Mississippi River Valley Division,
Regional Planning and Environment Division South

Upper Barataria Basin, Louisiana, Feasibility Study

Second Draft Appendix B - Economics

December 11, 2020

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Section 1
Introduction

This appendix presents an economic evaluation of the Recommended Plan for the Upper Barataria Basin, Louisiana Feasibility Study. It was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies, ER 1110-2-1302 "Civil Works Cost Engineering" and the Coastal Storm Risk Management (CSRM) National Economic Development (NED) Manual. The National Economic Development Procedures Manual for Flood Risk Management, prepared by the Water Resources Support Center, Institute for Water Resources, was also used as a reference, along with the User's Manual for the Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA).

Following the Tentatively Selected Plan (TSP) milestone, improvements were made to the Advanced Circulation (ADCIRC) model that resulted in changes in the without-project condition.

The coverage of the model was expanded, resulting in the addition of five new reaches located further west of the Recommended Plan's levee alignment. The inclusion of these reaches led to an increase in without-project damages.

It was discovered that the Sunset levee, a 100-year old, unarmored, uncertified local levee, was modelled with an effective elevation that was over 2 feet too high and could withstand unlimited overtopping. In the current iteration of the analysis, this levee was removed from the ADCRC model and was instead modelled within HEC-FDA at its correct effective elevation and without unrealistic resiliency. This change led to a significant increase in without-project damages.

In addition to improving the without-project conditions in the ADCIRC model, the TSP was modeled. Previously, only the without-project condition had been modeled in ADCIRC and the performance of the TSP had been estimated using the levee module in HEC-FDA. The addition of with-project modeling in ADCIRC provided new information about the performance of the TSP. It was discovered that the stacking behind the levee was significantly higher than what had been previously estimated from professional judgment. As a result, the TSP would experience significant overtopping to the point where its design would not meet the resiliency standards of the Hurricane and Storm Damage Risk Reduction System (HSDRRS) criteria and, therefore, would not be feasible. Thus, the higher 1 percent Annual Exceedance Probability (AEP) elevation revisited and became the Recommended Plan.

It was also found that this greater degree of stacking would induce flooding in three communities located on the eastern, exterior side of the levee. Although these communities would experience flooding under the without-project condition, with the Recommended Plan in place, the level of flooding was estimated to increase by 1 to 3 feet, depending on location. In order to mitigate for this induced flooding, 275 acquisitions from these communities were added to the Recommended Plan.

Furthermore, there were a couple of changes to the economics inputs. An additional damage category, Streets and Highways, was added to the economics analysis. Also, the equivalent annual damages and benefits as well as the average annual project costs were recalculated at the current Federal discount rate of 2.5 percent.

1.1 PROBLEM IDENTIFICATION

The headwater flooding from rainfall is intensified by tidal events, resulting in flood damages to industrial, commercial, and agricultural facilities, residential structures, and critical evacuation routes. Tidal events can create a backwater effect that does not allow rainfall to drain from the basin. The study area has been declared a Federal disaster area nine times in the past 30 years due to flood damages from storms. A coastal storm damage risk management project in the study area would reduce the risk of flooding for residential and commercial structures, major transportation routes, and many other commercially and culturally significant places and activities vital to the economy of the region and nation.

Section 2
Description of the Study Area

2.1 GEOGRAPHIC LOCATION

The study area includes communities in the southeast Louisiana parishes of Ascension, Assumption, Jefferson, Lafourche, St. Charles, St. James, and St. John the Baptist. The study area is bounded on the north and east by the Mississippi River Levee, on the west by Bayou Lafourche, and on the south it extends slightly past U.S. Highway 90. The study area covers approximately 800 square miles and is characterized by low, flat terrain with wetlands, numerous navigation channels, drainage canals, and natural bayous that drain into Lake Salvador and eventually the Gulf of Mexico.

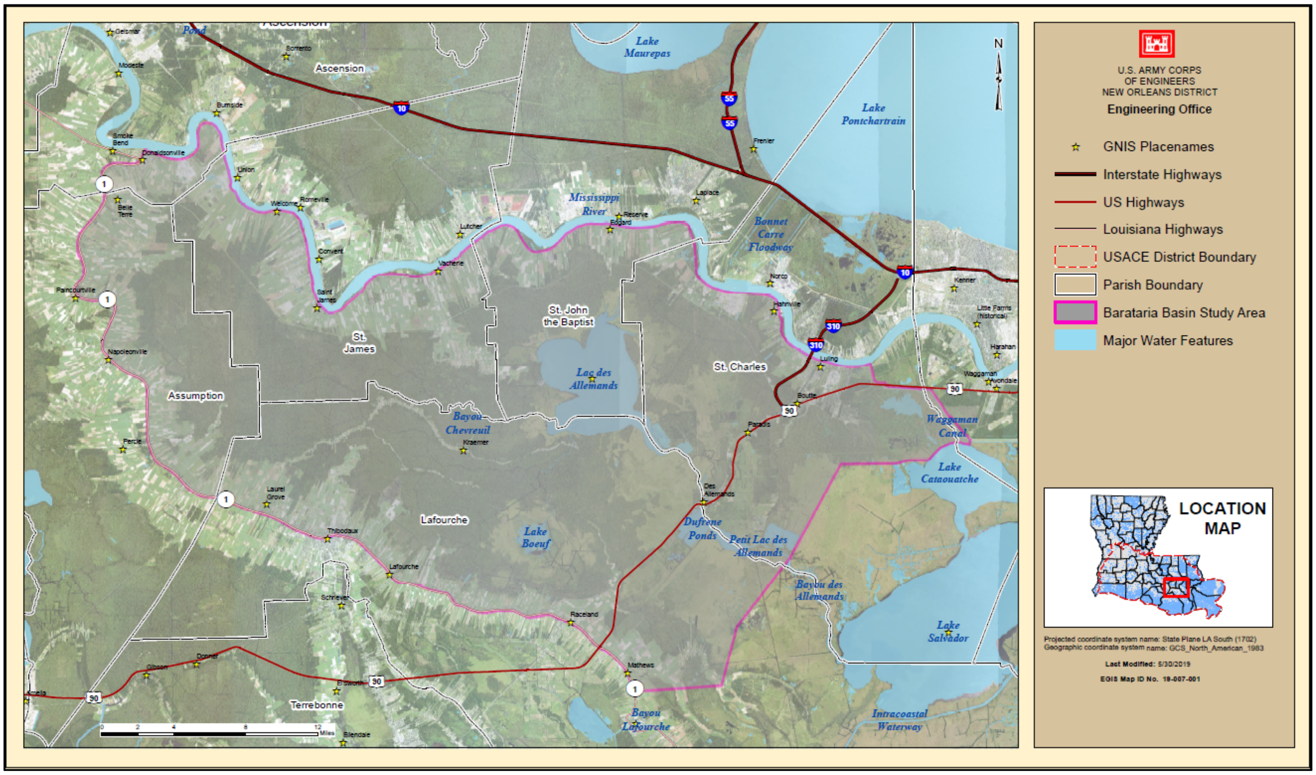

Figure B:2-1. Study Area Boundary

2.2 LAND USE

The total number of acres of developed, agricultural, and undeveloped land in the study area are shown in Table B:2-1. As shown in the table, 8 percent of the total acres in the study area is currently developed land. There are slightly over 500,000 acres of agricultural land and 1.4 million acres of undeveloped land.

Table B:2-1. Land Use in the Study Area

Land Class Name	Acres	Percentage of Total
Developed Land	159,197	8%
Agricultural Land	523,431	25%
Undeveloped Land	1,397,531	67%
Total	2,080,159	100%
Source: USGS National Land Cover Database, 2018		

Section 3

Socio-Economics Setting

3.1 POPULATION, NUMBER OF HOUSEHOLDS, AND EMPLOYMENT

Tables B:3-1. B:3-2, and B:3-3 display the population, number of households, and the employment (number of jobs) for each of the six populated parishes for the years 2000, 2010, and 2019, as well as projections for the years 2025 and 2045. The 2000, 2010, and 2019 estimates for population and number of households are from the U.S. Census Bureau. The 2001, 2010, and 2019 estimates for employment are from the U.S Bureau of Labor Statistics. All projections were developed by Moody's Analytics, which has projections to the year 2045. The study area also includes a very small section of Jefferson Parish, but since this area is unpopulated and undeveloped, Jefferson Parish is not included in these tables.

Table B:3-1. Study Area Historical and Projected Population by Parish

Parish	2000	2010	2019	2025	2045
Ascension	77,335	107,850	126,604	136,988	161,973
Assumption	23,324	23,352	21,891	22,408	21,733
Lafourche	89,775	96,681	97,614	98,970	99,479
St. Charles	48,118	52,845	53,100	55,339	58,101
St. James	21,201	22,006	21,096	22,599	23,727
St. John the Baptist	43,248	45,621	42,837	45,713	47,995
Total	**303,001**	**348,355**	**363,142**	**382,017**	**413,008**
Sources: 2000, 2010, 2019 from U.S. Census Bureau; 2025, 2045 from Moody's Analytics Forecast					

Table B:3-2. Existing Condition and Projected Households by Parish

Parish	2000	2010	2019	2025	2045
Ascension	26,995	38,050	42,649	51,815	66,244
Assumption	8,234	8,719	8,802	8,946	9,336
Lafourche	32,054	35,654	36,449	39,070	42,122
St. Charles	16,473	18,598	18,762	21,099	23,960
St. James	7,002	7,691	7,906	8,561	9,727
St. John the Baptist	14,381	15,875	15,418	17,249	19,602
Total	**105,139**	**124,587**	**129,986**	**146,740**	**170,991**
Sources: 2000, 2010, 2019 from U.S. Census Bureau; 2025, 2045 from Moody's Analytics Forecast					

Table B:3-3. Existing Condition and Projected Employment by Parish

Parish	2001	2010	2019	2025	2045
Ascension	30,124	34,207	46,953	57,390	74,840
Assumption	5,661	4,410	3,911	4,410	4,680
Lafourche	30,969	36,784	34,202	35,360	35,090
St. Charles	19,629	23,100	23,615	30,330	34,670
St. James	7,058	7,735	8,206	9,310	10,650
St. John the Baptist	12,645	15,214	14,460	16,460	18,810
Total	**106,086**	**121,450**	**131,347**	**153,260**	**178,740**
Sources: 2001, 2010, 2019 from U.S. Bureau of Labor Statistics; 2025, 2045 from Moody's Analytics Forecast					

3.2 INCOME

Table B:3-5 shows the actual and projected per capita personal income levels for the six populated parishes from 2000 to 2025. The 2000, 2010, and 2018 estimates are from the U.S Bureau of Economic Analysis and the projection for 2025 is from the Moody's Analytics Forecast.

Table B:3-4. Per Capita Income ($) by Parish

Parish	2000	2010	2018	2025
Ascension	24,052	39,416	49,829	60,180
Assumption	19,613	32,771	46,788	54,195
Lafourche	23,485	40,391	47,096	56,959
St. Charles	24,634	39,557	49,353	63,678
St. James	18,722	38,421	4,8484	60,576
St. John the Baptist	20,002	33,894	40,573	57,423

Sources: 2000, 2010, 2018 from U.S. Bureau of Economic Analysis; 2025 from Moody's Analytics (ECCA) Forecast

3.3 COMPLIANCE WITH POLICY GUIDANCE LETTER (PGL) 25 AND EO 11988.

Given continued growth in population, it is expected that development will continue to occur in the study area with or without the flood risk reduction measures in place, and will not conflict with PGL 25 and EO 11988, which state that the primary objective of a flood risk reduction project is to protect existing development, rather than to make undeveloped land available for more valuable uses. However, the overall growth rate is anticipated to be the same with or without the project in place. Thus, the project would not induce development, but would rather reduce the risk of the population being displaced after a major storm event.

Section 4
Recent Flood History

4.1 TROPCIAL FLOOD EVENTS

Coastal Louisiana experiences localized flooding from both excessive rainfall events, which leads to riverine flooding, and storm surge events from tropical storms and hurricanes. Table B:4-1 displays the FEMA disaster declarations that involved the seven parishes of the study area. Overall, there were 22 disaster declarations related to hurricane and tropical storm incidents in the study area from 1964 to 2016. During the same timeframe, the seven parishes were included in 19 disaster declarations related to flooding incidents. Since 1851, 62 tropical events have made landfall along the south central portion of the Louisiana coast. Table B:4-2 provides the top tropical storms and amount paid by FEMA for the study area.

Table B:4-1. FEMA Declarations by Parish from 1964-2016

Parish	Hurricane and Tropical Storm Incidents	Flooding Incidents
Ascension	18	16
Assumption	16	8
Lafourche	20	8
St. Charles	20	8
St. James	16	7
St. John the Baptist	18	6
Source: Federal Emergency Management Agency (FEMA)		

Table B:4-2. Top Tropical Storms by Amount Paid by FEMA

Event	Month & Year	Number of Paid Claims	Total Amount Paid (millions)
2016 Louisiana Floods	August 2016	26,909	$2,455.7
Tropical Storm Lee	September 2011	9,900	$462.2
Hurricane Ike	September 2008	46,684	$2,700.1
Hurricane Gustav	September 2008	4,545	$112.6
Hurricane Rita	September 2005	9,354	$466.2
Hurricane Andrew	August 1992	5,587	$169.1
Source: Federal Emergency Management Agency (FEMA)			
Note 1: Total amount paid is at price level at time of the event. Note 2: Claims and amount paid are for entire event, which may include areas outside of the study area.			

4.2 FEMA FLOOD CLAIMS

As of the 2019 season, the most recent named storms to affect the study area include, Hurricane Ike in 2008, Tropical Storm Lee in 2011, and Hurricane Gustav in 2008. Of the three, Hurricane Gustav brought the most damage to the study area. Table B:4-3 lists the FEMA flood claims, by parish, from January 1878 through September 2018.

Table B:4-3. FEMA Flood Claims by Parish for January 1878-September 2018

Parish	Total Number of Claims	Number of Paid Claims	Total Payments (millions)
Ascension	6,607	5,658	$336.89
Assumption	979	785	$4.45
Lafourche	5,335	3,920	$66.93
St. Charles	5,963	4,130	$101.05
St. James	249	204	$6.19
St. John the Baptist	4,942	3,996	$264.24
Total	24,075	18,693	$780*
Source: Federal Emergency Management Agency (FEMA) *rounded			

4.3 FEMS SEVERE REPETITIVE LOSS PROPERTIES

A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling 10-year period, since 1978. A RL property may or may not be currently insured by the NFIP. Table B:4-4 shows the repetitive loss property by parish.

Table B:4-4. FEMA Severe Repetitive Loss Properties by Parish (January 1978-December 2018)

Parish	Number of Structures
Ascension	394
Assumption	84
Lafourche	450
St. Charles	643
St. James	19
St. John the Baptist	230
Total	1,820

Source: Federal Emergency Management Agency (FEMA)

Section 5
Analysis Overview and Inputs

5.1 OVERVIEW

The economic appendix contains a description of the methodology used to determine National Economic Development (NED) damages, benefits, and projects costs. The sources of damages for this analysis are structures, contents, and vehicles. The project benefits are accrued due to reducing damages to structures through the lowering of stages caused by storm surge. The damages and costs were calculated using fiscal year (FY) 2020 price levels. Per EGM, 20-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2021, the FY 2021 Federal Discount rate of 2.5 percent was used to calculate interest during construction from the beginning of construction up to the base year of the project, 2026. This discount rate was also used to discount the future levee lift and operation and maintenance (O&M) costs occurring throughout the 50-year period of analysis, back to the project base year.

The study area is divided into 19 reaches that were developed based on hydrologic conditions. Figure B:5-1 shows the reach boundaries overlaid on the study area. They are numbered 1a through 5c. Another dummy reach called “Basin” was used to place structures that were not impacted by surge. Intermediate sea-level rise was used in this analysis for the computation of damages and benefits. Hydrologic conditions are expected to change in the future due to sea-level rise and subsidence. As a result, the discount rate is also used to calculate the equivalent annual damages and benefits between the future condition of 2076 and the base year of 2026. As per ER 1105-2-101, uncertainty parameters were estimated for all major variables used in the analysis, such as structure value, first floor elevation, content-to-structure value ratios, and depth-damage functions.

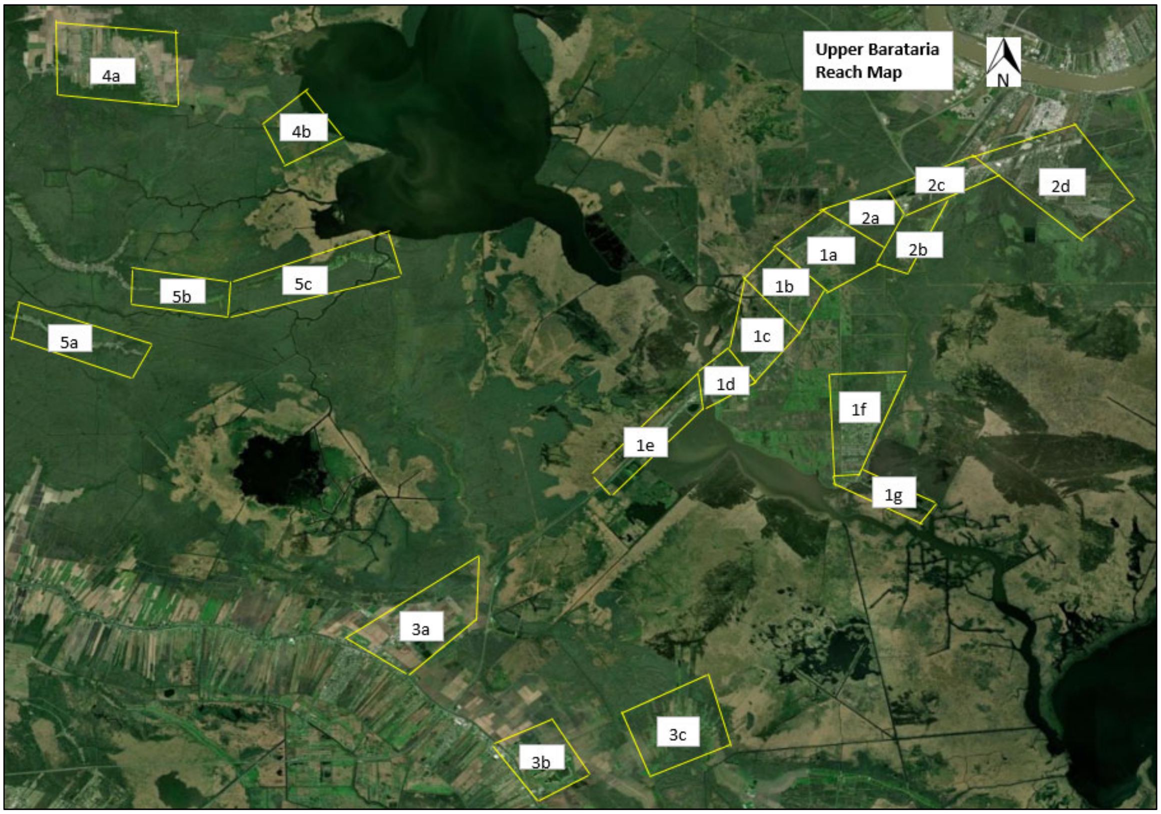

Figure B:5-1. Reach Boundaries

5.2 RECOMMENDED PLAN DESCRIPTION

The Upper Barataria Basin Recommended Plan is a structural alignment constructed to a 1 percent AEP (100-yr future design) and totaling a little over 161,300 feet (30.6 miles) in length. The system starts in Luling where it connects the Mississippi River Levee through the Davis Pond Diversion Structure West Guide Levee. Continuing south, the Recommended Plan improves upon and updates deficiencies in the St. Charles Parish Levee, crosses Bayou Des Allemands with a 270 feet barge gate structure, and continues parallel to US Highway 90 before it ties into high ground across the Barataria Basin near Raceland (Figure B:5-2). The proposed levee is designed to HSDRRS specifications with a 1V:4H and a 10 foot crown, with multiple levee lifts authorized over the initial 50 years. The first lift is projected to occur in 2026 and would raise the levee to an elevation of 14 feet except in hydraulic reaches F and H where it would be constructed to 16 feet elevation after settlement. Subsequent lifts would sustain-maintain the 1 percent AEP over the initial 50 years of the authorized project.

In addition to the levee, there is also a buyout component of the Recommended Plan. The 1 percent AEP design levee is estimated to induce flooding in the communities of Bayou Gauche, Gheens, and Mathews, which are located outside of the system on the east side of the levee. The induced flooding is greatest within the community of Bayou Gauche, which is directly adjacent to the levee. This area is estimated to receive 1 to 1.5 feet of induced flooding under existing conditions and 2 to 4 feet under future conditions. In order to mitigate for the induced flooding, 64 residential structures in Bayou Gauche would be acquired. Due to the presence of existing or proposed flood risk reduction measures in Gheens and Mathews, the extent of induced flooding in those communities is more uncertain and will be investigated further in the PED phase of the study. Currently, it is estimated that 173 residential structures would be acquired in Gheens. In Mathews, it is estimated that 33 residential structures and 5 commercial structures would be acquired.

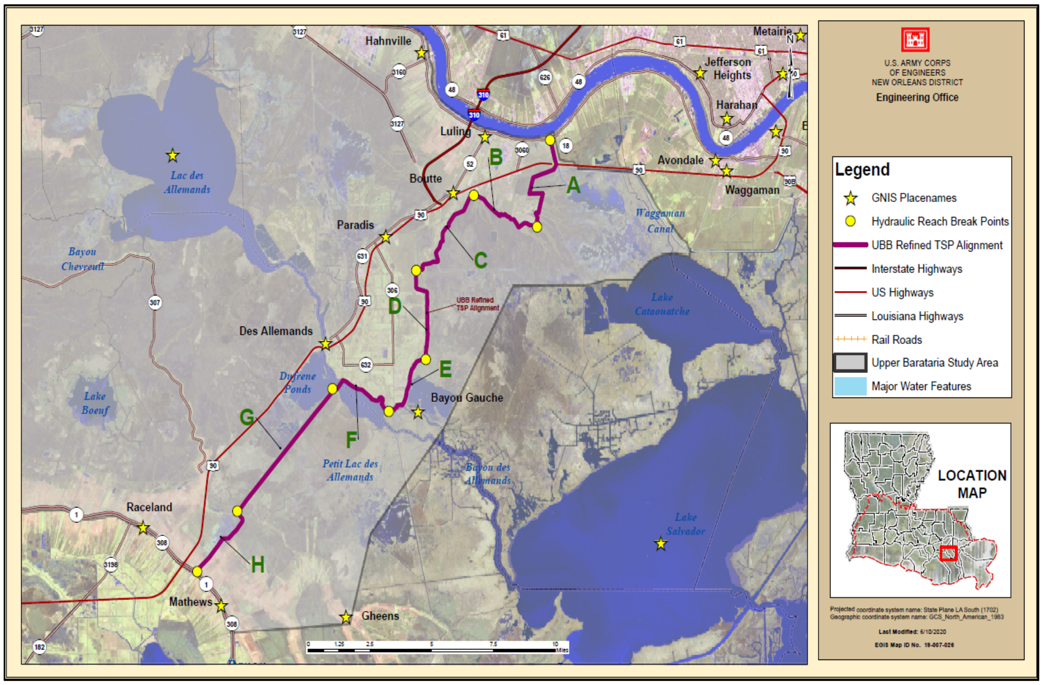

Figure B:5-23. The Recommended Plan

5.3 STRUCTURE INVENTORY

There are 22,726 residential structures and 2,200 non-residential structures in the total structure inventory. The source of the inventory 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 and the square footage of structures over the previous version of the NSI. RS Means was used to calculate the depreciated replacement value of structures. The RS Means construction cost index was used to update the depreciated replacement value from FY 2018 to FY 2020. The foundation heights of the structures were updated using the foundation heights from the Donaldsonville to the Gulf study, which were based on samples by occupancy type. Table B:5-1 displays the structure counts by occupancy type. Table B:5-2 displays the structure counts by reach.

Table B:5-1. Residential and Non-Residential Structure Inventory

Structure Category	
Residential	**Number**
Single Family 1-Story Slab	8,099
Single Family 1-Story Pier	718
Single Family 2-Story Slab	3,036
Single Family 2-Story Pier	7,564
Mobile Home	3,309
Total	22,726
Non-Residential	**Number**
Multi-Family	304
Professional	480
Public	272
Repair	220
Restaurants	193
Retail	421
Warehouse	310
Total	2,200

Table B:5-2. Structure Counts and Value by Reach (2020 price level; $1,000s)

Reach	Structure Count	Total Value
1a	505	314,366
1b	15	5,163
1c	315	166,867
1d	334	240,701
1e	245	130,380
1f	636	241,804
1g	64	17,799
2a	118	58,942
2b	70	44,159
2c	746	224,523
2d	3,159	1,161,570
3a	514	126,153
3b	38	27,613
3c	173	37,304
4a	553	359,543
4b	11	78,807
5a	203	77,004
5b	280	189,630
5c	144	57,514
Ridge	6,703	6,138,573

5.4 STRUCTURE VALUE UNCERTAINTY

The uncertainty surrounding the residential structure values was based on the depreciation percentage applied to the average replacement cost per square foot calculated from the four exterior wall types. A triangular probability distribution was used to represent the uncertainty surrounding the residential structure values in each occupancy category. The most-likely depreciated value was based on the average construction class and a 20 percent depreciation rate (consistent with an observed age of a 20-year old structure in average condition), the minimum value was based on the economy construction class and a 45 percent depreciation rate (consistent with an observed age of a 30-year old structure in poor condition), and the maximum value was based on the luxury construction class and a 7 percent depreciation rate (consistent with an observed age of a 10-year old structure in good condition). These values were then converted to a percentage of the most-likely value with the most-likely value equal to 100 percent of the average value for each occupancy category and the economy and luxury class values equal to a percentage of these values. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values in each residential occupancy category.

The uncertainty surrounding the non-residential structure values was based on the depreciation percentage applied to the average replacement cost per square foot calculated from the six exterior wall types. A triangular probability distribution based on the depreciation percentage associated with an observed age (determined using the professional judgment of personnel familiar with the study area) and the type of frame structure was used to represent the uncertainty surrounding the non-residential structure values in each occupancy category. The most-likely depreciated value was based on the depreciation percentage (25 percent) assigned to structures with an observed age of 20 years for masonry and wood construction, the minimum depreciated value was based on the depreciation percentage (40 percent) assigned to structures with an observed age of 30 years for framed construction, and the maximum depreciated value was based on the on the depreciation percentage (8 percent) assigned to structures with an observed age of 10 years for masonry on masonry or steel construction. These values were then converted to a percentage of the most-likely value with the most-likely value being equal to 100 percent and the minimum and maximum values equal to percentages of the most-likely value. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values for each non-residential occupancy category.

5.5 VEHICLE INVENTORY AND VALUES

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. According to Edmunds.Com, the average value of a used car was $18,800 as of 2nd quarter 2015. The Manheim Used Vehicle Value Index was used to adjust the average value to reflect FY 2019 price levels. According to the Manheim index, the average value of a used car increase 8.0 percent to $20,000 between the years 2015 and 2019. Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $12,000 ($20,000 x 2.0 x 0.30) was assigned to each individual residential automobile structure record in the HEC-FDA model. If an individual structure contained more than one housing unit, then the adjusted vehicle value was assigned to each housing unit in a residential or multi-family structure category. Only vehicles associated with residential structures were included in the analysis. Vehicles associated with non-residential properties were not included in the evaluation. Finally, every apartment building was assumed to contain 50 units so every apartment building has $600,000 as the average value for vehicles (50 units x $10.6 thousand).

5.6 VEHICLE VALUE UNCERTAINTY

The uncertainty surrounding the values assigned to the vehicles in the inventory was determined using a triangular probability distribution function. The average value of a used car, $18,600, was used as the most-likely value. The average value of a new vehicle, $34,000, before taxes, license, and shipping charges was used as the maximum value, while the average 10-year depreciation value of a vehicle, $3,000 was used as the minimum value. The percentages were developed for the most-likely, minimum, and the maximum values with the most-likely equal to 100 percent, and the minimum and the maximum values as percentages of the most-likely value (minimum=25 percent, most-likely=100 percent, maximum=183 percent). These percentages were entered into the HEC-FDA model as a triangular probability distribution to represent the uncertainty surrounding the vehicle value for both residential and non-residential vehicles.

5.7 FIRST FLOOR ELEVATIONS

Topographical data based on North American Vertical Datum (NAVD 88) 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 (DEM) with a 15 feet by 15 feet grid resolution developed by the United States Geological Survey (USGS). The ground elevation was added to the height of the foundation of the structure above the ground 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.

5.8 UNCERTAINTY SURROUNDING ELEVATIONS

There are two sources of uncertainty surrounding the first floor elevations: the use of the LiDAR data for the ground elevations and the methodology used to determine the structure foundation heights above ground elevation. The error surrounding the LiDAR data was determined to be plus or minus 0.5895 feet at the 95 percent level of confidence. This uncertainty was normally distributed with a mean of zero and a standard deviation of 0.3 feet.

The uncertainty surrounding the foundation heights for the residential structure categories and commercial structures was estimated by calculating the standard deviations surrounding the sampled mean values. An overall weighted average standard deviation for all of the sampled structures was computed for each residential and non-residential structure category and for all of the residential and non-residential structures, regardless of structure category.

Uncertainty can only be applied to structure occupancies in the HEC-FDA model. In order to develop a standard deviation for each structure occupancy, first, the structures in each residential category had to be grouped into the structure occupancies; second, a mean foundation height value was the structures within the structure occupancy; third, the standard deviation as a percentage of the mean foundation height value for all the sampled residential structures was calculated and that percentage was applied to the mean foundation value of the residential and non-residential occupancies; fourth, the calculated standard deviation for each structure occupancy was entered into the HEC-FDA model.

5.9 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 the Donaldsonville to the Gulf study area. Professionals in the fields of residential and non-residential construction, general contractors, insurance claims adjusters with experience in flood damage, and a certified restoration expert were selected to sit on the panel. The panel was tasked with developing an array of residential and non-residential structure and content types. Residential structure types were divided into one-story on pier, one-story on slab, two-story on pier, two-story on slab, and mobile homes. Non-residential structure types were categorized as metal-frame walls, masonry bearing walls, and wood or steel frame walls. Residential contents were evaluated as one-story, two-story, or mobile home. Non-residential content categories included the following types: eating and recreation, groceries and gas stations, multi-family residences, repair and home use, retail and personal services, professional businesses, public and semi-public, and warehouse and contractor services. 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 Donaldsonville to the Gulf Feasibility Study, March 2006 Final Report.”

5.10 DEBRIS REMOVAL COSTS

Debris removal costs are typically discussed in the Other Benefit Categories section of the Economic Appendix. However, because debris removal costs were included as part of the HEC-FDA structure records for the individual residential and non-residential structures in the Upper Barataria Basin study area, these costs are being treated as an economic input. The HEC-FDA model does not report debris removal costs separately from the total expected annual without-project and with-project damages.

Following Hurricanes Katrina and Rita, interviews were conducted with experts in the fields of debris collection, processing, and disposal to estimate the cost of debris removal following a storm event. Information obtained from these interviews was used to assign debris removal costs for each residential and non-residential structure in the UBB structure inventory. The experts provided a minimum, most likely, and maximum estimate for the cleanup costs associated with the 2 feet, 5 feet, and 12 feet depths of flooding. A prototypical structure size in square feet was used for the residential occupancy categories and for the non-residential occupancy categories. The experts were asked to estimate the percentage of the total cleanup caused by floodwater and to exclude any cleanup that was required by high winds.

In order to account for the cost/damage surrounding debris cleanup, values for debris removal were incorporated into the structure inventory for each record, according to its occupancy type. These values were then assigned a corresponding depth-damage function with uncertainty in the HEC-FDA model. For all structure occupancy types, 100 percent damage was reached at 12 feet of flooding. All values and depth-damage functions were selected according to the long-duration flooding data specified in a report titled "Development of Depth-Emergency Cost and Infrastructure Damage Relationships for Selected South Louisiana Parishes." The debris clean-up values provided in the report were expressed in 2010 price levels for the New Orleans area. These values were converted to 2020 price levels using the indexes provided by Gordian's 2020 edition of "Square Foot Costs with RS Means Data." The debris removal costs were included as the "other" category on the HEC-FDA structure records for the individual residential and non-residential structures and used to calculate the expected annual without-project and with-project debris removal and cleanup costs.

5.11 DEBRIS REMOVAL COSTS UNCERTAINTY

The uncertainty surrounding debris percentage values at 2 feet, 5 feet, and 12 depths of flooding were based on range of values provided by the four experts in the fields of debris collection, processing, and disposal. The questionnaires used in the interview process were designed to elicit information from the experts regarding the cost of each stage of the debris cleanup process by structure occupancy type. The range of responses from the experts were used to calculate a mean value and standard deviation value for the cleanup costs percentages provided at 2 feet, 5 feet, and 12 feet depths of flooding. The mean values and the standard deviation values were entered into the HEC-FDA model as a normal probability distribution to represent the uncertainty surrounding the costs of debris removal for residential and non-residential structures. The depth-damage relationships containing the damage percentages at the various depths of flooding and the corresponding standard deviations representing the uncertainty are shown with in the depth–damage tables.

5.12 DAMAGES TO STREETS AND HIGHWAYS

The reduction of potential flood damages to streets and highways in an evaluation area can form a significant category of benefits attributable to a project alternative. Major and secondary highways are defined as roadways with four lanes with relatively higher volumes of traffic and access, while streets are defined as roadways with two lanes with relatively lower volumes of traffic and access. The NED costs associated with transportation infrastructure were estimated based on data obtained during interviews with professionals familiar with infrastructure inundation impacts. The information compiled as part of the interview process can be found in the report entitled, "Development of Depth-Emergency

Costs and Infrastructure Damage Relationships for Selected South Louisiana Parishes," dated March 2012.

The experts provided costs for three components of streets (street surface, street base, and street curb), three components of major and secondary highways (road surface, road base, and road shoulder, and three components of railroad tracks (electrical interlocking and grade crossings and non-electrical track structures). The experts also provided estimates of the depreciation of the roadways. The value of each mile of roadway and railway component was discounted by the estimated depreciation percentage. Finally, the experts estimated the percentage of the road components that would be damaged at the 2-feet, 5-feet, and 12-feet depths of flooding.

The damage to the highways, streets and railroad tracks per mile was calculated by multiplying the cost of the materials and labor to replace each infrastructural component by the inverse of the depreciation percentage by the percentage damage to each component. The minimum, most likely, and maximum damages for each roadway and railway component were used to develop a range of values for the total cost of the infrastructural damages per mile. Using a normal distribution, a mean value for the damages per mile and a standard deviation were calculated for each of the three depths of flooding. The mean value for the damages per mile in the report were updated from 2010 to 2020 values using the roads, railroads, and bridges index from the Civil Works Construction Cost Index System (CWCCIS). An HEC-FDA structure record was created for each roadway or railroad segment within a station. The elevation and value per segment of roadway or railroad in each station were entered on the structure record for the HEC-FDA model. The value was based on the costs of replacing or repairing a roadway or railways segment on a per mile basis.

The depth-damage relationships for major and secondary highways, streets and railroads were converted to percentages and entered into the HEC-FDA model, along with the major and secondary highways, streets, and railroad track structure records. The damage value for each mile of highways, streets, and railroads at 12 feet of flooding was used as the infrastructure value, and the stage-probability relationships for each station within the study area reaches was used to calculate the expected annual without-project and with-project damages to major and secondary highways, streets and railroad tracks for the base year (2026) and the final year of the 50-year period of analysis (2076). The expected annual damages were converted to equivalent annual values using the current Federal discount rate of 2.5 percent and a 50-year period of analysis.

5.13 DAMAGES TO STREET AND HIGHWAYS UNCERTAINTY

The uncertainty surrounding the damage percentages for each mile of streets and highways at the three depths of flooding (2 feet, 5 feet, and 12 feet) was represented by a normal probability distribution with mean values and standard deviations. The depth-damage relationships containing the damage percentages at the various depths of flooding and the corresponding standard deviations representing the uncertainty are shown with in the tables for depth–damage relationships.

Section 6
Damages and Benefits Estimation

6.1 MODEL OVERVIEW

The HEC-FDA Version 1.4.2 Corps-certified model was used to calculate the damages and benefits for the study. The economic and engineering inputs necessary for the model to calculate damages and benefits include structure inventory, contents-to-structure value ratios, vehicles, first floor elevations, and depth-damage relationships, ground elevations, and without-project stage probability relationships. The uncertainty surrounding each of the economic and engineering variables was also entered into the model. Either a normal probability distribution, with a mean value and a standard deviation, or a triangular probability distribution, with a most likely, a maximum and a minimum value, was entered into the model to quantify the uncertainty associated with the key economic variables. A normal probability distribution was entered into the model to quantify the uncertainty surrounding the ground elevations. The number of years that stages were recorded at a given gage was entered for each study area reach to quantify the hydrologic uncertainty or error surrounding the stage-probability relationships.

6.2 HEC-FDA MODEL CALCULATIONS

The HEC-FDA model was utilized to evaluate flood damages using risk-based analysis. Damages were reported at the index location for each of the 20 study area reaches. A range of possible values, with a maximum and a minimum value for each economic variable (first floor elevation, structure and content values, and depth-damage relationships), was entered into the HEC-FDA model to calculate the uncertainty or error surrounding the elevation-damage, or stage-damage, relationships. The model also used the number of years that stages were recorded at a given gage to determine the hydrologic uncertainty surrounding the stage-probability relationships. The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. For each variable, a sampling technique was used to select from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes. This process is performed on the without-project condition and repeated for the Recommended Plan. The study area reaches are located inland away from the shoreline, so the developed areas are shielded from the force of storm surge and high velocity flooding. As a result, it is expected that no significant erosion will occur to the developed areas during the period of analysis

6.3 HYDRAULIC AND HYDROLOGIC UNCERTAINTY PARAMETERS

HEC-FDA requires the input of the standard deviation of error associated with stages determined by the hydraulic modeling. Additionally, a period of record must be input in order to calculate the distribution for the flow data determined in the hydrologic analysis.

6.4 STAGE-DAMAGE RELATIONSHIPS WITH UNCERTAINTY

The HEC-FDA model used the economic and engineering inputs to generate a stage-damage relationship for each structure category in each study area reach under 2026 and 2076 conditions. The possible occurrences of each economic variable were derived through the use of Monte Carlo simulation. A total of 1,000 iterations were executed by the model for the Upper Barataria evaluation. The sum of all sampled values was divided by the number of samples to yield the expected value for a specific simulation. A mean and standard deviation was automatically calculated for the damages at each stage.

6.5 STAGE-PROBABILITY RELATIONSHIPS WITH UNCERTAINTY

The HEC-FDA model used an equivalent record length of 50 years for each study area reach to generate a stage-probability relationship with uncertainty through the use of graphical analysis. The model used eight stage-probability events together with the equivalent record length to define the full range of the stage-probability or stage-probability functions by interpolating between the data points. Confidence bands surrounding the stages for each of the probability events were also provided. Stages were provided for the 0.1, 0.05, 0.02, 0.01, 0.005, 0.002, and 0.001 AEP events. Place holders were used for the 1.0 AEP events. These stage-probability curves were provided for both the without-project condition and the Recommended Plan. Table B:6-1 shows the damages by probability event.

Table B:6-1. Study Area Damages by Year and Probability Event ($1,000s)

AEP	Damages 2026	Damages 2076
0.1	38,696	592,784
0.05	188,942	1,422,473
0.02	1,244,522	1,879,244
0.01	1,662,632	2,147,365
0.005	1,944,927	2,384,101
0.002	2,273,833	2,721,109
0.001	2,556,648	2,961,179

6.6 EXPECTED ANNUAL DAMAGES

The model used Monte Carlo simulation to sample from the stage-probability curve with uncertainty. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). For the without-project condition, the expected annual damages (EAD) were totaled for each study area reach to obtain the total without-project EAD under 2026 and 2076 conditions. Table B:6-2 shows the without-project damages by damage category for 2026 and 2076. Tables B:6-3 and B:6-4 show the without-project damages by reach for 2026 and 2076 respectively. The increase in damages from 2026 to 2076 are due to sea-level rise. No future development was included in this analysis. This process is repeated for the Recommended Plan. .

Table B:6-2. Study Area Damage by Damage Category ($1,000s)

Year	Auto	Commercial	Mobile Homes	Residential	Streets	Highways	Total
2026	2,330	24,114	451	25,577	1,734	304	54,510
2076	6,766	75,058	1,458	68,769	4,274	855	157,181

Table B:6-3. Study Area Expected Annual Damages Without-Project (2026)

Reach	EAD
1a	7,133
1b	68
1c	3,104
1d	4,003
1e	2,385
1f	4,977
1g	104
2a	2,162
2b	666
2c	4,189
2d	19,943
3a	308

3b	38
3c	255
4a	383
4b	1,466
5a	153
5b	3,094
5c	82
Total	**54,510**

Table B:6-4. Study Area Expected Annual Damages Without-Project (2076; $1,000s)

Reach	EAD
1a	29,392
1b	270
1c	11,494
1d	15,784
1e	4,526
1f	19,883
1g	313
2a	3,598
,2b	1,621
2c	8,464
2d	48,628
3a	961
3b	99
3c	637
4a	1,137
4b	3,132
5a	748
5b	6,041
5c	453
Total	**157,181**

6.7 EQUIVALENT ANNUAL DAMAGES

The model uses the discount rate to discount the future damages and benefits occurring in 2076 back to the base year of 2026. Table B:6-5 shows the equivalent annual damages by reach for the without-project condition and the damages reduced for the Recommended Plan.

Table B:6-5. Study Area Equivalent Annual Damages and Benefits by Reach (FY 20 Price Level; FY 21 Discount Rate; $1,000s)

Reach	Without Project Damages	Residual Damages	Damages Reduced
1a	15,807	1,111	14,696
1b	147	3	144
1c	6,373	162	6,211
1d	8,594	266	8,328
1e	3,219	101	3,118
1f	10,786	747	10,038
1g	185	2	183
2a	2,722	40	2,681
2b	1,038	16	1,022
2c	5,855	149	5,706
2d	31,121	788	30,333
3a	563	52	511
3b	62	0	62
3c	404	0	404
4a	677	66	611
4b	2,115	103	2,012
5a	385	22	362
5b	4,242	143	4,099
5c	226	20	206
Total	94,519	3,792	90,727

Section 7
Costs

7.1 AVERAGE ANNUAL COSTS

The initial construction cost (first costs), along with the schedule of expenditures, were used to determine the interest during construction and gross investment cost at the end of the installation period (2026). The FY 2021 Federal discount rate of 2.5 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis. The operations, maintenance, relocations, rehabilitation, and repair (OMRR&R) costs for the Recommended Plan were discounted to present value and annualized using the Federal discount rate of 2.5 percent for 50 years. Table B:7-1 provides the life cycle costs for each of the project components, the average annual construction costs, the annual operation and maintenance costs, and the total average annual costs for the Recommended Plan.

Table B:7-1. Recommended Plan (2020 Price Level; FY 20 Discount Rate)

Year	Years from Base Year	Expenditures	Present Value Factor	Present Value of Expenditures
2021	4	$65,999,500	1.1175	$73,756,116
2022	3	$65,999,500	1.0903	$71,957,187
2023	2	$532,799,333	1.0637	$566,726,259
2024	1	$532,799,333	1.0377	$552,903,668
2025	0	$532,799,333	1.0124	$539,418,212
2026	-1	$149,281	0.9877	$147,449
2027	-2	$259,158	0.9636	$249,734
2028	-3	$259,107	0.9401	$243,595
2029	-4	$259,107	0.9172	$237,654
2030	-5	$259,107	0.8948	$231,857
2031	-6	$1,467,617	0.8730	$1,281,243
2032	-7	$259,107	0.8517	$220,685
2033	-8	$259,107	0.8309	$215,303
2034	-9	$259,107	0.8107	$210,051
2035	-10	$259,107	0.7909	$204,928
2036	-11	$4,201,625	0.7716	$3,242,027
2037	-12	$259,107	0.7528	$195,054
2038	-13	$5,524,107	0.7344	$4,057,081
2039	-14	$259,107	0.7165	$185,655
2040	-15	$259,107	0.6990	$181,127
2041	-16	$22,653,617	0.6820	$15,449,614
2042	-17	$259,107	0.6654	$172,399
2043	-18	$259,107	0.6491	$168,194
2044	-19	$16,538,607	0.6333	$10,473,875
2045	-20	$16,538,607	0.6179	$10,218,415
2046	-21	$4,748,827	0.6028	$2,862,510
2047	-22	$259,107	0.5881	$152,376
2048	-23	$259,107	0.5737	$148,659
2049	-24	$259,107	0.5597	$145,033
2050	-25	$259,107	0.5461	$141,496
2051	-26	$70,392,617	0.5328	$37,503,219
2052	-27	$259,107	0.5198	$134,678
2053	-28	$259,107	0.5071	$131,393

Year	Years from Base Year	Expenditures	Present Value Factor	Present Value of Expenditures
2054	-29	$62,208,607	0.4947	$30,776,577
2055	-30	$62,208,607	0.4827	$30,025,928
2056	-31	$16,296,625	0.4709	$7,673,964
2057	-32	$12,354,107	0.4594	$5,675,571
2058	-33	$259,107	0.4482	$116,132
2059	-34	$4,431,607	0.4373	$1,937,812
2060	-35	$4,431,607	0.4266	$1,890,549
2061	-36	$1,467,617	0.4162	$610,823
2062	-37	$8,269,107	0.4060	$3,357,666
2063	-38	$259,107	0.3961	$102,644
2064	-39	$259,107	0.3865	$100,140
2065	-40	$259,107	0.3771	$97,698
2066	-41	$4,748,827	0.3679	$1,746,907
2067	-42	$259,107	0.3589	$92,990
2068	-43	$259,107	0.3501	$90,722
2069	-44	$259,107	0.3416	$88,510
2070	-45	$259,107	0.3333	$86,351
2071	-46	$1,467,617	0.3251	$477,174
2072	-47	$259,107	0.3172	$82,190
2073	-48	$259,107	0.3095	$80,185
2074	-49	$259,107	0.3019	$78,230
2075	-50	$259,107	0.2946	$76,322
		$2,058,528,578		$1,978,831,831
Interest Rate (%)	2.5			
Amortization Factor	0.03526			
Average Annual Costs	$67,655,000			
Average Annual O&M Costs	$2,114,800			
Total Average Annual Costs	$69,769,800			

Section 8
Results

8.1 NET BENEFITS

The net benefits for the Recommended Plan were calculated by subtracting the average annual costs from the equivalent annual benefits. The net benefits were used to determine the economic justification of the Recommended Plan. Table B:8-1 displays the equivalent annual damages and benefits, total first costs, average annual cost, benefit-to-cost ratio, and equivalent annual net benefits for the Recommended Plan. The Recommended Plan is economically justified, meaning its benefit-to-cost ratio is a least 1.

Table B:8-1. Net Benefits Summary for the Recommended Plan

Alternative	Recommended Plan
Project First Cost	$1,945,840,000
Interest During Construction	$74,364,000
Total Investment Cost	$2,020,204,000
AA Investment Costs	$67,655,000
AA O&M Costs	$2,114,800
Total AA Costs	$69,769,800
Construction Duration (Years)	5
Without Project EAD	$94,519,000
EAD Reduced Benefits	$90,727,000
Net Benefits	$20,957,200
B/C Ratio	**1.3**

8.2 BENEFIT EXCEEDANCE PROABILITY RELATIONSHIP

The HEC-FDA model used the uncertainty surrounding the economic and engineering inputs to generate results that can be used to assess the performance of the Recommended Plan. Table B:8-2 shows the expected annual benefits at the 75, 50, and 25 percentiles. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values. The benefit exceedance probability relationship for the Recommended Plan can be compared to the point estimate of its average annual cost. The table indicates the percent chance that the expected annual benefits will exceed the expected annual costs therefore the benefit cost ratio is greater than one and the net benefits are positive. The net benefits and B/C ratios are also displayed at each of the percentiles.

Table B:8-2. Risk Analysis Probability that Expected Annual Benefits Exceed Annual Costs (FY 2020 Price Level; FY 2021 Discount Rate; $1,000s)

		Probability that Damages Reduced exceed indicated values				
Plan Name	**Equivalent Annual Damages Reduced**	**0.75**	**0.5**	**0.25**	**Average Annual Costs**	**Probability Benefits Exceed Costs**
Recommended Plan	$90,727	51,355	85,985	123,199	69,769	Greater Than 50%
Net Benefits		-18,414	16,216	53,430		
B/C Ratio		0.7	1.2	1.8		

8.3 RELATIVE SEA LEVEL RISE SCENARIOS

The prior analysis incorporated H&H data that was developed from the intermediate relative sea-level rise scenario, which was determined to be the most likely scenario to occur. H&H data was also developed for low and high relative sea-level rise scenarios. The project benefits, net benefits, and b/c ratios were recalculated under both alternate relative sea-level rise scenarios. These results are displayed in table B:8-3.

Table B:8-3. Relative Sea Level Rise Scenarios

Scenario	Low RSLR	High RSLR
Total AA Costs	69,769	69,769
Without Project EAD	59,233	203,061
EAD Reduced Benefits	57,129	195,806
Net Benefits	-12,640	126,037
B/C Ratio	0.8	2.8

8.4 PROJECT PERFORMANCE

The results from the HEC-FDA model were also used to calculate the long-term annual exceedance probability (AEP) and the conditional non-exceedance probability, or assurance, for various probability storm events. The model provided a target stage to assess project performance for each study area reach for the base year, 2026, and the last year in the 50-year period of analysis under both without-project and with-project conditions. For study area reaches without proposed levees or berms, the target stage was set by default at the elevation where the model calculated five percent residual damages for the 1% AEP (100-year) event.

The HEC-FDA model calculated a target stage AEP with a median and expected value that reflected the likelihood that the target stages will be exceeded in a given year. The median value was calculated using point estimates, while the expected value was calculated using Monte Carlo simulation. The results also show the long-term risk or the probability of a target stage being exceeded over 10-year, 30-year, and 50-year periods. Finally, the model results show the conditional non-exceedance probability or the likelihood that a target stage will not be exceeded by the 10% AEP (10 year), the 4% AEP (25-year), the 2% AEP (50-year), the 1% AEP (100-year), the 0.4% AEP (250-year), and the 0.2% AEP (500-year). Tables B:8-4 through B:8-7 display the project performance results for each study area reach for the base year, 2026, and the last year in the 50-year period of analysis, 2076, under without-project and with-project conditions.

The Life Safety analysis can be found in Appendix A, Annex 14.

Table B:8-4. Project Performance by Reach, Without Project 2026

					Long Term Risk (years)				Conditional Non-Exceedance Probability by Events				
Reach	**Target Stage**	**Geo Tech**	**Median**	**Expected**	**10**	**30**	**50**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
1a	5	L	0	0.0321	0.2783	0.6241	0.8042	0.9997	0.6474	0.3573	0.1944	0.0266	0.0039
1b	5	L	0.0212	0.0248	0.2216	0.5284	0.7143	0.9996	0.7829	0.4755	0.2664	0.0479	0.0096
1c	5	L	0	0.024	0.2157	0.5176	0.7033	0.999	0.7949	0.4873	0.273	0.0523	0.0109
1d	5	L	0	0.0203	0.1858	0.4602	0.6421	0.9989	0.8657	0.5661	0.3305	0.0653	0.0136
1e	3	L	0	0.0976	0.642	0.9541	0.9941	0.5395	0.11	0.0305	0.0297	0.0024	0.0003
1f	5	L	0	0.0271	0.2401	0.5612	0.7466	0.9989	0.7357	0.4299	0.2296	0.0476	0.0093
1g	3.66	L	0.0972	0.0984	0.6451	0.9553	0.9944	0.5278	0.1139	0.0336	0.0299	0.0028	0.0004
2a	4	L	0	0.099	0.6476	0.9562	0.9946	0.5276	0.1073	0.0289	0.0279	0.0029	0.0004
2b	4	L	0	0.1009	0.6546	0.9588	0.9951	0.5162	0.1026	0.0267	0.0254	0.0025	0.0004
2c	3	L	0	0.1005	0.6532	0.9583	0.995	0.5325	0.046	0.0089	0.0086	0.0007	0
2d	4	L	0	0.1008	0.6545	0.9588	0.9951	0.5155	0.1011	0.0257	0.0253	0.0022	0.0003
3a	3.11	L	0.1	0.1008	0.6545	0.9588	0.9951	0.5014	0.118	0.0402	0.0381	0.0029	0.0004
3b	1.7	L	0.1	0.1237	0.7329	0.9809	0.9986	0.1959	0.0002	0.0255	0.0067	0.0027	0.0018
3c	2.62	L	0.0991	0.1013	0.6561	0.9593	0.9952	0.5083	0.1069	0.0306	0.0291	0.0041	0.0009
4a	1.11	L	0.0876	0.0997	0.6501	0.9572	0.9948	0.7096	0.0058	0.0006	0	0	0
4b	3	L	0	0.1006	0.6537	0.9585	0.995	0.5109	0.1051	0.0287	0.0175	0.0028	0.0005
5a	-0.97	L	0.1	0.1237	0.7329	0.9809	0.9986	0.1918	0.0267	0.009	0.0035	0.0021	0.0016
5b	2	L	0	0.1016	0.6574	0.9598	0.9953	0.5208	0.0848	0.0198	0.0189	0.0082	0.0042
5c	1.73	L	0.0977	0.1013	0.6563	0.9594	0.9952	0.5247	0.0502	0.009	0.0034	0.0003	0

Table B:8-5. Project Performance by Reach, Without Project 2076

					Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach	**Target Stage**	**Geo Tech**	**Median**	**Expected**	**10**	**30**	**50**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
1a	5	L	0	0.1377	0.7726	0.9882	0.9994	0.3208	0.0633	0.0174	0.0162	0.0028	0.0004
1b		L	0.0939	0.0946	0.63	0.9494	0.9931	0.5567	0.1339	0.0428	0.0415	0.0048	0.0009
1c	5	L	0	0.0892	0.607	0.9393	0.9906	0.604	0.1653	0.0561	0.0517	0.0058	0.0015
1d	5	L	0	0.0805	0.5679	0.9193	0.9849	0.682	0.2109	0.0751	0.0614	0.0073	0.0017
1e	5	L	0	0.0991	0.6479	0.9563	0.9946	0.5224	0.1206	0.0394	0.0349	0.004	0.0007
1f	5	L	0	0.1085	0.683	0.9682	0.9968	0.4273	0.0847	0.0274	0.0271	0.0039	0.0005
1g	5.17	L	0.0982	0.0991	0.6479	0.9564	0.9946	0.5199	0.1147	0.0346	0.0338	0.0043	0.0005
2a	5	L	0	0.1009	0.655	0.9589	0.9951	0.5095	0.1068	0.0315	0.0297	0.0041	0.0009
2b	5	L	0	0.1005	0.6533	0.9583	0.995	0.5165	0.1034	0.0276	0.0259	0.0035	0.0006
2c	5	L	0	0.1008	0.6542	0.9587	0.9951	0.5254	0.07	0.0156	0.0126	0.0015	0.0001
2d	5	L	0	0.1005	0.6533	0.9583	0.995	0.5151	0.0969	0.0254	0.0176	0.0023	0.0002
3a	4.36	L	0.1	0.1005	0.6534	0.9584	0.995	0.5014	0.1221	0.0443	0.035	0.0039	0.0005
3b	3.52	L	0.0988	0.0991	0.6477	0.9563	0.9946	0.5158	0.1222	0.0406	0.0407	0.0429	0.0052
3c	4.2	L	0.0992	0.1001	0.6517	0.9577	0.9949	0.51	0.1191	0.0398	0.039	0.005	0.0013
4a	2.55	L	0.0973	0.1017	0.6577	0.9599	0.9953	0.5386	0.0029	0.0003	0.0003	0	0
4b	4	L	0	0.0986	0.646	0.9556	0.9944	0.5255	0.113	0.0336	0.0258	0.0031	0.0004
5a	1.97	L	0.1022	0.1	0.6512	0.9575	0.9948	0.474	0.163	0.0742	0.0676	0.0351	0.0201
5b	3	L	0	0.1	0.6512	0.9576	0.9948	0.5158	0.1177	0.0379	0.0301	0.0043	0.0011
5c	3.01	L	0.0987	0.101	0.6551	0.959	0.9951	0.5153	0.0895	0.0211	0.0183	0.001	0

Table B:8-6. Project Performance by Reach, Recommended Plan 2026

					Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach	**Target Stage**	**Geo Tech**	**Median**	**Expected**	**10**	**30**	**50**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
1a	5		0	0.0009	0.0088	0.0263	0.0434	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
1b	5		0.0001	0.0001	0.001	0.003	0.005	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
1c	5		0	0.0001	0.001	0.003	0.005	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
1d	5		0	0.0001	0.001	0.003	0.005	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
1e	3	L	0	0.0025	0.0244	0.0714	0.1162	0.9997	0.9997	0.9997	0.9997	0.9997	0
1f	5		0	0.0006	0.0059	0.0177	0.0294	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
1g	3.66	L	0.1745	0.1708	0.8463	0.9964	0.9999	0.1691	0.0333	0.0106	0.0105	0.0008	0
2a	4	L	0	0.0001	0.001	0.003	0.005	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
2b	4	L	0	0.0001	0.001	0.003	0.005	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
2c	3	L	0	0.0001	0.001	0.003	0.005	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
2d	4	L	0	0.0001	0.001	0.003	0.005	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
3a	3.11	L	0.0024	0.0024	0.0234	0.0686	0.1117	0.9998	0.9998	0.9998	0.9998	0.9998	0
3b	1.7	L	0.1	0.1237	0.733	0.981	0.9986	0.2006	0.0002	0.021	0.0055	0.0024	0.0016
3c	2.62	L	0.1585	0.1531	0.8103	0.9932	0.9998	0.2452	0.0553	0.0186	0.0187	0.0032	0.0005
4a	1.11	L	0.0045	0.0045	0.0438	0.1257	0.2006	0.9998	0.9998	0.9998	0.9998	0	0
4b	3	L	0	0.0027	0.027	0.0787	0.1277	0.9997	0.9997	0.9997	0.9997	0.9997	0
5a	-0.97	L	0.1	0.1236	0.7327	0.9809	0.9986	0.21	0	0	0	0	0
5b	2	L	0	0.0028	0.0278	0.081	0.1313	0.9997	0.9997	0.9997	0.9997	0.9997	0
5c	1.73	L	0.0027	0.0027	0.0268	0.0782	0.1269	0.9998	0.9998	0.9998	0.9998	0.9998	0

Table B:8-7. Project Performance by Reach, Recommended Plan 2076

					Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach	**Target Stage**	**Geo Tech**	**Median**	**Expected**	**10**	**30**	**50**	**0.1**	**0.04**	**0.02**	**0.01**	**0.004**	**0.002**
1a	5		0	0.0001	0.001	0.003	0.005	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
1b	5		0.0001	0.0001	0.001	0.003	0.005	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
1c	5		0	0.0001	0.001	0.003	0.005	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
1d	5		0	0.0001	0.001	0.003	0.005	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
1e	5	L	0	0.0024	0.0238	0.0696	0.1133	0.9998	0.9998	0.9998	0.9998	0.9998	0
1f	5		0	0.0001	0.001	0.003	0.005	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
1g	5.17	L	0.4131	0.4133	0.9952	1	1	0	0	0	0	0	0
2a	5	L	0	0.0027	0.0271	0.0791	0.1283	0.9997	0.9997	0.9997	0.9997	0.9997	0
2b	5	L	0	0.0024	0.0243	0.071	0.1155	0.9998	0.9998	0.9998	0.9998	0.9998	0
2c	5	L	0	0.0029	0.0287	0.0837	0.1356	0.9997	0.9997	0.9997	0.9997	0.9997	0
2d	5	L	0	0.0026	0.0258	0.0755	0.1226	0.9997	0.9997	0.9997	0.9997	0.9997	0
3a	4.36	L	0.0027	0.0027	0.0271	0.0791	0.1283	0.9997	0.9997	0.9997	0.9997	0.9997	0
3b	3.52	L	0.7174	0.7148	1	1	1	0	0	0	0	0	0
3c	4.2	L	0.3399	0.3403	0.9844	1	1	0.0011	0.0009	0.0015	0.0006	0.0008	0.0001
4a	2.55	L	0.0032	0.0032	0.0314	0.0912	0.1474	0.9998	0.9998	0.9998	0.9998	0.9998	0
4b	4	L	0	0.0027	0.0262	0.0765	0.1243	0.9997	0.9997	0.9997	0.9997	0.9997	0
5a	1.97	L	0.0029	0.0029	0.0287	0.0836	0.1353	0.9997	0.9997	0.9997	0.9997	0.9997	0
5b	3	L	0	0.003	0.0296	0.0863	0.1396	0.9997	0.9997	0.9997	0.9997	0.9997	0
5c	3.01	L	0.0027	0.0027	0.0269	0.0785	0.1274	0.9998	0.9998	0.9998	0.9998	0.9998	0

Section 9
Regional Economic Development (RED)

9.1 GENERAL.

The Regional Economic Development (RED) account addresses the impacts that the USACE expenditures associated with the construction of a coastal storm risk management system will have on the levels of income, output and employment throughout the region. These impacts are not included in the NED analysis, but can still be used by decision makers as part of their investment decision process. The RED analysis does not address the indirect losses, or nonphysical impacts, to the national economy that were calculated as part of the REMI analysis discussed in the Other Benefit Categories section of the Economic Appendix.

9.2 METHODOLOGY.

This Regional Economic Development (RED) analysis employs input-output economic analysis, which measures the interdependence among industries and workers in an economy. This analysis uses a matrix representation of a regional economy to predict the effect that changes in one industry will have on other industries. The greater the interdependence among industry sectors, the larger the multiplier effect on the economy. Changes to government spending drive the input-output model to project new levels of sales (output), value added Gross Regional Product (GRP), employment, and income for each industry.

RECONS Version 2 was the specific input-output model used to estimate the regional economic development impacts of the Recommended Plan. The U.S. Army Corps of Engineers (USACE) Institute for Water Resources, Louis Berger, and Michigan State University developed the regional economic impact modeling tool, RECONS (Regional Economic System), that provides estimates of jobs and other economic measures such as labor income, value added, and sales that are supported by USACE programs, projects, and activities. This modeling tool automates calculations and generates estimates of jobs, labor income, value added, and sales through the use of IMPLAN®'s multipliers and ratios, customized impact areas for USACE project locations, and customized spending profiles for USACE projects, business lines, and work activities. RECONS allows the USACE to evaluate the regional economic impact and contribution associated with USACE expenditures, activities, and infrastructure.

9.3 DESCRIPTION OF METRICS.

"Output" is the sum total of transactions that take place as a result of the construction project, including both value added and intermediate goods purchased in the economy. "Labor Income" includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. "Gross Regional Product (GRP)" is the value-added output of the study regions. This metric captures all final goods and services produced in the study areas because of the existence of the project. It is different from output in the sense that one dollar of a final good or service may have multiple transactions associated with it. "Jobs" is the estimated worker-years of labor required to build the project.

9.4 ASSUMPTIONS.

Input-output analysis rests on the following assumptions. The production functions of industries have constant returns to scale, so if output is to increase, inputs will increase in the same proportion. Industries face no supply constraints; they have access to all the materials they can use. Industries have a fixed commodity input structure; they will not substitute any commodities or services used in the production of output in response to price changes. Industries produce their commodities in fixed proportions, so an industry will not increase production of a commodity without increasing production in every other commodity it produces. Furthermore, it is assumed that industries use the same technology to produce all of its commodities.

9.5 RESULTS.

The construction expenditures associated with the Recommended Plan are estimated to be $1.94 billion. Of this total expenditure, $1.65 billion will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added). The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures of $1.94 billion support a total of 27,728 full-time equivalent jobs, $1.67 billion in labor income, $1.91 billion in the gross regional product, and $3.3 billion in economic output in the local impact area. More broadly, these expenditures support 38,291 full-time equivalent jobs, $2.4 billion in labor income, $3 billion in the gross regional product, and $5.3 billion in economic output in the nation. Table B:9-1 summarizes the RED effects from the construction expenditures.

The operations and maintenance expenditures associated with the Recommended Plan are estimated to be an average of $2.2 million annually. Of this total expenditure, $2 million will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures of $2.2 million support a total of 37 full-time equivalent jobs, $2.2 million in labor income, $2.5 million in the gross regional product, and $4 million in economic output in the local impact area. More broadly, these expenditures support 49 full-time equivalent jobs, $3 million in labor income, $3.7 million in gross regional product, and $6.2 million in economic output in the nation. Table B:9-2 summarizes the RED effects from the O&M expenditures.

Table B:9-1. Regional Economic Development Effects, Construction

Area	Output	Jobs*	Labor Income	Value Added
Local				
Direct Impact	$1,654,172,785	18,074.3	$1,141,510,100	$975,548,253
Secondary Impact	$1,637,981,706	9,653.7	$534,871,772	$937,255,978
Total Impact	$3,292,154,491	27,728.0	$1,676,381,873	$1,912,804,232
State				
Direct Impact	$1,406,569,391	13,387.1	$951,864,834	$726,419,926
Secondary Impact	$1,514,191,774	9,047.3	$478,500,338	$844,009,859
Total Impact	$2,920,761,165	22,434.4	$1,430,365,173	$1,570,429,785
US				
Direct Impact	$1,867,927,656	20,915.9	$1,358,997,068	$1,187,050,965
Secondary Impact	$3,496,798,722	17,375.3	$1,115,986,818	$1,901,046,869
Total Impact	$5,364,726,378	38,291.2	$2,474,983,887	$3,088,097,834

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

Table B:9-2. Regional Economic Development Effects, O&M

Area	Output	Jobs*	Labor Income	Value Added
Local				
Direct Impact	$2,087,101	25.1	$1,530,477	$1,365,539
Secondary Impact	$2,007,631	11.9	$660,952	$1,155,498
Total Impact	$4,094,732	37.0	$2,191,429	$2,521,036
State				
Direct Impact	$1,530,934	14.6	$1,036,372	$808,677
Secondary Impact	$1,640,272	9.8	$522,250	$916,286
Total Impact	$3,171,206	24.4	$1,558,622	$1,724,963
US				
Direct Impact	$2,230,114	29.0	$1,756,723	$1,572,786
Secondary Impact	$4,055,224	20.5	$1,301,114	$2,218,862
Total Impact	$6,285,338	49.5	$3,057,838	$3,791,648

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

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