenarios for each event.

As demonstrated in Figure 8-3, at the Lake Borgne Surge Barrier location, both plans' intermediate RSLR surge elevations (18 ft and 19.5 feet) are approximately 6 inches higher than the low RSLR elevation and approximately 1.5 feet below the high RSLR elevation, at the end of the study's period of analysis (2073).

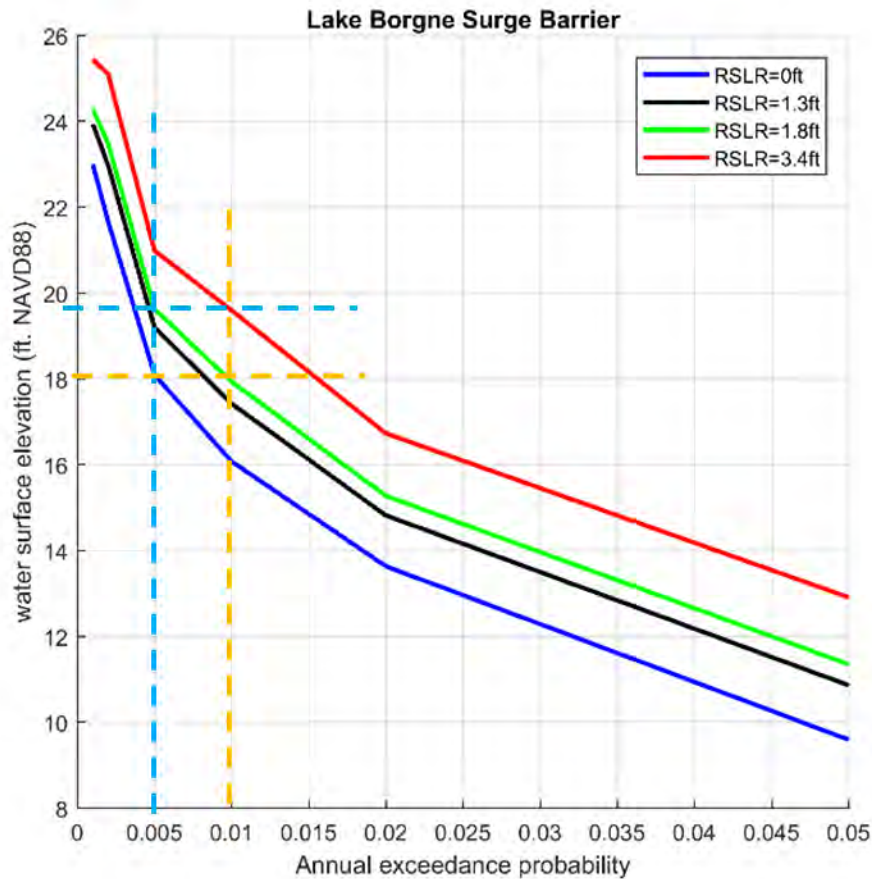


Figure 8-3. Projected Still Water Elevations at the Lake Borgne Surge Barrier for a Range of Events (RSLR Projected Values for 2073)

Because the two alternatives are very similar, the study team could identify no critical thresholds (physical characteristics of the area or the structures at risk) that would materially differentiate between the two plans with regard to their performance under different RSLR scenarios. As discussed in Section 8.4.1, the timing and duration of performance at the intended design level could vary between the plans. And the plans' abilities to provide sufficient risk reduction for system certification (and thereby reduced flood insurance premiums) will vary under different RSLR scenarios.

For the most part, both plans can be adapted to higher RSLR conditions in the future by raising the levees and modifying the floodwalls. Both of these actions are relatively straightforward up to certain thresholds. The study team identified the following general thresholds, beyond which alterations become much more complicated and costly:

- 1) Levee raises can be accomplished on existing right of way until the corresponding increases in the levee base exceed the available right of way.
- 2) Floodwalls can be extended vertically, within limits, or replaced.
- 3) Overtopping of the Lake Borgne Surge Barrier can be adequately stored in the IHNC up to a point and then those structures would need to be raised or replaced.

Levee adaptation is relatively straightforward and theoretically has no limit – simply add a layer of soil on top of the existing levee. However, as the top of the levee increases in elevation, the base of the levee expands and, depending on the location, stability berms may need to be added. The expansion of the base and berms can be accommodated on existing levee right-of-way up to a point, which varies around the system. When that point is reached, additional land will need to be acquired. However, the analysis of the two final plans indicate that the additional land required due to increased levee height may not be significant. If there are structures located in the levee's design footprint, they may need to be purchased and removed or a floodwall may need to be constructed instead. Possible adaptation actions to accommodate levee raises include pre-purchasing additional right of way adjacent to the levees.

A high RSLR scenario extended out to the 100-year horizon would also present additional challenges beyond height concerns. 8.6 feet of RSLR would result in perimeter levees that are constantly loaded, possibly requiring additional measures to address seepage and stability, in addition to overtopping. Some of these additional features may extend beyond the available right of way or may have increased impacts on the environment, cultural resources, or existing structures.

Floodwall adaptation is more limited than levee adaptation. The ability of a floodwall to be extended vertically depends on its foundation type and the original design parameters. If a floodwall can't be extended vertically (or reaches its limit), it must be replaced. Possible adaptation actions to allow for more vertical extension include designing the foundations for each plans' new floodwalls to handle additional wall height or design them to be below the upper limits of the design criteria. Similar challenges would arise in a high RSLR scenario if modifications were required for the Harvey and Algiers Locks.

8.4.2 PERFORMANCE FOLLOWING CONSTRUCTION IF THERE ARE NO ADDITIONAL LIFTS

To consider how these alternatives would perform in different RSLR scenarios, it is helpful to consider what would happen if there were no additional levee lifts or floodwall replacements following completion of construction. This is an unrealistic scenario because the local sponsor will be required to maintain the authorized level of risk reduction, but it does help to demonstrate how varying the RSLR assumption can affect the expected performance of the project.

Figure 8-4 displays the estimated level of risk reduction through time for the 0.5% AEP and 1% AEP alternatives at a portion of HSDRRS near the WBV West Closure Complex. Notice that the intermediate RSLR (the assumed scenario for the alternatives) is in green, low RSLR is in blue and high RSLR is in red.

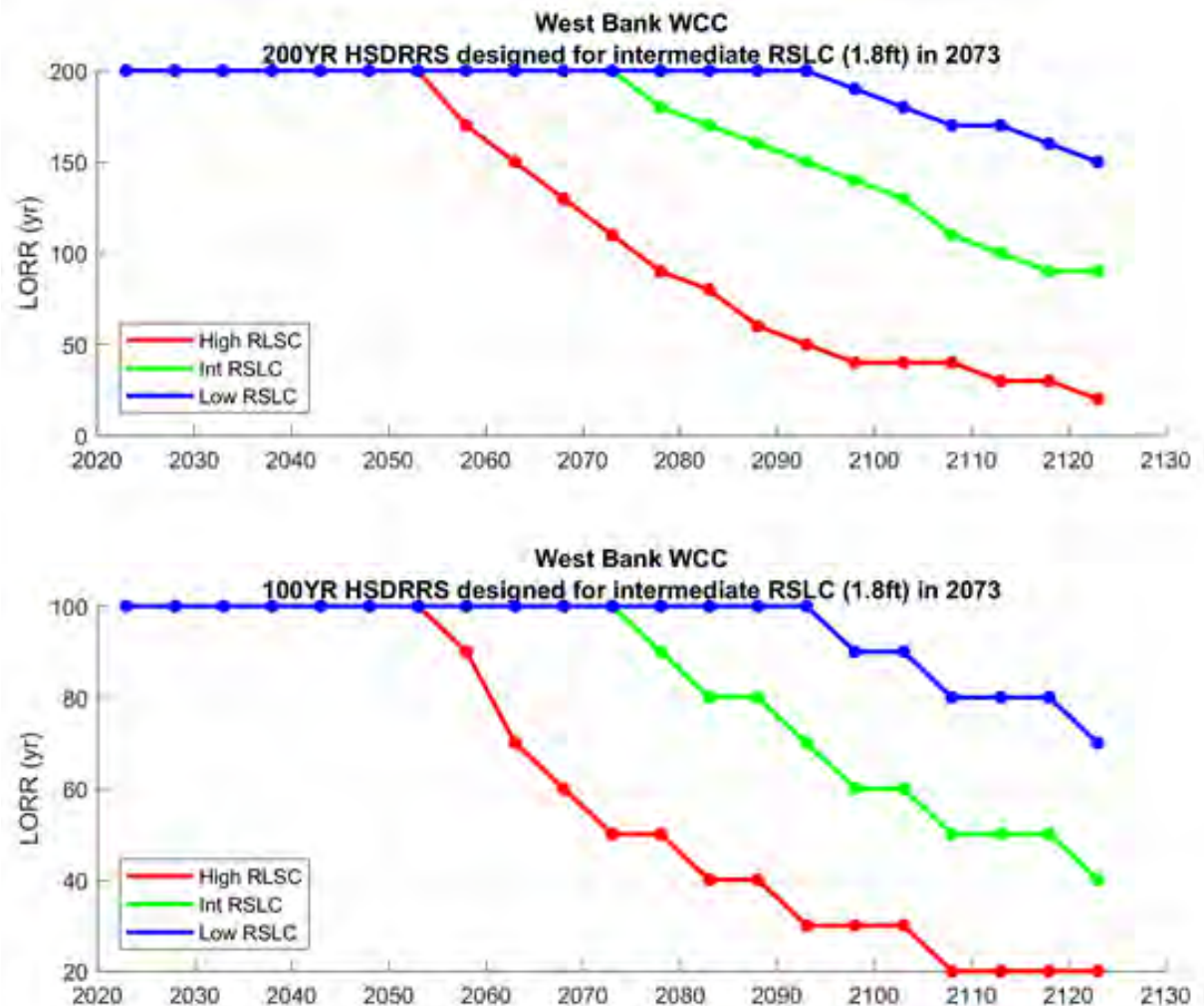


Figure 8-4. Level of risk reduction for the 200YR and 100YR alternatives for 3 RSLC projections at a location along the West Closure Complex

The following conclusions about project performance under different RSLC scenarios can be drawn from these graphs.

- 1) For both alternatives, the project begins to lose performance near 2053 for the high RSLC projection.
- 2) For both alternatives, the project begins to lose performance in 2073 for intermediate RSLC projections (this is as designed).
- 3) For both alternatives, the project would perform adequately to 2093 in a low RSLC scenario.

8.5 COMPLETENESS, EFFECTIVENESS, EFFICIENCY & ACCEPTABILITY

Completeness, effectiveness, efficiency, and acceptability are four basic criteria used in the evaluation and screening of alternative plans. Alternatives considered in any planning study

should meet minimum subjective standards of these criteria to qualify for further consideration and comparison with other plans.

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other federal and non-federal entities. Part of the evaluation of completeness will include the contribution of the plan towards the resilience in the engineered infrastructure, as well as in the community, economy, and environment.

Resilience is generally defined as the ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or anthropogenic, under all circumstances of use.

Completeness also considers sustainability, which is an evaluation of whether the plans include the features and resources to meet the study objectives in the study area beyond the period of analysis and the impact of the proposed project.

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. Effectiveness will also consider the resiliency of the plan, the contribution of redundant features to overall plan effectiveness, and the robustness of the plan.

Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe. Robustness is the ability of a system to continue to operate as intended across a wide range of foreseeable operational conditions with minimal damage, alteration, or loss of functionality and to fail in a predictable way outside of that range.

Efficiency is the extent to which an alternative plan is a cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment. Efficiency will also consider redundancy and robustness in the alternatives and should describe any potential trade-offs with economic efficiency.

Acceptability is the workability and viability of an alternative plan with respect to acceptance by state and local entities, tribes, and the public and compatibility with existing laws, regulations, and public policies.

Table 8-6 compares the final array of alternatives against these criteria.

Table 8-6. Evaluation of Alternatives using Principles and Guidelines Criteria

Alternative	Complete	Effective	Efficient	Acceptable
No Action Alternative	No	No	No	No
Alternative 2	Yes	Yes	Yes	Yes
Alternative 3	Yes	Yes	Yes	Yes

Completeness – Both of the action alternatives are complete in that they include all of the necessary investments to achieve the objectives. They all include appropriate levee resilience and are all sustainable if properly operated, maintained, repaired, rehabbed, and replaced when necessary. The No Action plan is not complete because it does not address any of the objectives.

Effectiveness – *At this stage of the study*, both of the action alternatives have been evaluated to be effective in achieving the economic and life safety risk reduction objectives. None of the action plans contain redundant features. The No Action Plan is not effective because it does not achieve any of the objectives.

Efficiency – Both of the action alternatives reduce the life safety risk due to overtopping by different amounts for different levels of investment. Increased investment does result in additional decrease in life safety risk but Alternative 2 is more cost-effective from an economic standpoint and has similar life safety risk reduction achievements. The No Action plan is not efficient because it does not achieve any of the objectives.

Acceptability – Both of the action alternatives have been designed to be acceptable in terms of laws, regulations, and public policies. They are likely to have varying levels of public acceptance (from the general public, the sponsor, affected communities, and governmental entities), which will be discussed further following the public review period. The No Action plan is unlikely to be acceptable to the public.

8.6 COMPARISON SUMMARY

The results of the evaluation of the final array are presented in Table 8-7. The costs are presented at FY 19 price levels and the economic calculations utilize the FY 20 discount rate of 2.75%.

Table 8-7 only displays the evaluation information that was critical to differentiating between the monetary and non-monetary costs and benefits of each plan. Additional information on the differences between the plans with regard to Other Social Effects (OSE) and Environmental Quality (EQ) can be found in Section 7. Following identification of the recommended plan, Section 9 presents additional and updated details on the costs and benefits of the recommended plan.

Table 8-7. Evaluation of Final Array

Key Factor	WBV No Action (Intermediate RSLR)	WBV ALTERNATIVE 2 System Levee Lifts to the Projected 1% AEP Event at 2073 (Intermediate RSLR)	WBV ALTERNATIVE 3 System Levee Lifts to the Projected 0.5% AEP Event at 2073 (Intermediate RSLR)
Costs			
Total Project First Cost	\$0	\$613,000,000	\$719,000,000
Annual O&M Costs ³	\$0	\$15,000,000	\$16,000,000
Average Annual Costs	\$0	\$29,000,000	\$34,000,000
Economic Benefits - NED			
Average Annual Damages Reduced (Benefits)	\$0	\$69,000,000	\$74,000,000
Average Annual Net Benefits	\$0	\$40,000,000	\$39,000,000
Benefit-to-Cost Ratio (BCR)	N/A	2.4	2.2
Life Safety Risk - OSE			

Key Factor	WBV No Action (Intermediate RSLR)	WBV ALTERNATIVE 2 System Levee Lifts to the Projected 1% AEP Event at 2073 (Intermediate RSLR)	WBV ALTERNATIVE 3 System Levee Lifts to the Projected 0.5% AEP Event at 2073 (Intermediate RSLR)
Tolerability	Life safety risk will be above tolerable levels.	The plan is anticipated to reduce life safety risk due to overtopping below TRG1	The plan is anticipated to reduce life safety risk due to overtopping below TRG1
Environmental Impacts – EQ¹			
Mitigation BLH-Wet AAHUs	N/A	37.21	39.55
Mitigation Costs	N/A	\$6,624,200	\$8,700,000
Real Estate²			
Temporary Road Access and Work Area (acres)	N/A	179	179
Perpetual Levee (acres)	N/A	63	63
Borrow (acres)	N/A	160	368
Residual Risk			
Life Safety	Life safety risk will remain above tolerable levels.	Residual risks are high due to the extensive population protected by the levee system, even with good evacuation procedures.	Residual risks are high due to the extensive population protected by the levee system, even with good evacuation procedures.
Average Annual Economic Damages	\$77,000,000	\$8,000,000	\$3,000,000
Critical Infrastructure (#) at Risk	185	90	84

¹ Environmental impacts in this table reflect the information available prior to selection of the recommended plan. After selection, the recommended plan was further refined and the revised numbers can be found in Chapter 7 and Section 8.8.1.

² Requirements for ROW will continue to be evaluated to determine whether temporary or permanent easements are most advantageous to the Government.

³ OMRR&R estimates at this stage of the study were incorrectly calculated but did not impact the comparison and selection of the recommended plan. See Section 9.3 for the correct estimate of OMRR&R costs for the recommended plan.

8.7 RECOMMENDED PLAN / NATIONAL ECONOMIC DEVELOPMENT PLAN

The primary decision criteria for identifying the NED Plan includes reasonably maximizing net benefits while remaining consistent with the federal objective of protecting the nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

Based on the evaluation and comparison analysis summarized above, Alternative 2 was identified as the NED Plan and the Recommended Plan. Based on these preliminary numbers, the recommended plan had a total project first cost of approximately \$613 million and a BCR of 2.4. Additional refinements to the plan (summarized in Section 8.8) resulted in changes to the estimated benefits and the revised numbers are described in Section 9.

In order to implement the Recommended Plan, Public Law 113-121, Section 3017, REHABILITATION OF EXISTING LEVEES requires modification to extend or eliminate the authorization termination date of 2024.

8.8 REFINEMENTS TO RECOMMENDED PLAN

Following identification of the recommended plan, the study team made further refinements to the recommended plan, including incorporation of additional detail into the modeling and the design of features, consideration of additional measures, and an update to the period of analysis. This section discusses each of these areas of refinement.

8.8.1 ANALYSIS AND DESIGN REFINEMENTS

The study team updated the hydraulic modeling with additional information about foreshore ground conditions and other existing features located exterior to the system, such as existing wave berms. These modifications resulted in reduced surge and wave heights, thereby reducing the required design elevations. Reduced design heights resulted in reduced quantities for levee lifts and reduced need for floodwall replacement. Cubic yards of borrow required were reduced by 25%. Floodwall replacements were reduced from 1 mile to 268 feet. This reduction reflects that the initial design estimated that most of the floodwalls were less than two feet below the originally estimated design height and the refined design lowered that height enough that some of them no longer needed to be replaced. In areas where floodwalls were still determined to be deficient in height, the refined structural analysis determined that modification could only be considered if the deficiency were less than 6 inches (rather than the two feet originally assumed). A decision was made at that time to conservatively assume any floodwall height deficiency would require full replacement.

Refinements to the hydraulic modeling also affected the calculations of existing, future without project and future with project economic damages, as well as estimates of life safety risk. Reduced damage estimates due to lower surge and wave heights were offset by price level increases and discount rate reductions, resulting in little to no change to with-project benefits estimates. Combined with the overall construction cost reductions, the net economic benefits and the benefit-to-cost ratio increased. Life risk estimates placed the with-project residual risk slightly above tolerable levels (see Section 9.8.2 for additional discussion).

Additionally, survey data was gathered in the area of new co-located levees along the Mississippi River, which demonstrated that one reach lacked sufficient space to incorporate a levee lift and, instead, a 1-mile floodwall would need to be constructed. This resulted in

increased costs in these reaches but also reduced the estimated environmental impacts. The acreage of Bottomland Hardwood-Wet habitat impacted decreased from 63 to 60 acres and the average annual habitat units (AAHUs) of mitigation required decreased from 39 to 37.

8.8.2 UPDATE TO THE PERIOD OF ANALYSIS

Per USACE policy, the period of analysis begins when project benefits begin to be accrued. For this project, that would be the year of completion of the first construction contract. As discussed in Section 1.4, the current construction authority terminates in June 2024. With the current schedule to complete the study in 2021 and the need for additional authorization, the study team estimated that the earliest the first construction contract could be completed would be 2028. This shift of three years does not have any impact on identification of the recommended plan but does have a small impact on the economic analysis and those updated calculations are presented in Appendix J.

Adjusting the period of analysis is unlikely to substantively change the projected RSLR calculations and projected design heights – most likely no more than a few tenths of a foot. Design elevations are rounded up to the nearest 0.5 feet, allowing some flexibility to accommodate any change, and design elevations are also likely to continue to change in the future as updated ADCIRC modeling and more detailed design efforts are completed during PED. Therefore, the study did not adjust any engineering modeling, design calculations or cost estimates to reflect this change in the period of analysis. Additionally, the estimating timing of levee lifts and floodwall construction presented in the appendices was not revised to reflect the delay in construction authorization. However, the economic analysis did shift the construction schedules to reflect the revised period of analysis.

Appendix J provides the updated economic analysis. The updated benefits are presented in Section 9.3 and the updated residual economic risk is presented in Section 9.8.3.

8.8.3 CONSIDERATION OF ADDITIONAL MEASURES

During this time of design refinement, the team also reconsidered several measures that were previously found during measure screening to be insufficiently effective on their own but could possibly be added to the recommended plan to increase its effectiveness or efficiency. These considerations included adding non-structural features (such as improved risk communication, additional risk reduction for critical infrastructure, etc.), features to increase robustness or resilience (additional armoring, etc.) and increased interior drainage measures (storage and pumping). The team reached the conclusion that no additional measures should be added to the recommended plan. The following paragraphs discuss the rationale for this conclusion.

Additional Non-Structural Features

Risk communication is an essential aspect associated with all flood and coastal storm risk management studies. In general, risk communication in the New Orleans area is already at a high level (see discussion in Section 3.2). Each Parish, as well as the State of Louisiana, has an emergency action plan for a hurricane event. As such, the recommended plan does not include additional non-structural features such as flood warning systems or evacuation plans. However, USACE has the responsibility to continue to assess levee systems and communicate findings (including associated benefits and risks) in order to ensure the project is delivering the intended federal benefits. Based on the results of future levee screening assessments, USACE will

continue to coordinate a risk communication strategy with the sponsor, FEMA, and other entities as appropriate.

Additional Risk Reduction for Critical Infrastructure

USACE guidance requires that special consideration is given to critical infrastructure within a study area. Critical infrastructure includes emergency services such as hospitals, fire stations, schools, refineries, and other high value facilities. As seen in Figure 8-5, there is critical infrastructure located throughout the WBV system.



Figure 8-5. Critical Infrastructure Within the WBV System (red dots)

As displayed in Table 8-8, the recommended plan greatly reduces the number of critical infrastructure structures at risk of inundation due to overtopping. The study team evaluated possible measures to further reduce the remaining flood risk for critical infrastructure once the project is constructed. As an example, one potential solution might be compartmentalization by either building a small ring levee or floodwall around certain areas containing critical infrastructure.

A targeted evaluation of critical infrastructure included assessing residual damages to three categories of critical infrastructure: emergency services (e.g., hospitals, fire stations, national shelters, state and local emergency operations centers, American Red Cross facilities, etc.), chemical manufacturing plants, and bridges. Under the future with-project condition, inundation is minimal or non-existent at these key locations (see Table 8-8). This assessment indicates that residual risk of flood damages to critical infrastructure is low. As such, targeted risk reduction measures are not currently recommended.

Table 8-8. Select Critical Infrastructure Impacted by Residual Flooding (WBV)

Critical Infrastructure Category	Structures Inundated	Inundation >1 foot
Emergency Services		
American Red Cross Facilities	0	0
Helipads	0	0
Communication Centers	0	0
Emergency Medical Services	0	0
FEMA Recovery Offices	0	0
Fire Stations	2	0
State Emergency Operations Centers	0	0
Receiving Hospitals	0	0
National Shelter Systems	1	0
Service Providers	0	0
Chemical Manufacturing Plants	2	0

Increased Resiliency and Robustness

Additional features such as wave berms and armoring were evaluated to determine their effectiveness at improving the resiliency or robustness of the recommended plan. However, all perimeter levees are already armored with either high performance turf reinforcement mats, concrete aprons, rip-rap, or articulated concrete blocks. In addition, upon further evaluation of potential wave berm locations, there were only limited technically feasible locations to place wave berms in the project area. Therefore, it was determined that there are limited opportunities to provide significant improvements in overall project performance with the addition of these types of features.

Interior Drainage Facilities

The interior drainage infrastructure in the study area includes local pump stations and drainage canals, the federal flood risk reduction Southeast Louisiana Urban Flood Control Project ("SELA"), and the post-Hurricane Katrina authorized storm-proofing of interior pump stations to ensure the operability of the stations during hurricanes, storms, and high water events. As previously discussed, the authorizing language limits considering of additional interior drainage features to those that may be required if the perimeter features were to have an adverse impact on interior drainage. The study found no adverse impacts and, therefore, additional interior drainage facilities are not required.

9 RECOMMENDED PLAN*

This section discusses the details of the Recommended Plan, as updated during design refinement. All information reflects the project requirements at the end of the 50-year period of analysis and assume an intermediate scenario for relative sea level rise.

9.1 DESCRIPTION

Alternative 2 is the Recommended Plan which includes system levee lifts to the projected 1% AEP event at 2073, assuming an intermediate RSLR condition. Construction of the Recommended Plan is anticipated to generally occur in the same footprint as the existing WBV project and existing MRL levees. Project features consist of 49 miles of levee lifts along the existing levee alignment, with construction timing to occur before the combined effects of consolidation, settlement, subsidence, and sea level rise reduce the levee elevations in each levee reach below the required design elevation. In some reaches, levee lifts may need to occur more than once during the period of analysis. Additionally, the Recommended Plan includes 268 feet of floodwall replacements in a co-located reach and one mile of new floodwall in a reach where a lift of the MRL levee cannot be accommodated. Approximately 10 miles of MRL levees will be added as co-located features with the WBV project. In addition, approximately 5.6 acres of foreshore protection would be constructed to support implementation of the Recommended Plan. Mitigation is anticipated to be required to address potential impacts to habitat along the Mississippi River in the co-located reach. Project implementation is estimated to require acquisition of approximately 16 acres for temporary road access, 163 acres for temporary work areas, 60 acres for perpetual levee easements, and 120 acres for borrow. These estimates may be revised during the design phase when additional modeling is completed and may also be revised if a different RSLR condition is realized in the future.

Figure 9-1 depicts the location of features included in the Recommended Plan. Areas of the existing WBV project that are not highlighted in Figure 9-1 were determined to not require modification.



Figure 9-1. Location of Features Included in the Recommended Plan

The new design elevation will require additional areas of WBV levee co-location with the MRL along the Mississippi River. The current and estimated new crossover points can be seen in Figure 9-2. The existing west bank crossover point is in red at River Mile 85.5 and the west bank Recommended Plan crossover point is in yellow at River Mile 95.5.



Figure 9-2. Existing (red) and With-Project (yellow) Crossover Points on the MRL

9.2 COSTS

Based on October 2020 price levels, the total first cost of the Recommended Plan is estimated to be \$621 million. Additional information about how these costs were estimated can be found in the civil, structural, real estate, mitigation, and cost appendices. Appendix I (Cost Engineering) includes contingency estimates by Civil Works Breakdown Structure as well as the fully funded cost estimate including inflation through the midpoint of construction.

Table 9-1. Total Project First Cost Summary by Feature (Oct 2020 price level)

Feature Code	Feature Name	First Cost
06	Fish and Wildlife Facilities	\$8,900,000
11	Levees and Floodwalls	\$466,600,000
01	Lands and Damages	\$17,300,000
30	Planning, Engineering and Design	\$66,600,000
31	Construction Management	\$42,800,000
	Total	\$602,200,000

9.3 BENEFITS

This report section summarizes the impacts (both positive and negative) of the recommended plan. Some of the information is summarized from detailed information provided in Chapter 7 (Environmental Consequences) and the reference to the relevant sections are provided.

9.3.1 NATIONAL ECONOMIC DEVELOPMENT (NED) BENEFITS

The Recommended Plan reduces estimated annual economic damages by \$76 million and has annual net benefits of approximately \$59 million. Table 9-2 summarizes the updated economic information for the recommended plan.

Table 9-2. NED Summary for the Recommended Plan (October 2020 Price Level; FY 2021 Discount Rate)

Total Project First Cost	\$602,200,000
Interest During Construction	\$9,800,000
Total Investment Cost	\$612,100,000
Average Annual Investment Costs	\$15,800,000
Average Annual OMRR&R Costs	\$400,000
Total Average Annual Costs	\$16,200,000
Without Project Expected Annual Damages	\$84,200,000
Expected Annual Damages Reduced (Benefits)	\$76,100,000
Net Benefits	\$59,800,000
Benefit-to-Cost Ratio	4.7

9.3.2 REGIONAL ECONOMIC DEVELOPMENT (RED) BENEFITS

The Recommended Plan generates benefits to the regional economy through construction activities. These activities can impact the levels of income, output and employment throughout the region. These impacts are not included in the NED analysis and may be used by decision makers as part of their investment decision process. The study estimates that 96% of the construction expenditures will be captured within the local area, with the remainder accruing to the state or nation. These local direct expenditures are estimated to support approximately 158 average annual, full-time equivalent jobs, \$609 million in labor income, \$702 million in the gross regional product, and \$1.1 billion in economic output in the local impact area. Additional information about the effects at the state and national level, as well as income and value information, can be found in Appendix J (Economics).

9.3.3 OTHER SOCIAL EFFECTS (OSE)

9.3.3.1 LIFE RISK REDUCTION

Given the study's limited time and budget, and considering the authorizing language to "address consolidation, settlement, subsidence, sea level rise, and new datum to restore Federally authorized hurricane and storm damage reduction projects", the study's SQRA focused on risks related to overtopping of the levee system and did not evaluate prior-to-overtopping risks. This

decision was supported by examination of the available Screening Level Risk Assessments, which identified overtopping of levees as the major risk driver. However, this scope decision means that the risk estimates presented in this report do not reflect the full project related flood risks, but rather just those risks related to overtopping of the system by stillwater and waves. If future risk assessments find that prior-to-overtopping failure modes drive the risk for the system, then it is possible that the project benefits identified by this study will not be fully realized.

The Recommended Plan does not reduce the future life safety risk associated with overtopping to a level below the societal life safety tolerable risk guideline associated with TRG-1. This is due to free flow overtopping at the 0.2% AEP (500-year) event near the WBV-12 reach. This reach will be re-evaluated during the design phase. It reduces the risk of damages to 95 critical infrastructure structures.

The recommended plan is cost-effective, socially acceptable, and environmentally acceptable. The system already includes features that reduce the likelihood of failure (splash pads, armoring) and those are also included in the recommended plan. While additional actions could be taken locally to further reduce risk through continual improvements to communication and evacuation plans, current plans are very robust.

Incremental (with-project) life safety risk estimates are discussed in Section 9.8.2. The limited scope of the study and of the supporting risk assessment prevents an evaluation of TRG-1 and 4 for total levee system risk.

9.3.3.2 URBAN, RURAL, AND COMMUNITY IMPACTS

The recommended plan reduces the risk of flooding impacts due to overtopping to major transportation and evacuation corridors within the WBV system. Although the use of area roads would increase during construction, thereby impacting traffic and causing localized delays, road use would return to normal following construction (Section 7.16.2).

The plan would have some benefit to agricultural land within the system by reducing the storm surge flooding and related introduction of brackish water (Section 7.2.3). Borrow acquired from outside the system would impact up to 177 acres of prime farmland across seven parishes, which is a significant regional impact (Section 7.2.2).

The recommended plan does not displace any residents or businesses. In the long-term, the recommended plan's level of risk reduction should improve the confidence of residents and businesses and generate additional interest in redevelopment of storm-damaged neighborhoods (Section 7.17.2). The plan is expected to create a long-term increase in economic productivity by providing a more reliable hurricane and coastal storm damage risk reduction system for a portion of the greater New Orleans area. Increased reliability would prevent disruption to the local economy and prevent loss of wages for community residents. Increased reliability could create a long-term economic benefit to existing businesses that rely on reduced flooding for production. An improved hurricane and coastal storm damage risk reduction could also attract new industrial and commercial business to the study area, which would provide a long-term increase in economic productivity through increased revenue and jobs (Section 7.21.4). The plan lowers the actual and perceived risk to minority and/or low-income population groups within the system, who might otherwise consider relocation, thereby increasing the potential for continued community cohesion (Section 7.18.2). It would also allow vulnerable populations within the study area to better recover from a hurricane event. The improved level of overtopping risk

reduction with the recommended plan would contribute to a sense of safety, cultural security, and identity and promote social connectedness of affected communities.

The recommended plan also reduces the risk of flooding due to overtopping to four buildings listed on the National Register of Historic Places. (Section 7.11.2) as well as reduces the risk that valued leisure and recreational activities would be disrupted by flooding (Section 7.13.2).

9.3.3.3 HEALTH AND SAFETY

The recommended plan reduces the risk of vector-borne diseases, contaminated drinking water and direct harmful contact with contaminated surface water that may occur if flood water inundation related to overtopping mixes with sewer and hazardous industrial substances (Section 7.19.2). The recommended plan would likely contribute to residents feeling safer in their community and living space.

9.3.4 ENVIRONMENTAL QUALITY (EQ) EFFECTS

At borrow areas, long-term negative effects on soil productivity would be expected since these soils would be taken out of use. However, long-term positive effects on soil productivity for soils within the protected levee system are expected due to reduced risk of storm surge and flooding (Section 7.21.1). Borrow area excavation would also impact wildlife. Substantial habitat could be permanently lost, altered, and fragmented (Section 7.21.3).

The plan impacts 60 acres of bottomland hardwoods in the co-located reaches along the Mississippi River. Impacts would be mitigated through purchase of mitigation bank credits.

The recommended plan is not anticipated to have disproportionate adverse effects on minority and/or low-income populations in the study area (Section 7.18.2).

Cumulative effects determinations on all resources can be found in Section 7.1.3.

9.4 REAL ESTATE REQUIREMENTS

Most of the Recommended Plan will be constructed on land already acquired for the WBV project. The exception is the area along the MRL between the existing crossover point and the new crossover point. Additional right of way will be required in this area. Project implementation requirements for lands, easements, rights-of-way, relocations, and disposal (LERRD) include approximately 9 acres for temporary road access, approximately 170 acres for temporary work areas, approximately 72 acres for perpetual levee easements, and approximately 120 acres for borrow.

9.5 CULTURAL RESOURCES REQUIREMENTS

The proposed levee shifts of the Mississippi River Levee outside of the existing right of way, unidentified borrow areas, and other project features have the potential to impact known and unknown cultural resources. To comply with Section 106 of the NHPA, for the features that are co-located with the Mississippi River Levee, the USACE has developed a programmatic agreement (PA) pursuant to 36 CFR 800.14(b) in consultation with the SHPOs, Tribes, ACHP, and other interested parties. The PA for the Mississippi River Levees (MRL) Supplemental Environmental Impact Statement (SEIS) establishes an alternative process for USACE to reach Section 106 compliance for undertakings co-located with the. The PA lists 'Programmatic Allowances' agreed upon by USACE, SHPOs, Tribes, and ACHP. The allowances are types of

work that USACE will be able to conduct without consulting with SHPOs and Tribes, including levee and berm maintenance, floodwall replacement, levee enlargement, and others. The PA also creates a process for streamlined project reviews that allows USACE to expedite reviews of undertakings in areas that were previously surveyed and to mitigate impacts to identified cultural resources by implementing treatment measures from a list of agreed upon measures.

For the MRL portion of the WBV project, USACE will utilize the allowances and streamlined reviews as established in the MRL SEIS PA. The PA stipulations are applicable for undertakings associated with the MRL system, including WBV. For the WBV features that are not co-located with the MRL, the District determined that no adverse effect to historic properties would occur. Letters were emailed to the Louisiana SHPO and Federally-recognized Tribes on March 9, 2021 with a determination of No Adverse Effect to Historic Properties for most WBV features and describing the implementation of the MRL SEIS PA for the co-located WBV/MRL portions of the project. As such, the WBV project achieved full compliance with Section 106 of the NHPA on April 8, 2021.

9.6 MITIGATION REQUIREMENTS

Most of the Recommended Plan will be constructed on land already impacted by the WBV project. One exception is the area along the MRL between the existing crossover point and the new crossover point. The proposed mitigation plan assumes the 37.21 AAHUs of flood side BLH-wet impacts (approximately 60 acres) would be mitigated through the purchase of mitigation bank credits. Additionally, borrow sites for the levee raises have not been identified. USACE will endeavor to identify sites that would not require compensatory mitigation; however, a need for compensatory mitigation associated with borrow excavation remains a possibility. The proposed mitigation plan is detailed in Appendix K. If mitigation would be required for future, proposed borrow sites, mitigation plans would be included in future NEPA documents evaluating those sites.

9.7 RISK & UNCERTAINTY

At the planning level, there is always uncertainty about the extent to which the Recommended Plan will meet the planning objectives. Even when project performance uncertainty is negligible, there are some retained risks. In addition, there can be new or transferred risks associated with the recommended plan. It is important to evaluate, communicate, and manage these risks. This section addresses analytical risks associated with the study which are important to understand when considering the recommendation. These include remaining study risks (uncertainty related to the study's conclusions), implementation risks (uncertainty related to design and construction activities), and outcome risks (uncertainty related to the ability to achieve the plan's estimated benefits).

9.7.1 REMAINING STUDY RISKS

Over the course of the study, the study team made many assumptions and, with each assumption, there was a risk that the assumption could be wrong. If the study team assessed that an incorrect assumption could result in a poor study decision, it sought to either confirm the reasonableness of the assumption or took actions (usually additional analyses) to reduce the risk of a poor decision. Through this activity, most study assumptions were eventually confirmed as reasonable and/or the remaining risk was assessed to be low. This section summarizes the study risks that remain and are relevant to the recommendations of this study.

Limited ADCIRC model updates – As discussed in Section 3.2, the existing ADvanced CIRCulation (ADCIRC) and Simulating Waves Nearshore (SWAN) simulations were processed with the ERDC JPM-OS statistical code to produce exterior surge and wave statistics for design elevations. It was assumed that the datasets from the ADCIRC model sufficiently forecast exterior surge conditions to compute feasibility level design elevations. Additionally, the overtopping calculations and resulting inundation estimates are 50%, or, average value deterministic estimates. The risk associated with this assumption is that the estimated design heights will be incorrect.

- **Management:** To reduce the uncertainty associated with the existing ADCIRC model results the 2017 CPRA storm surge and wave modeling (2017 Coastal Master Plan: Storm Surge) water levels, wave heights, and wave periods results were used in the overtopping calculations.
- **Outcome:** This reduced the study risk to a tolerable level but some risk remains that design heights could change during PED when the ADCIRC model is fully updated.

Economic analysis assumes levees do not breach prior to overtopping – Damages associated with a levee breach (due to non-performance or design exceedance) are not included in the economic analysis, possibly resulting in conservative (underestimated) damage estimates. The risk associated with this assumption is that the economic damages and benefits are not accurate. Additionally, if future risk assessments find that prior-to-overtopping failure modes drive the risk for the system, then it is possible that the project benefits identified by this study will not be fully realized.

- **Management:** The study team considered if fragility curves could be developed from the SQRA effort and incorporated into the economic modeling. The team determined that it would be a large effort and had a low likelihood to change the recommendation. The lack of fragility curves is anticipated to result in underestimated damages for all study conditions (existing, future without project, and future with project)
- **Outcome:** This is a tolerable risk that is not likely to affect the recommendation.

9.7.2 IMPLEMENTATION RISKS

Availability of specific borrow areas during construction window – Real Estate acquisition estimates and NEPA compliance actions assume the sponsor will procure the necessary real estate in a timely manner on lands that avoid environmental impacts over the lengthy construction period. Impacts of borrow areas for the proposed actions were evaluated based on the list of assumptions outlined in Table 7-2. Because there are multiple projects in the area, the area is highly urbanized, and borrow sites are relatively shallow there is risk that protracted real estate acquisition and NEPA compliance actions could delay project implementation if not proactively managed.

- **Management:** In order to reduce the risk, additional coordination with USFWS and the local sponsor will be pursued during PED to ensure areas identified for borrow avoid impacts to wetlands and minimize impacts to sensitive areas. The recommendations provided from USFWS would be followed as much as practicable when identifying future borrow sites (See Appendix L, *Coordination*).

Prior to construction, additional NEPA documentation and associated public review would be conducted, as necessary, to address impacts associated with borrow areas including compliance with all environmental laws and regulations.

Future availability of mitigation bank credits – Real Estate and NEPA compliance analyses assume there will be credits available from mitigation banks in the future, thereby precluding the need to construct mitigation sites. This is the most cost-effective alternative to mitigate the impacts of the project. Although the total number of credits needed is relatively small, there are currently insufficient mitigation bank credits available to cover the needs of the project. However, USACE anticipates that additional banks and credits will become available before the credits are required by the project. The risk associated with this assumption is that, if bank credits are not available, additional time and effort will be needed to acquire land and construct mitigation sites.

- **Management:** The New Orleans District currently tracks and will continue to track mitigation needs for all projects in its geographical area and monitor availability of credits. The project will identify credit needs incrementally as construction contracts are designed and implemented. If credits will not be available when needed, the project can develop mitigation sites at an additional cost.

Stability of existing floodwalls not recommended for replacement – Project costs assume little to no need to modify or replace existing floodwalls that are of sufficient height to meet the wave overtopping criteria under the future loading conditions. Due to study time constraints, stability of the existing floodwalls that will not be replaced by the project was not checked during the study under the modeled future stillwater loading. The risk associated with this assumption is that some floodwalls may not have a sufficient factor of safety when evaluated for future stillwater loading and will therefore need to be modified or replaced, thereby increasing project costs.

- **Management:** The cost risk register has an increased contingency applied to the floodwall feature. Updated ADCIRC modeling developed during PED will be used to evaluate stability. The PDT will calculate the factors of safety associated with the longer design life and develop new fragility curves to determine the appropriate risk and make informed decisions during PED.

9.7.3 OUTCOME RISKS

River Discharge Assumption – As discussed in Section 5.2.2, a Mississippi River discharge of 400,000 cubic feet per second was assumed in the ADCIRC modeling. This assumption is a key element in the estimate of surge elevations in the Mississippi River, which then drives the design elevations for levees and floodwalls located along the river. This was an assumption contained in the original ADCIRC modeling (circa 2002) as a reasonable estimate of average river flows during hurricane season and was not revised during the study. The risk associated with this decision is that the estimated design heights may be incorrect.

- **Management:** The study team did consider if this was a reasonable assumption by looking at additional data on river flows through 2019. When the latest data is added and statistics processed, there appears to be up to a 10% increase in mean discharge during hurricane season, which could affect storm surge estimates by up to 1 foot. However,

due to the number of other anticipated changes to the ADCIRC model which could also affect design heights, the study team chose not to revise this single input to the model.

- Outcome: The ADCIRC model is currently being updated through an effort outside of this study and is anticipated to be available for use during the design phase to determine final design heights. Part of that update includes reconsideration of the river discharge assumption.

Intermediate Sea Level Rise Scenario – Alternatives development and evaluation utilized an intermediate RSLR scenario to estimate potential damages in the future, the necessary design heights (and thereby costs) of alternatives, and the reduction in damages (benefits) in the future if the alternatives were implemented. Due to the lengthy projection timeline, there is a relatively high risk that any estimate of RSLR at the end of the period of analysis will not be accurate. The potential consequences associated with this risk include increased costs associated with higher required design elevations (including construction quantities, real estate needs, and environmental impacts and associated mitigation).

- Management: All three relative sea level rate scenarios were calculated and evaluated. It was determined that the low and intermediate relative sea level rise scenarios were similar at 1.3 ft. and 1.8 ft. respectively and therefore the risk of under or over estimating benefits based on scenario selection between these two scenarios was low. However, the variance of 1.5 feet between the intermediate (1.8ft) and high (3.4 ft.) sea level rise scenarios is likely to affect benefits. Additional discussion on the sensitivity of the Recommended Plan to the low and high sea level rise scenarios is discussed with alternatives' comparison in Section 8.4.1. Construction of project features will occur over several decades and the timing of each contract will be dependent on the monitored progress of the combined effects of subsidence, settlement and sea level rise. If RSLR is occurring faster or slower than anticipated, adjustments can be made to design elevations, as needed (see Section 8.4.2 for discussion of critical thresholds and adaptability of features). If a higher RSLR is realized and significant additional related project costs are incurred, the project may need additional authorization.

9.8 RESIDUAL RISK

Implementation of flood risk reduction measures does not remove all risks due to flooding. There is always a residual risk of economic damages or life safety consequences associated with any project. Residual flood risk is defined as the risk of flooding in an area that remains at any point in time after accounting for the flood risk reduction contributed by the levee system. This risk stems from the possibility of the project design being exceeded, the possibility that the project will not perform as intended, or the possibility that the project changes the flood risk in nearby areas (this last one is termed “risk transfer” or “induced flooding”).

This section discusses the residual risks estimated to occur if the project performs as designed, which includes estimates of likelihood of failure (breach) due to overtopping of the system. In this discussion, breach is not the result of an underlying system problem or unforeseen circumstance, but rather the result of design exceedance. The section presents estimated residual inundation within the system when the design is exceeded by a larger, less-frequent event but does not breach. It also includes consideration of possible induced flooding outside of the system. Estimates of economic and life risk are included.

This section does not evaluate flood risk in the possibility of project non-performance due to unforeseen circumstances. The public does need to be aware that unforeseen circumstances can cause non-performance (for example, a levee breach) and result in sudden localized high velocity flows and rapid increases in flood depth on the interior of the system.

9.8.1 RESIDUAL INUNDATION

As stated in Section 5.1, the study assumes that the MRL portions of the system will continue to be maintained at their currently required design heights and will function as intended. Additionally, as discussed in Section 3.4, the study's economic damage assessment assumes that the levees do not fail under any storm conditions. Other system components that are not recommended for action by this study (for example the Lake Borgne Surge Barrier and interior pumps) are also assumed to function as intended and in their current configuration into the future. This discussion of residual inundation in this section is based on these same assumptions and, therefore, inundation information is based solely on surge and wave overtopping estimates.

9.8.1.1 INTERIOR INUNDATION

The recommended plan is designed to prevent surge overtopping and significantly limit (but not completely prevent) wave overtopping for the 1% AEP event in the intermediate RSLR scenario, through the year 2073 (the end of the study's period of evaluation). This level of performance may extend beyond the year 2073 if a low RSLR scenario is realized (see Section 8.4 for detailed discussion) but will decline over time after 2073 if the intermediate or high RSLR scenarios are realized.

Figure 9-3 and Figure 9-4 display the estimated locations and depths of flooding if a 1% or 0.2% AEP event occurs in 2073 and the project performs as designed. As discussed in Section 3.1.1, the inundation modeling did not include the effects of rainfall and a rainfall sensitivity analysis concluded that the model of interior flooding was not very sensitive to rainfall effects. However, there is always a possibility that extreme rainfall during a hurricane event could cause variations to the extent and depth of flooding depicted in Figure 9-3 and Figure 9-4.



Figure 9-3. Residual Flooding for the 1% AEP Event with Full Performance of the Recommended Plan



Figure 9-4. Residual Flooding for the 0.2% AEP Event with Full Performance of the Recommended Plan

9.8.1.2 RISK TRANSFER (INDUCED FLOODING)

Increasing the levee and floodwall heights may result in increased flood depths on areas exterior to the system. To consider these potential impacts, the modeled storm surge depths for the future without-project conditions were compared to surge depths for the with-project condition in the year 2073, assuming the intermediate RSLR scenario (conditions in 2078 would be expected to be similar – see discussion in Section 8.8.2). Figure 9-5 demonstrates that in the future without-project condition, current modeling indicates that the 1% AEP event produces flood depths to elevations between 4.5 and 17 feet (NAVD88) in the area to the south of the WBV system.

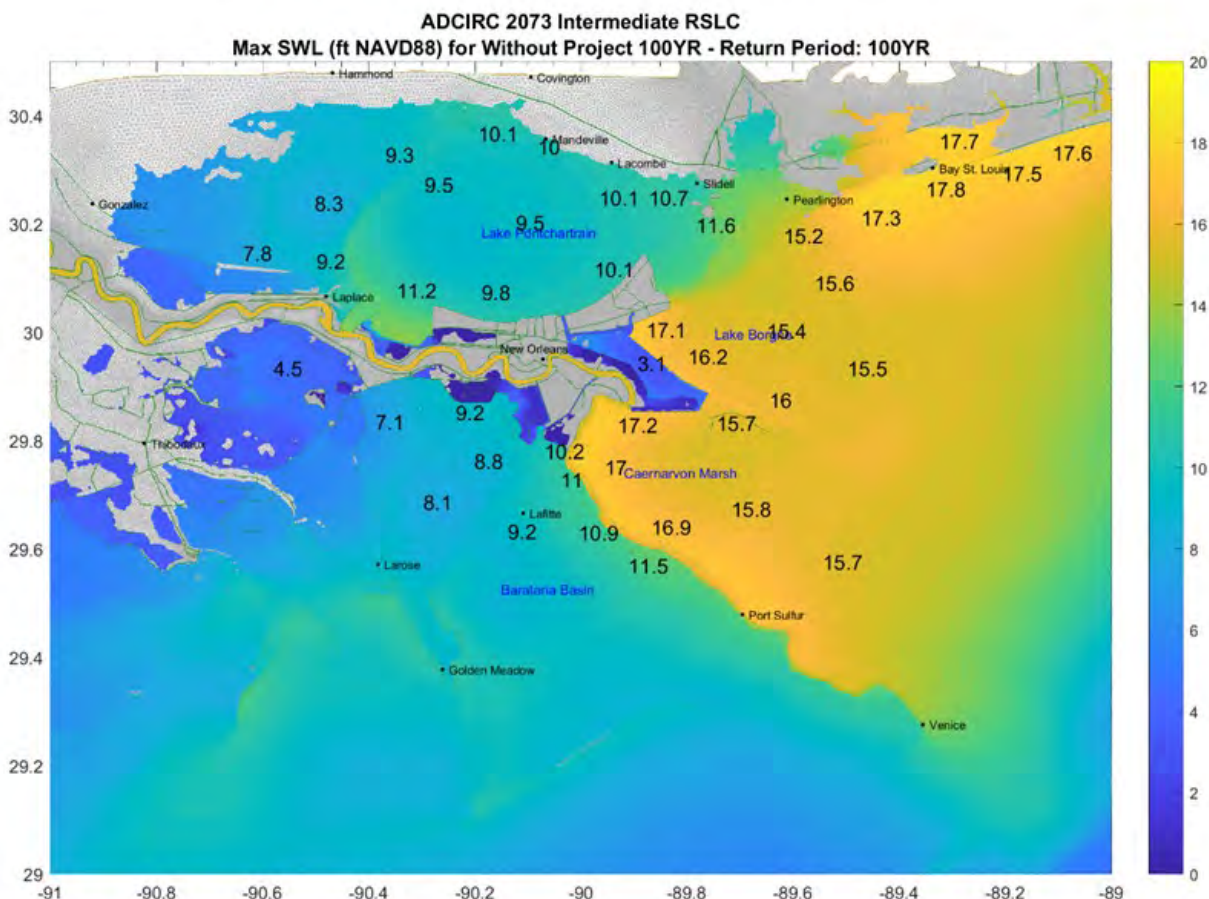


Figure 9-5. 1% AEP Future Without-Project Potential Storm Surge Depths in the LPV and WBV Area (Intermediate RSLR Scenario)

In the current with-project modeling, these 1% AEP flood depths are estimated to increase by less than six inches in most areas and up to one foot in areas immediately adjacent to the system. Much of this area of potential induced flooding is undeveloped. In the one area that is developed, there are roughly 40 structures; all but six of these structures have first-floor elevations that are above the potential induced stage. These conclusions about the potential for induced flooding will be confirmed or revised during the design phase with the updated ADCIRC model when the final system design heights are determined. At that time, a determination will be made regarding whether any significant induced flooding is reasonably anticipated and the additional actions needed to address any potential induced flooding.

9.8.2 LIFE RISK

With any hurricane and storm risk reduction project, there remains life risk after project completion. This risk arises from the possibility (however small) that the project may not perform as designed or that the design may be exceeded. The detailed assessment of life risk for the recommended plan is presented in Appendix D, which is not provided for public review due to the sensitive nature of the information contained within the appendix.

The estimated annual probability of failure of the system due to overtopping following implementation of the recommended plan is in the range of $3E-05$ to $3E-04$ (0.00003 to 0.0003) and the corresponding average annual incremental life loss is $3E-03$ (0.003) lives per year.

The recommended plan does not reduce the future life safety risk associated with overtopping to a level below the societal life safety tolerable risk guideline. The risks for WBV at the 1% AEP plan are above the societal tolerable risk line due to free flow overtopping at the 0.2% AEP (500-year) event near the WBV-12 reach. As discussed in Section 9.7, additional ADCIRC modeling is planned for the design phase, which will further revise the required design heights. This reach will need to be re-evaluated during the design phase and possible actions taken to reduce the risks to an tolerable level for the 0.2% AEP event.

9.8.3 ECONOMIC DAMAGES

With any hurricane and storm risk reduction project, there remains the risk for economic damages after project completion. The residual economic risks estimated for the Recommended Plan are related to events that exceed the project design (events greater than 1% AEP) but do not result in project non-performance. These damages are estimated to be \$8 million annually.

9.9 EXECUTIVE ORDER 11988

EO 11988 requires federal agencies to recognize the significant values of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains. It is the general policy of USACE to formulate projects that, to the extent possible, avoid or minimize adverse impacts associated with use of the base floodplain and avoid inducing development in the base floodplain unless there is no practicable alternative that meets the project purpose. Screening of measures and alternatives for this study considered impacts to the floodplain and minimizing induced development. Per the procedures outlined in ER 1165-2-26 (Implementation of EO 11988 on Flood Plain Management), the study team has analyzed the potential effects of the NED plan on the overall floodplain management of the study area. USACE implementation guidance in ER 1165-2-26 states the following in Paragraph 6:

EO 11988 has as an objective to avoid, to the extent possible, the long-and short-term adverse impacts associated with the occupancy and modification of the base floodplain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative. Under the Order, USACE is required to provide leadership and take action to:

- Avoid development in the base flood plain unless it is the only practicable alternative;
- Reduce the hazard and risk associated with floods;
- Minimize the impact of floods on human safety, health and welfare; and
- Restore and preserve the natural and beneficial values of the base floodplain.

There are eight steps reflecting the decision-making process required in this EO. The eight steps and responses to them are summarized below.

Step 1. Determine if the proposed action is in the base floodplain.

The proposed actions are located within the base floodplain for the Mississippi River.

Step 2. If the action is in the floodplain, identify and evaluate practicable alternatives to locating in the base floodplain.

As the primary objective of the project is coastal storm risk management, there are no practicable alternatives completely outside of the base floodplain for the proposed features that would achieve this objective.

As part of the analysis conducted for the NED described throughout this report, the study team completed analysis of residual risks including any induced or transferred flood risks to determine whether coastal storm risk management measures are economically justified as providing greater benefits than costs.

Step 3. Provide public review.

The public had the opportunity to review and comment on the draft report during the 45-day public review period which began in December 2019. Public meetings occurred in January 2020 to present the Recommended Plan and allow the public to respond and ask questions. Responses to public comments on the draft GRR are included in Appendix L of the final GRR.

Step 4. Identify the impacts of the proposed action and any expected losses of natural and beneficial floodplain values.

Sections 6, 7, and 8 of this document presents an analysis of alternatives. Practicable measures and alternatives were formulated and potential impacts and benefits were evaluated both qualitatively and quantitatively. The anticipated impacts associated with the Recommended Plan are summarized in Sections 7 and 8 of this report. For each resource analyzed in Section 7, wherever there is a potential for adverse impacts, appropriate best management practices or other mitigation considerations were identified. Best management practices are also described in Section 7.

Step 5. Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.

Implementing the Recommended Plan would have a significant reduction to flooding impacts on human health, safety, and welfare. The proposed project is not anticipated to induce development in the floodplain above and beyond development that is expected to occur in the FWOP condition as described in Section 4. It is further assumed that new development will be built above the base 1% AEP floodplain to comply with building codes of local municipalities and to maintain participation in the NFIP, even if not able to participate in the NFIP for the without project condition. Flood insurance is recommended for both without project and with the Recommended Plan as insurance provides greater resiliency by providing financial risk management for residual risks.

Step 6. Re-evaluate alternatives.

Sections 6, 7, and 8 of this document presents an analysis of alternatives. There are no practicable alternatives completely outside of the base floodplain for the features included in the Recommended Plan that would achieve study objectives of reducing coastal storm risks.

Step 7. Issue findings and a public explanation.

Public meetings occurred in January 2020 to present the Recommended Plan and allowed the public to respond and ask questions. The public has been advised that no practicable alternative to locating the proposed action in the floodplain exists with a public notice and involvement under NEPA to fulfill this requirement as indicated in Item 3 above.

Step 8. Implement the action.

The proposed project on its own does not contribute to increased development in the floodplain and does not increase coastal storm risk. The Recommended Plan is consistent with the requirements of this EO.

9.10 MEETING ENVIRONMENTAL OPERATING PRINCIPLES

USACE has reaffirmed its long-standing commitment to environmental conservation by formalizing a set of Environmental Operating Principles (EOPs) applicable to decision-making in all programs. The EOPs outline the USACE role and responsibility to sustainably use and restore natural resources in a world that is complex and changing. The recommended plan meets the intent of the EOPs.

The Recommended Plan supports each of the seven USACE EOPs. The recommended plan strives to achieve environmental sustainability by implementing a project to provide flood risk management while minimizing negative changes to the natural environment. Developing alternatives which were sensitive to environmental effects was key during the plan formulation process. While recognizing the life safety and economic benefits to be gained from hurricane and storm damage risk reduction, the recommended plan has been developed to be sustainable but sensitive to the balance and synergy between development and nature through the use of USACE design criteria and guide specifications while striving to reduce the amount of disruption to wetland habitats. In developing mitigation solutions, coordination was conducted with multiple public resource agencies such as the USFWS, Department of Natural Resources, LDEQ, CPRAB, Louisiana Department of Transportation and Development, the NOAA, and USEPA to build knowledge to understand environmental impacts in order to collaboratively develop innovative, win-win solutions that also protect and enhance the environment. For each adverse effect identified, a responsible mitigation or action to minimize the adverse effect is identified in the Integrated EIS and will be implemented to reflect USACE commitment to accept responsibility and accountability for its actions.

9.11 LESSONS LEARNED DURING HURRICANES KATRINA AND RITA

The selected plan will be consistent with each of the Chief of Engineers' Actions for Change for Applying Lessons Learned during Hurricanes Katrina and Rita issued 24 August 2006. The twelve actions are grouped into four themes.

Actions in the first theme, Comprehensive Systems Approach, include employing integrated, comprehensive systems-based approaches; employing adaptive planning and engineering systems; and focusing on sustainability. The study evaluated WBV both as an individual project and how it effects adjacent systems and levees. The team considered all components of the levee system which entailed analyzing and discussing data and pertinent features to ensure that they would not indirectly affect other areas.

Actions in the second theme, Risk Informed Decision Making, include employing risk-based concepts in planning, design, construction, operations, and major maintenance and reviewing and inspecting completed works. The Recommended Plan for WBV was selected using a risk-informed decision making process. The Recommended Plan significantly reduces future incremental life risk. The selected plan was designed and informed by a methodology that considers not only the performance and potential failure modes that cause the increased risk to the system, but also accounts for the consequences of said failure modes.

Actions in the third theme, Communication of Risk to the Public, include effectively communicating risk and establishing public involvement risk reduction strategies. The report establishes the current condition of WBV levee system with regard to overtopping and how this condition relates to public safety. However, because prior-to-overtopping risk was not included in the analysis, the report cannot communicate the full system risk. The Levee Safety Program Manager for the New Orleans District will include this information in the communication plans for the WBV system until such time as a full risk assessment can be completed. The Integrated EIS will be available for review on the USACE project webpage. Several meetings took place during the study process between USACE, the sponsor, the public, and other stakeholders.

Actions in the fourth theme, Professional and Technical Expertise, include continuously reassessing and updating policy for program development, planning guidance, design and construction standards; dynamic independent reviews; assessing and modifying organizational behavior; managing and enhancing technical expertise and professionalism; and investing in research. The report will be continuously reassessed during its development. The analysis has undergone DQC (District Quality Control) and ATR (Agency Technical Review) reviews for existing and future conditions, as well as DQC of the draft report with Recommended Plan. Additional DQCs, ATR, and constructability review have occurred for the final report. Finally, an Independent External Peer Review has been conducted, where a panel of subject matter experts outside of the agency (USACE) have provided comments and recommendations to the study team that have been considered for implementation.

9.12 USACE CAMPAIGN PLAN

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

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

- identifying a plan to reduce existing and future economic and life safety hurricane and storm damage risk related to overtopping within the WBV Project,
- coordinating with significant stakeholder groups throughout the study process, and
- recommending a sustainable and resilient hurricane and storm damage risk management plan, with appropriate consideration and identification of the long term operation and maintenance of the risk reduction features.

Goal 3 (Reduce Disaster Risks) includes the following objectives: 3a – Enhance interagency disaster response and risk reductions capabilities; 3b – Enhance interagency disaster recovery capabilities; 3c – Enhance interagency disaster mitigation capabilities; and 3d – Deliver and advance Army Geospatial Engineering. The WBV Project supports Goal 3 by:

- contributing significantly to interagency efforts to reduce coastal storm risks in the study area before, during, and after plan implementation, and.
- increasing awareness of the potential coastal storm risks among the project stakeholders through coordination and increased communication with other relevant agencies, thus enhancing interagency disaster capabilities and coordination relative to disaster preparation and response.

9.13 SPONSOR SUPPORT

The sponsor for construction is the CPRAB, who has indicated it may enter into Cooperative Endeavor Agreements or other sub-agreements for performance of the NFS's obligations and responsibilities, including acquisition of LERRDs, OMRR&R, and other items of local cooperation with the local levee districts or other state entities. The CPRAB is fully supportive of the Recommended Plan, has identified no other locally preferred plan, and has provided a sponsor self-certification of financial capability and letter of support as part of the final report submittal.

9.14 SUMMARIZED COSTS AND BENEFITS OF THE RECOMMENDED PLAN

Table 9-3. Details of the Recommended Plan¹

Key Factor	WBV ALTERNATIVE 2 System Levee Lifts and Floodwall Modifications to the Projected 1% AEP Event at 2078 (Intermediate SLC)
Costs	
Total Project First Cost	\$602,000,000
Average Annual O&M Costs	\$400,000
Average Annual Costs	\$16,000,000
Economic Benefits - NED	
Average Annual Damages Reduced (Benefits)	\$76,000,000
Average Annual Net Benefits	\$60,000,000
Benefit-to-Cost Ratio (BCR)	4.7
Life Safety Risk - OSE	
Tolerability	The plan does not currently reduce life safety risk below the societal tolerable risk guideline. Further refinement is anticipated to occur during PED.
Residual Risk	
Life Safety	Residual risks are high due to the extensive population protected by the levee system, even with good evacuation procedures.
Residual Average Annual Economic Damages	\$8,000,000

Critical Infrastructure Damaged (Remaining/FWOP)	90/185
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1. October 2020 Price Level and FY 2021 Discount Rate (2.5%); Base year 2028.

10 PROJECT IMPLEMENTATION

Implementation of the project depends on approval of this report, additional Congressional authorization, appropriation of sufficient federal design and construction funding, and matching sponsor contributions in the form of cash, land acquisition credit, or work-in-kind credit. A PPA will also need to be executed with the CPRAB.

The features and costs of the Recommended Plan described in Section 9 are based on a Feasibility level of design and rely on several outstanding assumptions. These features will need to undergo final design prior to construction, which involves additional technical analysis and confirmation or revision of those outstanding assumptions.

The study's assumptions about the rates of subsidence, consolidation, compaction, and sea level change were key drivers in the recommended project's design and related requirements (real estate, mitigation, etc.). If the actual rates of any of these parameters vary significantly from the study's assumptions during the implementation phase, the features and requirements necessary to achieve the recommended 1% AEP level of risk reduction may be significantly greater or less than estimated in this report. It is recommended that a monitoring and adaptive management plan for the project design be developed as an early activity during the design phase to establish methods and timing for monitoring these parameters, as well as identify likely triggers that may lead to significant design changes and/or the need to re-evaluate the project. This plan would be separate from any monitoring and adaptive management plan that may be required for environmental mitigation activities.

This section documents several important aspects of the design that must be considered and/or completed prior to and during construction, as well as summarizing requirements and responsibilities associated with project implementation.

10.1 REAL ESTATE CONSIDERATIONS

Real estate estimates associated with borrow are currently based on a feasibility-level design effort and assumption that suitable agricultural land is available. The number of acres required, as well as the suitability and availability of land will have to be further assessed as each levee reach is designed during PED.

Additionally, there is no land acquisition currently estimated for mitigation requirements, as the assumption was made that mitigation bank credits would be available for purchase. If mitigation bank credits are unavailable or not sufficiently available in the future, additional acquisition may be required for construction of mitigation sites.

No utility relocations are included in the LERRDs estimate, as the recommended features are all located on the current project footprint, or that of the MRL levee project. This will need to be confirmed or revised for each design segment.

Real Estate PED efforts may include:

- Submit right-of-entry requests for surveys or field work to occur during PED.
- Reacquire temporary estates since the term of three years for the prior construction period would be expired.
- Conduct research for updated ownership information.

The sponsor will not receive credit for lands previously purchased as an item of cooperation.

10.2 DESIGN CONSIDERATIONS

10.2.1 ENVIRONMENTAL AND CULTURAL RESOURCES CONSIDERATIONS

- Specific borrow areas will be identified during pre-construction engineering and design. At that time, additional NEPA documentation, HTRW surveys, cultural resource surveys, permit acquisition, and agency coordination, as appropriate, should be conducted. USFWS recommendations for identification of borrow areas should be followed to the greatest extent practicable. See Section 7.2.1 for additional information on the generalized borrow evaluation. Coordination with CEMVN Regulatory will be necessary to avoid potential conflicts with other permitting actions.
- Continue coordination with natural resource agencies to ensure final designs have all necessary approvals, avoid and minimize impacts, and enhance fish and wildlife habitat to the fullest extent practicable.
- The Louisiana Department of Natural Resources Office of Coastal Management determined that a “phased consistency determination” was the appropriate approach for this project for compliance with the Coastal Zone Management Act. Accordingly, during the design phase and prior to any construction activities, modifications to the existing consistency determination need to be submitted by USACE and approved by LDNR.
- Manatee protection measures and Best Management Practices to avoid impacts to pallid sturgeon in the Mississippi River are to be included in construction plans and specifications.
- If any borrow areas are located in air quality non-attainment areas, conduct general conformity analyses as required.
- Pre-construction nesting bird surveys are to be conducted by USFWS and USACE. USFWS recommends that a qualified biologist inspect the proposed work sites for the presence of undocumented nesting colonies during the nesting season (e.g. February through September depending on the species). If colonies exist, work should not be conducted within 1,000 feet of the colony during the nesting season.
- Prevent colonial nesting birds from establishing active nests within the project construction right-of-way.
- Close coordination with USFWS and LDWF is necessary in order to avoid disturbance of the existing rookery adjacent to WBV 09a.
- Recommendations to minimize potential project impacts to eagles and their nests are provided by LDWF in Appendix L and USFWS in their National Bald Eagle Management Guidelines and these recommendations are to be followed during construction. Pre-construction surveys, buffer areas, and construction seasons may be required.
- For work on the co-located WBV/MRL work, carry out any actions required by the MRL SEIS Programmatic Agreement. This includes any necessary investigations and coordination associated with construction of each project feature.
- Comply with the notification and avoidance requirements regarding manatees, nesting birds, bald eagles, Gulf sturgeon, pallid sturgeon, blue suckers, and live oak forest per LDWF recommendations provided in Appendix L.

10.2.2 HYDROLOGY AND HYDRAULICS CONSIDERATIONS

- Storm surge and wave hazard analysis. Before levee and floodwall design elevations are finalized during PED, the latest available surge and wave hazard analysis should be completed for with-project conditions. At the time of this report, CPRA (through ERDC) is in

the process of conducting a new surge hazard analysis in support of recertifying the HSDRRS system for the NFIP. The updates include a new storm suite, updated ADCIRC grid and source code, and new statistical methodology. However, this analysis will only be for without project conditions. Surge hazard analysis should be completed for existing and future conditions for with and without project. It is anticipated that the updated surge analysis outputs will be different than the values developed for this study. Under no circumstances should the levee designs developed during feasibility phase be used in the PED phase. The storm surge analysis conducted during PED should also be focused on determining the true impacts of the HSDRRS on water levels in communities outside the system.

- Variability and the potential range of river discharge during hurricane season should be revisited during the design phase.
- Complete Internal and external review of the surge hazard analysis, overtopping criteria, and Monte Carlo based overtopping design scripts. Consider review of these critical assumptions by the American Society for Civil Engineers and others, as done in the past.
- A review of the relative sea level rise assumptions in the surge hazard analysis should be conducted to ensure the future condition 100YR design elevations are compliant with USACE climate change policies. Actual relative sea level change should be monitored over time (a suggested timeframe is at least every 10 years) and required design elevations and other related features reconsidered, as appropriate. Changes in relative sea level change will also affect the crossover point and the amount of co-located levees.

10.2.3 CIVIL, STRUCTURAL, AND GEOTECHNICAL ENGINEERING CONSIDERATIONS

- Complete foundation and structural design will be required for the new floodwalls and tie-ins included in the Recommended Plan. Pile curves and geotechnical parameters (unbalanced load determination, settlement-induced bending moments analysis, etc.) are required to complete the final design for each site.
- Non-replaced floodwalls and tie-ins are assumed to perform adequately but will need stability checks during PED to confirm this assumption or include additional actions.
- Settlement curve projections may be analyzed for each levee reach.
- For final design of each levee reach, profiles and cross sectional surveys will be required.

10.3 CONSTRUCTION CONSIDERATIONS

This section documents construction considerations that need to be addressed during the PED and construction phases.

Environmental

- Ensure commitments associated with the USFWS Coordination Act Report recommendations in Section 7.23.1 are followed.
- Use standard threatened and endangered species protection measures as outlined in Appendix G. Manatee protection measures and Best Management Practices to avoid impacts to pallid sturgeon are to be included in construction plans and specifications.

- Pre-construction nesting bird surveys are to be conducted by USFWS and USACE. USFWS recommends that a qualified biologist inspect the proposed work sites for the presence of undocumented nesting colonies during the nesting season (e.g. February through September depending on the species). If colonies exist, work should not be conducted within 1,000 feet of the colony during the nesting season.
- Prevent colonial nesting birds from establishing active nests within the project construction right-of-way.
- Close coordination with USFWS and LDWF is necessary in order to avoid disturbance of the existing rookery adjacent to WBV 09a.
- Recommendations to minimize potential project impacts to eagles and their nests are provided by LDWF in Appendix L and USFWS in their National Bald Eagle Management Guidelines and these recommendations are to be followed during construction. Pre-construction surveys, buffer areas, and construction seasons may be required.
- The Louisiana Department of Natural Resources Office of Coastal Management determined that a “phased consistency determination” was the appropriate approach for this project for compliance with the Coastal Zone Management Act. Accordingly, during the design phase and prior to any construction activities, modifications to the existing consistency determination need to be submitted by USACE and approved by LDNR.
- For specific borrow areas identified during pre-construction engineering and design, coordination with CEMVN Regulatory will be necessary to avoid potential conflicts with other permitting actions.
- General cultural resources mitigation measures as outlined in Section 5.2.1.12.1 of the CED, Phase 1 (USACE 2013) should be followed.
- For work on the co-located WBV/MRL work, follow the stipulations of the MRL SEIS Programmatic Agreement for protection of cultural and historical resources.
- If Limited English Proficiency communities are present, ensure meaningful access to project information, notifications, etc.
- Comply with the notification and avoidance requirements regarding manatees, nesting birds, bald eagles, Gulf sturgeon, pallid sturgeon, blue suckers, and live oak forest per LDWF recommendations provided in Appendix L.

10.4 OMRR&R REQUIREMENTS

The sponsor currently has Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) responsibilities associated with the existing system under an existing Project Partnership Agreement (PPA). A new PPA will be executed for the work included in this report, which will continue those responsibilities into the future and they are expected to remain largely unchanged until completion of the recommended plan, except as new reaches of co-located features are added during project construction. The sponsor will gradually accrue additional cost to annual OMRR&R for the new co-located reach along the Mississippi River, which includes mowing and minor floodwall maintenance. The total additional cost of OMRR&R during the 50-year period of analysis project is anticipated to be \$400,000 per year.

However, upon project completion, the non-federal sponsor will also be required to maintain the authorized level of risk reduction to account for any future settlement, subsidence or actual sea level rise as part of its OMRR&R responsibilities. These costs are highly uncertain, primarily due to uncertainties related to long-term actual relative sea level change (see Table 8-5 for scenario projections out to 2123), and have not been estimated by this study.

10.5 MITIGATION REQUIREMENTS

The proposed mitigation plan is detailed in Appendix K. The proposed mitigation plan to offset impacts from the Recommended Plan assumes the 37.21 AAHUs of flood side BLH-Wet would be mitigated through the purchase of mitigation bank credits equaling 37.21 AAHUs. No new impacts to SAV habitat due to proposed foreshore protection are expected. Purchase of credits would be dependent on the receipt of an acceptable proposal and total purchase cost. No particular bank(s) is (are) proposed for use at this time. 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, USACE may choose to purchase mitigation bank credits from more than one bank to fulfill compensatory mitigation requirements. The mitigation bank must be in compliance with the requirements of the USACE Regulatory Program and its Mitigation Bank Instrument, which specifies the management, monitoring, and reporting that would be required by the bank. Purchase of mitigation bank credits relieves the USACE and non-federal sponsor of the responsibility of monitoring, adaptive management, and of demonstrating mitigation success. If borrow sites require mitigation, a mitigation plan would be included in the NEPA evaluation for those sites.

10.6 IMPLEMENTATION SCHEDULE

A preliminary implementation plan has been developed to support calculations for construction and economic costs. Based on estimates of compaction, subsidence, and sea level rise, timeframes were estimated for levee lifts and floodwall construction to maintain the 1% level of risk reduction. This plan lays out the construction features by decade over the 50-year period of analysis and is generally displayed in Table 10-1. As described in Section 9.1, there are 49 miles of levee requiring lifts. However, some reaches will require more than one lift. The miles listed in Table 10-1 include the sum of all lifts. Additional detail can be found in Appendices A and E.

Table 10-1. General Implementation Plan, by Decade

Feature	2023-2033	2034-2043	2044-2053	2054-2063	2064-2073
Levee Lift	6 lifts = 11 miles	5 lifts = 16 miles	10 lifts = 23 miles	3 lifts = 14 miles	0 lifts
Floodwall Construction	2 walls = 5800 linear ft				

A project implementation schedule has been developed following additional design refinements and is based upon the assumption that this Report will be approved in the latter half of federal FY 2021. The project schedule estimates the timeframe for required levee lifts, and lays out a plan for floodwall modifications and mitigation activities. These timeframes are based on projections of the cumulative effects of consolidation, compaction, subsidence and sea level rise. The schedule also assumes federal funding is available in the years required, sponsor matching funds are also available, and that the real estate actions are completed on schedule.

The schedule reflects the information currently available and the current departmental policies governing execution of projects. It does not reflect program and budgeting priorities inherent in either the formulation of a national civil works construction program or the perspective of higher

review levels within the Executive Branch. Consequently, the schedule may be modified before it is transmitted to higher authority for implementation funding.

10.7 SPONSOR REQUIREMENTS

Federal implementation of the recommended project would be subject to the non-federal sponsor agreeing to comply with applicable federal laws and policies, including but not limited to:

- 1) Provide 35 percent total hurricane and storm damage reduction costs as further specified below:
 - a) Provide 35 percent of design costs allocated by the Government to hurricane and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the hurricane and storm damage reduction features;
 - b) Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to hurricane and storm damage reduction;
 - c) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the hurricane and storm damage reduction features;
 - d) Provide, during construction, any additional funds necessary to make its total contribution for hurricane and storm damage reduction equal to at least 35 percent of total costs;
- 2) Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
- 3) Not less than once each year, inform affected interests of the extent of risk reduction afforded by the hurricane and storm damage reduction features;
- 4) Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;
- 5) Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the hurricane and storm damage features;
- 6) Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with risk reduction levels provided by the hurricane and storm damage features;
- 7) Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might

reduce the level of risk reduction the hurricane and storm damage reduction features afford, hinder operation and maintenance of the project, or interfere with the project's proper function;

- 8) Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
- 9) Operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;
- 10) Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- 11) Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
- 12) Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;
- 13) Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);
- 14) Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the

- Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;
- 15) Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;
 - 16) Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
 - 17) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element

10.8 COST SHARING REQUIREMENTS

The CPRAB has stated that it intended or intends to enter into cooperation endeavor agreements or other sub-agreements, in accordance with the Constitution and Laws of the State of Louisiana, for performance of CPRAB's obligations under the PPA. Some of the state entities which CPRAB may enter into cooperation endeavor agreements or other sub-agreements with include, but are not limited to:

- The Southeast Louisiana Flood Protection Authority – West Bank
- Plaquemines Parish Government
- St. Charles Parish
- Orleans ParishJefferson Parish
- Sewerage and Water Board of New Orleans

The cost sharing requirement for this project is 65% federal and 35% non-federal. In addition to cash, the sponsor is anticipated to receive work-in-kind credit for some design and construction work, as well as credit for LERRDs acquisition.

The total project first cost is \$602 million. The federal share of the total project first cost is estimated to be approximately \$391 million and the non-federal share is estimated to be approximately \$211 million. The estimated value of LERRDs to be provided the sponsor is approximately \$17 million and the rest of the sponsor contribution will be in cash or in-kind credit. Additionally, the non-federal sponsor will maintain OMRR&R responsibility for the WBV and assume responsibility for OMRR&R upon physical construction completion of each initial project feature or functional portion of construction, and each incremental lift of each project feature, or functional portion, at no Cost to the Government, and in perpetuity, currently estimated to be \$400 thousand annually. Table 10-2 presents the estimated cost-sharing of the total project first cost. Additional detail on costs by project features can be found in Section 9.2.

Table 10-2. Total Project First Cost Sharing (October 2020 price level)

Item	Federal Cost	Non-Federal Cost	Total First Cost
Coastal Storm Risk Management	\$348,100,000	\$170,200,000	\$518,300,000
Lands, Easements, Rights of Way, Relocations and Disposal	\$0	\$17,300,000	\$17,300,000
Subtotal	\$348,100,000	\$187,500,000	\$535,600,000
Planning, Engineering and Design	\$43,300,000	\$23,300,000	\$66,600,000
Total Project	\$391,400,000	\$210,800,000	\$602,200,000

¹ Coastal Storm Risk Management costs include levees and floodwalls, fish and wildlife facilities (mitigation), and construction management.

The total project cost (TPC) is the total project first cost fully funded with escalation to the estimated midpoint of construction and is the cost used in Project Partnership Agreements. The TPC is provided for the sponsor's use in financial planning, as it provides information regarding the overall cost-sharing obligation. The TPC of the recommended plan is approximately \$1.2 billion, with the sponsor's share being approximately \$424 million.

10.9 FINANCIAL ANALYSIS

The CPRAB will have the financial capability to cost-share the estimated implementation costs and are willing to sign the PPA at the appropriate time. The organization takes advantage of both federal and state funding including general state revenues, a State Coastal Trust fund, settlement funds, and oil and gas revenue sharing from federal offshore waters. Sponsor self-certification of financial capability has been provided as part of the final report submittal.

11 PUBLIC INVOLVEMENT*

Public involvement is an important part of planning and decision-making. Agencies, nongovernmental organizations, and citizens provided valuable input for the study. NEPA provides people, organizations, and governments an opportunity to review and comment on proposed major Federal actions. Engaging and receiving input from the public, interested parties, stakeholders, government agencies, and nongovernmental organizations regarding the content of the study in all stages is critical to achieving the USACE objective of enhancing trust and understanding with customers, stakeholders, teammates, and the public through strategic engagement and communication.

In accordance with CEQ Implementation Guidance for NEPA (1978; 40 CFR 1508.22), a Notice of Intent to prepare an EIS was published in the Federal Register (Volume 84, No. 63) on 2 April 2019. A public scoping meeting was held within the study area on 30 April 2019 at the Cut-off Recreational Center in Algiers, LA. Comments were accepted via written correspondence and email. Feedback received during scoping was largely related to questions regarding the relationship between the current study and the existing system of protection and implementation timelines. Information on previous studies was provided by stakeholders during scoping and was considered in preparation of the study. All scoping comments and responses can be found in Appendix L.

In accordance with NEPA, a Notice of Availability announcing the 55-day public review period for the draft report was published in the Federal Register (Volume 84, No. 240) on 13 December 2019. A public meeting was held within the study area on 22 January 2020 at the Cut-off Recreational Center in Algiers, LA. Comments were accepted in-person at the public meeting, by written correspondence, and by email. Comments were provided regarding levee failures during Hurricane Katrina, locations of proposed features, construction materials and methods, relative sea level rise, potential land acquisition, and potential alternatives to proposed features. Comments were considered, as appropriate, during feasibility level design and preparation of this report. All comments on the draft report and responses can be found in Appendix L. Comments received during the final public review will be provided to the decision-maker.

It should be noted that this report includes an appendix (Appendix D) documenting the performance and conclusions of a Semi-Quantitative Risk Assessment. Appendix D contains sensitive information about life risk as related to system performance that is not releasable to the public, resulting in the majority of the appendix being withheld from public review. The appendix has a publicly-releasable executive summary which describes the risk assessment process and the general conclusions and this executive summary was included in the publicly-released documents.

12 RECOMMENDATION

I have considered all significant aspects of this project, including environmental, social and economic effects; and engineering feasibility. I recommend that the Recommended Plan for the West Bank and Vicinity, Louisiana, project area as generally described in this report for implementation as a federal project, with such modifications thereof as in the discretion of the Commander, USACE may be advisable. The estimated total project first cost of the recommended plan is approximately \$602 million at the October 2020 (FY21) price level. OMRR&R expenses are estimated to be approximately \$400,000 per year. The federal portion of the estimated total project first cost is approximately \$391 million. The non-federal sponsors' portion of the estimated total project first costs is approximately \$211 million.

In order to implement the Recommended Plan, Public Law 113-121, Section 3017, REHABILITATION OF EXISTING LEVEES requires modification to extend or eliminate the authorization termination date of 2024.

The recommendations contained herein reflect the information available at this time and current departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the national civil works construction program or the perspective of higher levels within the executive branch. Consequently, the recommendations may be modified before they are transmitted to Congress for authorization and/or implementation funding. However, prior to transmittal to Congress, the State of Louisiana, interested federal agencies, and other parties will be advised of any significant modifications in the recommendations and will be afforded an opportunity to comment further.



STEPHEN J. MURPHY
Colonel, Corps of Engineers
District Commander

13 LIST OF PREPARERS

Name	Role	Years of Experience
Heather Achord	Structural Engineering	14
Max Agnew	Hydraulic Engineering	11
Michele Aurand	GIS	21
Aven Bruser	Office of Counsel	11
Troy Cosgrove	Risk Assessment	25
Rob Dauenhauer	Structural Engineering	26
Bradley Drouant	Project Management	14
Jason Emery	Tribal Liaison	21
Pamela Fischer	Real Estate	11
Noah Fulmer	Cultural Resources	5
Daryl Glorioso	Office of Counsel	23
Lauren Hatten	Civil Engineering, Technical Lead	26
Michelle Kniep	Plan Formulation	25
Ben Logan	Economics	11
Steven Lowrie	Cost Engineering	12
Kat McCain	Environmental Compliance	12
Rachel Mesko	Plan Formulation	11
Joe Musso	HTRW; Air Quality	31
Landon Parr	HTRW	21
Andrew Perez	Environmental Justice; Recreation	21
Bich Quach	Geotechnical Engineering	14
Richard Radford	Aesthetics (Visual)	18
Matthew Roe	Public Affairs	13
Stephan Roth	District Counsel	19
Kip Runyon	Environmental Compliance	23
Monique Savage	Plan Formulation	11
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