PEARL RIVER WATERSHED

JACKSON METROPOLITAN AREA, MISSISSIPPI

APPENDIX B

ECONOMIC ANALYSIS

October 2017

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APPENDIX B
ECONOMIC ANALYSIS

SECTION I - INTRODUCTION

General - In accordance with congressional authorization, the Rankin-Hinds Pearl River Flood and Drainage Control District (RHPRFDCD) is preparing a Feasibility Study and Environmental Impact Statement, (FS/EIS), for the purpose of identifying the federal interest in the Pearl River Watershed, Mississippi. An economic evaluation of the improvements being considered is presented in this appendix. It was prepared in accordance with Engineering Regulation (ER) 1105-2-100 and ER 1105-2-101, Planning Guidance. The National Economic Development Procedures Manual for Flood Risk Management and Coastal Storm Risk Management, prepared by the Water Resources Support Center, Institute of Water Resourses, was also used as a reference, along with User's Manual for the Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA).

This evaluation consists of a description of the methodology used to determine economic damages and benefits under existing and with project conditions, project costs, and benefit-to-cost analysis. October 2017 price levels were used in the evaluation. The proposed improvements were evaluated by comparing estimated annual project benefits that would accrue to the Study Area with estimated annual project costs. Benefits and costs were converted to average annual equivalent values utilizing a federal discount rate of 2 ¾ percent and a project life of 50 years. The estimated based year (the year in which significant project benefits will accrue as a result of project construction) is the year 2020.

National Economic Development Benefits Considered - The National Economic Development (NED) Procedures Manual for Urban Flood Damage recognizes four (4) primary categories of benefits for urban flood control plans: inundation reduction, intensification, location, and employment benefits. The majority of the benefits attributable to a project alternative generally result from the reduction of actual or potential damages caused by inundation. Inundation reduction includes the reduction of physical damages to structures, contents, and vehicles. It also includes reduced damages to roads and bridges and other infrastructure. It also includes the reduction of emergency costs, evacuation and subsistence costs, reoccupation costs, commercial clean up, and Federal Insurance Administration costs saved. Other categories such as intensification, reduced fill requirements, and location are discussed in this appendix.

SECTION II-DESCRIPTION OF STUDY AREA

Geographical Location - The Pearl River Basin is located in the south-central portion of Mississippi and in a small part of southeastern Louisiana. The river drains an area of 8,760 square miles consisting of all, or parts, of 23 counties in Mississippi and parts of 3 Louisiana parishes. The primary Study Area, shown in Figure B-1, comprises the Pearl River Basin between River Mile (RM) 280.0 (south of Richland MS) and RM 301.77, (at the dam of Ross Barnett Reservoir). Municipalities within the Study Area include, Flowood, Jackson, Pearl, and Richland. The Study Area includes parts of Hinds, and Rankin Counties. Major tributaries of the Pearl River within the Study Area include Caney, Eubanks, Hanging Moss, Hog, Lynch, Prairie Branch, Purple, Richland, and Town Creeks. The Study Area is primarily affected by headwater flooding caused

by the Pearl River. Headwater flooding is caused by unusually heavy and intense rainfall over the upper Pearl River Basin.

Problem - Flood damage to nearly 3,000 commercial and residential structures within fifty square miles of Rankin and Hinds Counties is caused due to headwater flooding of the Pearl River causing disruption to business and industry throughout the Jackson Metropolitan area. There have been numerous flood events that have affected the Study Area. The most notable of these events are the Easter Flood of 1979, and the May Flood of 1983. The 1979 event flooded homes and businesses causing approximately $223 million dollars (1979 dollars) in damage.

There are over 13,000 businesses employing over 180,000 people located in the Rankin and Hinds portions of the Jackson Metropolitan area. The City of Jackson is the State Capital and is located within the Central Business District (CBD) along with other state and federal offices. Major transportation routes including interstates, state highways, local streets, and major rail carriers are affected causing detours throughout the area. Flooding causes infrastructure damage including damage to the 46 Million Gallons per day (MGD) wastewater treatment plant which serves this area.

The population for the Jackson Metropolitan area has increased from 497,168 to 567,122 from 2005 to the 2010 census and continues to grow. The estimated 2017 resident population of the Jackson metropolitan area was 578,715. In addition, traffic counts on major highways and interstates has increased 100 % over the last 25 years (traffic data provided by MDOT).

Approximately 13.5 miles of levees now protect portions of the Jackson Metropolitan area. Much of Rankin and Hinds Counties is still unprotected from Pearl River flooding including major transportation routes. The existing protection provides flood damage reduction to a small portion of the City of Jackson, the City of Pearl, and a small portion of Richland. Although some protection exists, the Jackson levee was compromised during the 1979 flood and inundated the Jackson Fairgrounds.

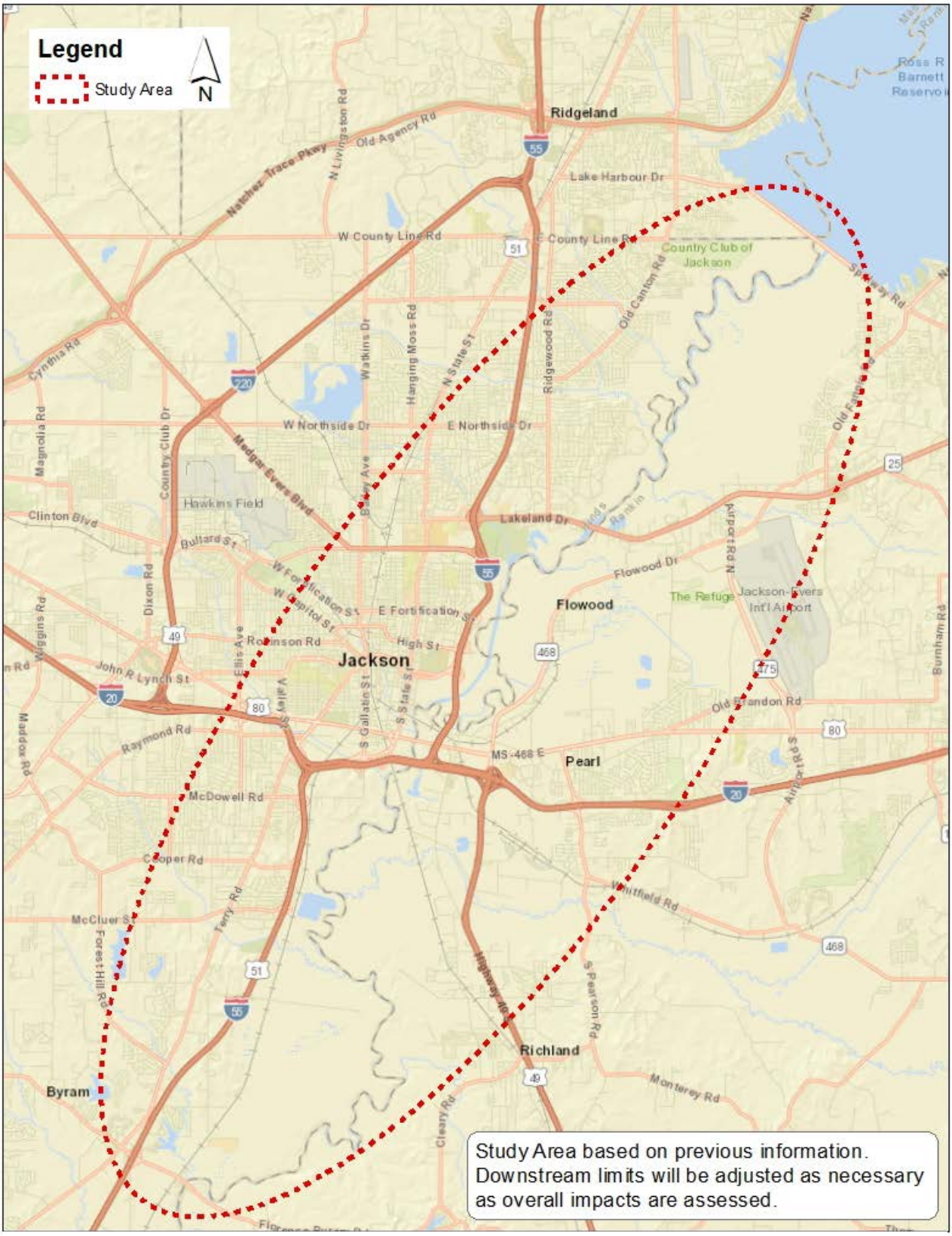

Figure B-1. Project Study Area

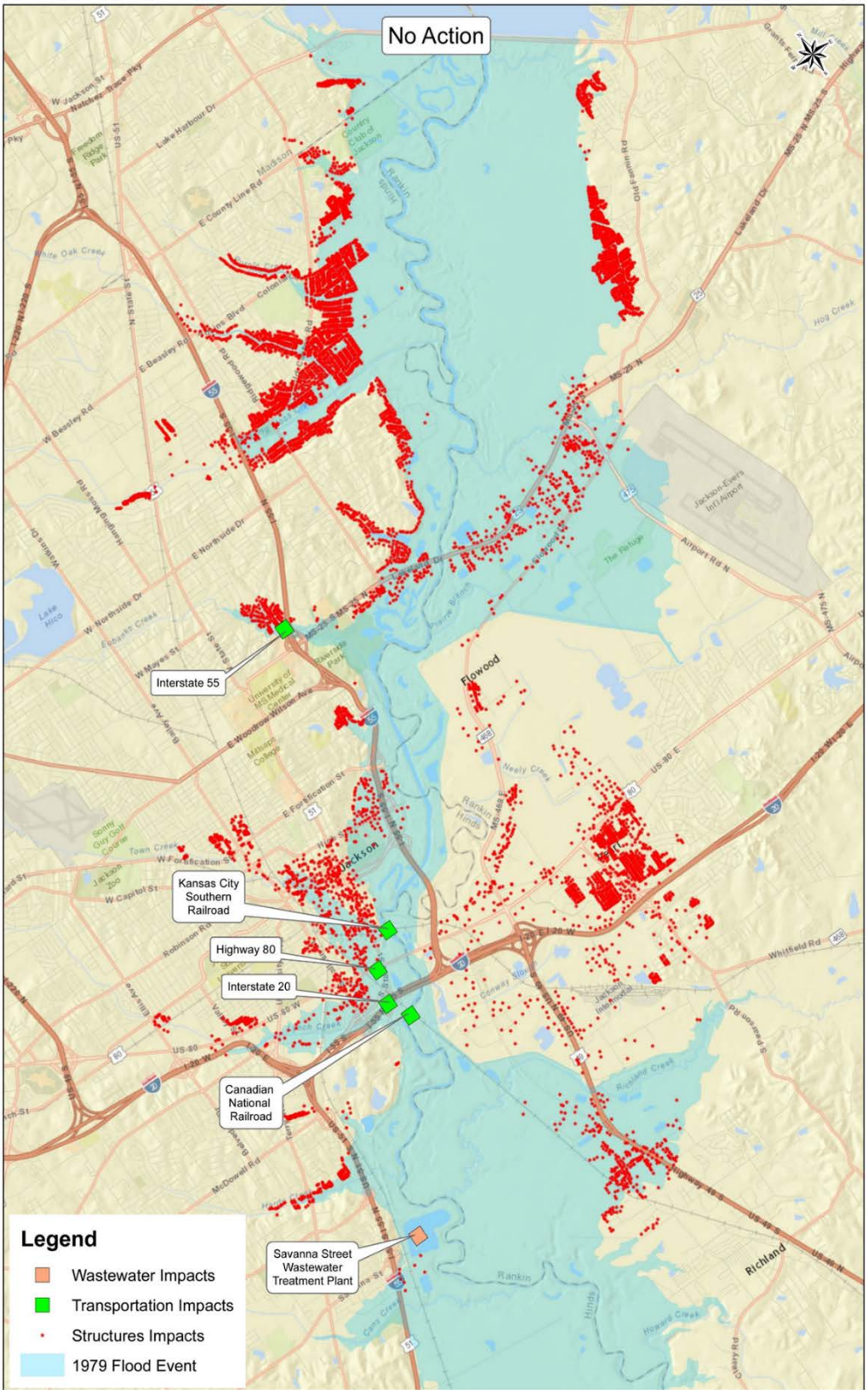

Figure B-2. Existing Conditions during the Annual 1% & 0.2% Chance Exceedance Flood Event.

SECTION III – ECONOMIC ANALYSIS

REACH DELINEATION

In order to adequately analyze the two existing levees and the levee alternative, it was necessary to break the Study Area into 14 separate reaches. The reach name, left or right descending bank, beginning river mile, ending river mile, and river mile of index location are presented in Table B-1 and Figure B-3.

HEC-FDA MODEL

Model Overview - The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.4 Corps-certified model was used to calculate the damages and benefits for the Alternative Project evaluation. The economic and engineering inputs necessary for the model to calculate damages for existing conditions, Alternative B, and the Alternative C are described in following paragraphs. The model would include structure inventory, contents-to-structure value ratios, vehicles, first floor elevations, and depth-damage relationships, ground elevations, without-project, and with-project stage probability relationships.

Table B-1

DESCRIPTION OF STUDY REACHES

Reach	Beginning Station	Ending Station	Index Location
Richland Levee (Left)	279.00	283.00	280.00
Existing East Levee (Left)	284.00	291.00	287.00
Flowood (Left)	292.00	297.00	296.00
Old Fannin (Left)	298.00	302.00	301.00
Treatment Plant Levee (Right)	279.00	282.00	281.00
South Jackson Levee (Right)	283.00	285.00	284.00
I-20 Levee (Right)	286.00	287.00	287.00
Existing West Levee (Right)	288.00	289.00	288.00
Belhaven Levee (Right)	290.00	290.00	290.00
LeFleur Levee (Right)	291.00	291.00	291.00
Lakeland West Levee (Right)	292.00	292.00	292.00
NE Jackson 1 (Right)	293.00	296.00	296.00
NE Jackson 2 (Right)	297.00	299.00	297.00
Ridgeland (Right)	300.00	302.00	301.00

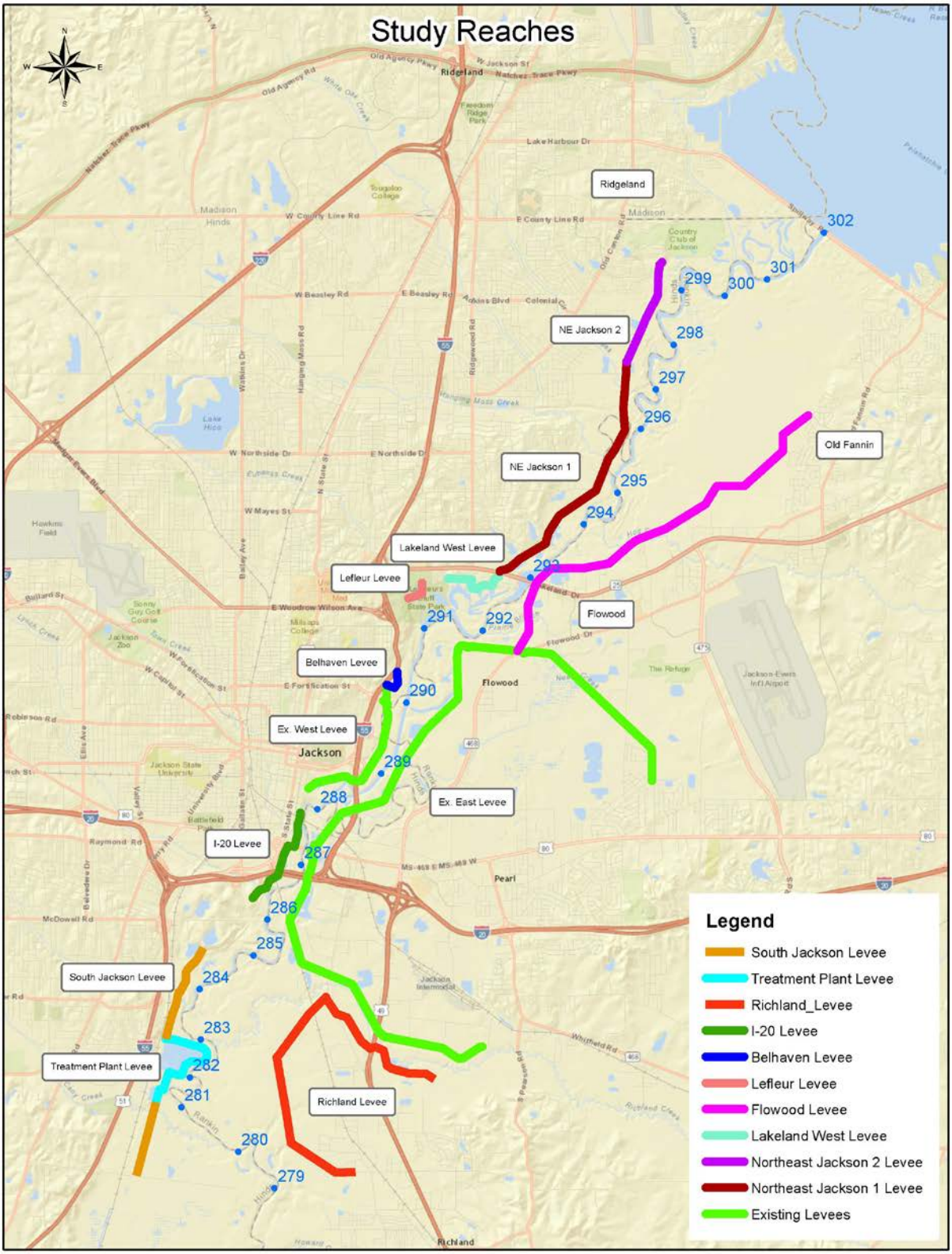

Figure B-3. Study Reaches

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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.

ECONOMIC INPUTS TO THE HEC-FDA MODEL

Structure Inventory - A detailed survey of approximately 8,000 structures to establish finished-floor elevations (FFE) using data acquired by mobile light-detection and ranging (LiDAR) system was completed in 2014 to develop a residential and non-residential structure inventory for the economic analysis. The survey encompassed approximately 700 miles of collection in the Jackson, Mississippi, metropolitan area including residential subdivisions, commercial developments, hospital/medical centers and a significant portion of downtown Jackson. The footprint of the project was a 200' buffer of the flooding limits of the infamous "Easter Flood" of 1979. The inventoried structures were classified as one of 14 structure types: residential one-story with slab or pier foundation, residential two-story with slab or pier foundation, mobile home, eating and recreation, grocery and gas station, multi-family residence, professional building, public and semi-public building, repairs and home use establishment, retail and personal services building, warehouse, or contractor services building.

Residential and Non-Residential Content-to-Structure Value Ratios - Content-to- structure value ratios (CSVRs) were developed based on the on-site interviews conducted as part of the New Orleans District's Morganza to the Gulf evaluations. These interviews were conducted with the owners of a sample of structures from each of the three residential content categories and each of the eight non-residential content categories. Thus, a total of 30 residential structures and 80 non-residential structures were used to determine the CSVRs for each of the residential and non-residential categories. The socio-economic characteristics of the areas were assumed to be similar enough to make the CSVR's from this study applicable to the Pearl River Study Area.

Vehicle Inventory - Based on 2010 Census information for the project area, it was determined that there are an average of two 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 privately owned vehicles remain parked at the residences and are subject to flood damages. According to the Vehicle Value Index, which is based on over 4 million annual automobile transactions adjusted to reflect retail replacement value, each vehicle was assigned an average value of $18,600 at the FY 2017 price level. Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $11,160 ($18,600 x 2.0 x 0.3) was assigned to each individual residential automobile structure value 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 have not been included in the evaluation.

First Floor Elevations and Structure Value - The project required collection of survey-grade data with a level of vertical accuracy consistent with 0.2' (~6 cm) National Standard for Spatial Data Accuracy (NSSDA) accuracy at 95% confidence interval to provide defensible results to the US Army Corps of Engineers. Utilizing the GPS-derived ground control points, the mobile LiDAR collections were fully constrained to meet survey requirements. Following rigorous testing, the final presented accuracy was 0.14' (~4 cm) NSSDA vertical accuracy. Using ArcGIS environment, the FFE's extracted were combined with tax roll information from the three counties to link the current appraised value of improvements on the property to the other data base features. Additionally, terrestrial photographs captured during LiDAR collection were hyperlinked to the appropriate structure for "desktop review" by others. All parcels, FFE's, roadway centerline profiles and other gathered GIS data was integrated into a single Personal Geodatabase.

Depth-Damage Relationships - Site-specific freshwater, long duration (approximately one week) depth-damage relationships, developed by a panel of building and construction experts for a separate study in the Morganza to the Gulf area of the New Orleans District were used in the economic analysis. These depth-damage relationships were used due to similar construction and demographic characteristics of the Project area as compared to the Morganza to the Gulf study area. These curves indicate the percentage of the total structure value that would be damaged at various depths of flooding. Damage percentages were determined for each one-half foot increment from one-half foot below first floor elevation to two feet above first floor, and for each one-foot increment from 2 feet to 15 feet above first floor elevation. The panel of experts developed depth-damage relationships for five residential structure categories and for three commercial structure categories. Depth-damage relationships were also developed for three residential content categories and eight commercial content categories.

The depth-damage relationships for vehicles for the Morganza to the Gulf study were developed based on interviews with the owners of automobile dealerships that had experienced flood damages and were used to calculate flood damages to vehicles at the various levels of flooding.

More specific data regarding the depth-damage relationships can be found in the final report in support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf Feasibility Studies (July 1997).

UNCERTAINTY SURROUNDING THE ECONOMIC INPUTS

The uncertainty surrounding the four key economic variables was quantified and entered into the HEC-FDA model. These economic variables included structure values, contents-to-structure value ratios, first floor elevations, and depth-damage relationships. The HEC-FDA model used the uncertainty surrounding these variables to estimate the uncertainty surrounding the stage-damage relationships developed for each study area reach.

Structure and Vehicle Values - The same information developed for the Morganza to the Gulf Study was used in measuring the uncertainty in these inputs. In that study, in order to quantify the uncertainty surrounding the values for the residential and non-residential structures, several survey teams valued an identical set of structures from various evaluation areas in the Gulf Coast region. The structure values calculated by each of the teams during windshield surveys were used to

develop a mean value and a standard deviation for each structure in the sample. The standard deviation was then expressed as a percentage of the mean value for the structure. The average standard deviation as a percentage of the mean for the sampled structures was then used to represent the uncertainty surrounding the structure value for all the inventoried residential and non-residential structures. The average standard deviation, which was expressed as a percentage of the mean structure value, totaled 11.4 percent for residential structures and 11.6 percent for non-residential structures.

The uncertainty surrounding the values assigned to the vehicles in the inventory was determined using a triangular probability distribution function. The Manheim vehicle value, adjusted for number of vehicles per household and for the evacuation of vehicles prior to a storm event, was used as the most likely value. The average value of a new vehicle before taxes, license, and shipping charges was used as the maximum value, while the average 10-year depreciation value of a vehicle was used as the minimum value.

Content-to-Structure Value Ratios - A CSVR was computed for each residential and non-residential structure in the sample based on the total depreciated content value developed from these interviews. The mean and standard deviation values for each residential and non-residential category were entered into the HEC-FDA model. The model used a normal probability density function to describe the uncertainty surrounding the CSVR for each content category. The expected values and standard deviations for each of the three residential categories and the eight non-residential categories are presented in Table B-2.

Table B-2
CONTENT-TO-STRUCTURE VALUE RATIOS (CSVRS) AND STANDARD DEVIATIONS (SDS) BY STRUCTURE CATEGORY

Structure Category		CSVR	SD
Residential	One-story	71%	21%
	Two-story	43%	21%
	Mobile home	139%	24%
Non-Residential	Eating and Recreation	83%	48%
	Groceries and Gas Stations	397%	61%
	Professional Buildings	44%	14%
	Public and Semi-Public Buildings	79%	71%
	Multi-Family Buildings	27%	14%
	Repair and Home Use	74%	102%
	Retail and Personal Services	367%	93%
	Warehouses and Contractor Services	256%	98%

First Floor Elevations - The topographical data used to estimate the first floor elevations assigned to the structure inventory was mobile LiDAR. A mean of zero and a standard deviation of 0.6 feet were used to estimate the uncertainty surrounding the first floor elevation of each of the inventoried structures

Depth-Damage Relationships - A triangular probability density function was used to determine the uncertainty surrounding the damage percentage associated with each depth of flooding. A minimum, maximum and most likely damage estimate was provided by a panel of experts for each depth of flooding. The specific range of values regarding probability distributions for the depth-damage curves can be found in the final report dated July 1997 entitled *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs)in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf Feasibility Studies*.

ENGINEERING INPUTS TO THE HEC-FDA MODEL

First Floor Elevations - Topographical data obtained from the LiDAR point cloud with NAVD88 elevations were the basis for first floor elevations (FFE). LiDAR technicians performed FFE extraction within a MicroStation environment using custom developed tools to accurately extract the FFE based upon a set of criteria. These criteria were developed to assign a quality to the FFE extraction (Best, Good, Fair, Poor) depending upon the identification of a clear and precise point of entry on a structure. During extraction, notes were added to delineate the location used to extract the FFE: front door threshold, alternative entry door, indication on structure exterior, or other remark.

Stage-Probability Relationships - Stage-probability relationships were provided for the existing without-project and with-project conditions. Water surface profiles include the eight annual chance exceedance (ACE) events: 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year), 0.5% (200-year), and 0.2% (500-year). The without-project water surface profiles were based on the peak discharges utilized within the FEMA Flood Insurance Study Effective Hydraulic Model, and subsequently calibrated to the United States Army Corps of Engineers 2007 Feasibility Study. More detailed information about the water surface elevation calibration can be found in Section 3.4 of Appendix C: Engineering, Hydrologic and Hydraulic Analysis. The with-project water surface profiles were based on the same hydrologic conditions, with hydraulic parameters modified to model each project condition studied.

Uncertainty Surrounding the Engineering Inputs - The uncertainty surrounding two key engineering parameters was quantified and entered into the HEC-FDA model. These engineering variables included ground elevations and the stage-probability curves. The HEC-FDA model used the uncertainty surrounding these variables to estimate the uncertainty surrounding the elevation of the storm surges for each study area reach.

Ground Elevations - A combination of the uncertainty surrounding the ground elevations and the foundation height (0.6 feet) of a residential and non-residential structure was used.

Stage-Probability Relationships - A 50-year equivalent record length was used to quantify the uncertainty surrounding the stage-probability relationships for each study area reach. Based on this equivalent record length, the HEC-FDA model calculated the confidence limits surrounding the stage-probability functions.

NATIONAL ECONOMIC DEVELOPMENT (NED) DAMAGES AND BENEFITS FROM FDA

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 14 study area reaches for which a structure inventory had been conducted. 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.

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 existing 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 Project 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.

Stage-Probability Relationships with Uncertainty - The HEC-FDA model used an equivalent record length (50 years) for each study area reach to generate a stage-probability relationship with uncertainty for the without-project and with-project conditions through the use of graphical analysis. The model used the 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.

Without-Project 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 and all alternative conditions, the expected annual damages (EAD) were totaled for each study reach to obtain the total EAD under without and all alternative conditions. These damages are presented by category for without project, Alternative B, and Alternative C in Tables B-4 through B-6.

Table B-3
ANTICIPATED ANNUAL DAMAGE REDUCTION

	Total Without Project	Total With Project	Damages Reduced
Existing	$ 17,943.79	$ 17,943.79	$ -
Alternative B	$ 17,943.79	$ 7,050.84	$ 10,892.95
Alternative C	$ 17,943.79	$ 4,276.84	$ 13,666.95
(October 2017 Price Levels)			

Table B-4
ANTICIPATED ANNUAL DAMAGES, EXISTING CONDITIONS

Reach	Automobiles	Commercial	Mobile Homes	Residential	Totals
Richland Levee	$13.37	$415.30	$5.93	$108.98	$543.58
Ex East Levee	$27.90	$2,464.58	$1.18	$122.08	$2,615.74
Flowood	$45.65	$3,080.27	$0.74	$447.03	$3,573.69
Old Fannin	$7.58	$ -	$ -	$112.65	$120.23
Treatment Plant Levee	$0.30	$68.45	$ -	$ -	$68.75
South Jackson Levee	$2.79	$3.78	$ -	$7.45	$14.02
I-20 Levee	$10.36	$1,919.24	$1.51	$15.09	$1,946.20
Ex West Levee	$1.05	$3,164.20	$ -	$ -	$3,165.25
Belhaven Levee	$2.01	$1.73	$ -	$13.53	$17.27
LeFleur Levee	$7.75	$6.62	$ -	$97.10	$111.47
Lakeland West Levee	$2.34	$231.59	$7.04	$8.48	$249.45
NE Jackson 1	$169.65	$734.93	$0.10	$2,423.43	$3,328.11
NE Jackson 2	$150.70	$418.15	$ -	$1,534.40	$2,103.25
Ridgeland	$0.86	$74.18	$1.56	$10.12	$86.72
Total Damages	**$442.31**	**$12,583.02**	**$18.06**	**$4,900.34**	**$17,943.73**
(October 2017 Price Levels)					

Alternative B

Approximately 13.5 miles of levees currently protect portions of the Jackson metropolitan area; however, much of the Jackson metropolitan area is unprotected. This alternative consists of building new levees and expanding the existing levees and pumps (Figure B-4). In some areas, floodwalls are needed due to right-of-way restrictions. Significant conveyance improvements would be constructed from RM 292 to RM 302 on the west bank to reduce flooding induced by new levees and reduce any impacts to the outlet structure of the Ross Barnett Reservoir.

Additional levees would improve flood risk reduction in unprotected areas and in already protected areas. Although risk reduction is improved, there is still risk of overtopping or failure in levee sections during extreme events. This alternative adds a significant number of structures and pumps that will require maintenance in addition to requiring operators during flood events with possible interior flooding. This plan would require significant clearing and maintenance of areas from RM 294 to RM 302 to insure no increase of flood elevations upstream near the Ross Barnett Reservoir. This conveyance improvement would be needed within a reach of the Pearl River that has not been significantly alternated in the past. Similar levee plans have been recommended in the past but have failed to be implemented with lack of community and leadership support.

Table B-5
ANTICIPATED ANNUAL DAMAGES, ALTERNATIVE B

Reach	Automobiles	Commercial	Mobile Homes	Residential	Totals
Richland Levee	$13.37	$415.36	$5.93	$108.98	$543.64
Ex East Levee	$5.20	$456.49	$0.23	$23.25	$485.17
Flowood	$24.92	$1,488.15	$0.24	$237.89	$1,751.20
Old Fannin	$8.51	$ -	$ -	$124.70	$133.21
Treatment Plant Levee	$0.06	$2.81	$ -	$ -	$2.87
South Jackson Levee	$2.75	$3.73	$ -	$7.37	$13.85
I-20 Levee	$1.57	$909.42	$0.22	$2.38	$913.59
Ex West Levee	$0.38	$1,216.29	$ -	$ -	$1,216.67
Belhaven Levee	$1.43	$1.22	$ -	$8.45	$11.10
LeFleur Levee	$4.39	$2.01	$ -	$44.55	$50.95
Lakeland West Levee	$0.47	$93.39	$0.43	$3.01	$97.30
NE Jackson 1	$73.99	$407.71	$0.11	$880.73	$1,362.54
NE Jackson 2	$29.77	$172.95	$ -	$175.46	$378.18
Ridgeland	$0.87	$76.68	$1.49	$11.52	$90.56
Total Damages	**$167.68**	**$5,246.21**	**$8.65**	**$1,628.29**	**$7,050.83**
(October 2017 Price Levels)					

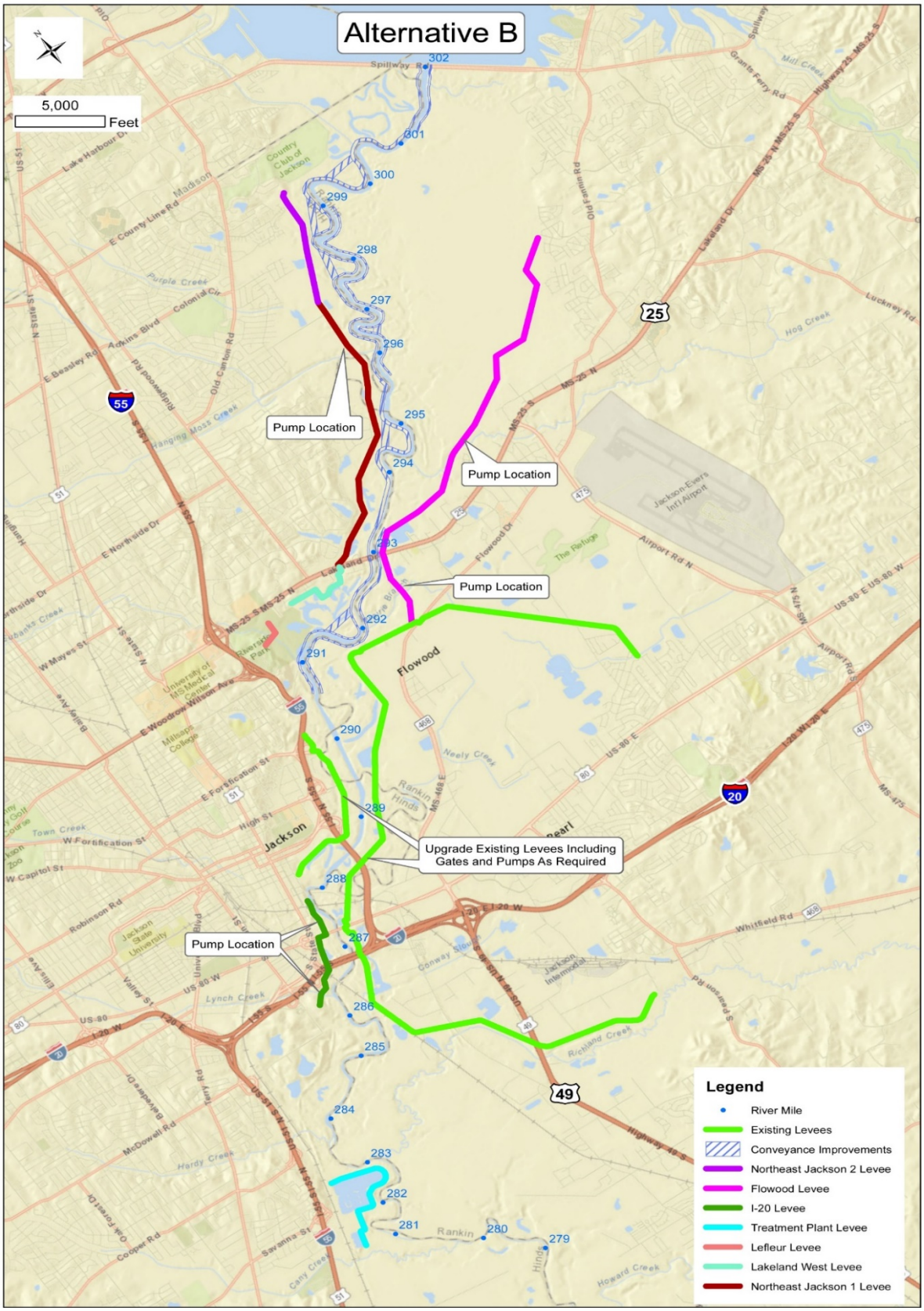

Figure B-4. Alternative B Location Map

Alternative C

This alternative, shown in Figure B-5, consists of significant channel modification from RM 284 to RM 293.5. Levees exist within much of this reach and would be relocated in some areas to reduce flood levels. This alternative would include excavating the overbanks of the channel. Excavation would be placed adjacent to existing levees, or adjacent to relocated levees. If the excavated fill is of suitable material for levee construction, the large amount of excavation needed would provide substantial land mass or expanded levee widths, providing additional protection and additional risk reduction. The weir currently located at RM 290.7 would be removed, and new weir with a gate for low flows would be constructed near RM 284.3. The new weir would be modified to a higher elevation and expanded width, providing additional conveyance and reducing channel maintenance for the expanded channel improvement. Additional pumps would not be needed to provide protection behind levees except where pumps already exist. A small levee segment would be constructed on the west bank from approximately RM 297 to RM 298 to mitigate flood risk in this area.

Table B-6
ANTICIPATED ANNUAL DAMAGES, ALTERNATIVE C

Reach	Automobiles	Commercial	Mobile Homes	Residential	Totals
Richland Levee	$13.37	$415.30	$5.93	$108.98	$543.58
Ex East Levee	$5.96	$528.01	$0.25	$26.00	$560.22
Flowood	$2.75	$120.41	$0.07	$38.29	$161.52
Old Fannin	$0.73	$ -	$ -	$17.67	$18.40
Treatment Plant Levee	$0.30	$68.45	$ -	$ -	$68.75
South Jackson Levee	$2.79	$3.77	$ -	$7.45	$14.01
I-20 Levee	$5.96	$791.74	$0.91	$8.07	$806.68
Ex West Levee	$0.26	$777.64	$ -	$ -	$777.90
Belhaven Levee	$0.23	$0.20	$ -	$1.83	$2.26
LeFleur Levee	$0.95	$1.22	$ -	$14.06	$16.23
Lakeland West Levee	$0.38	$31.56	$1.31	$1.24	$34.49
NE Jackson 1	$24.80	$66.24		$420.20	$511.24
NE Jackson 2	$49.80	$99.51	$ -	$581.11	$730.42
Ridgeland	$0.39	$28.95	$0.86	$0.96	$31.16
Total Damages	**$108.67**	**$2,933.00**	**$9.33**	**$1,225.86**	**$4,276.86**
(October 2017 Price Levels)					

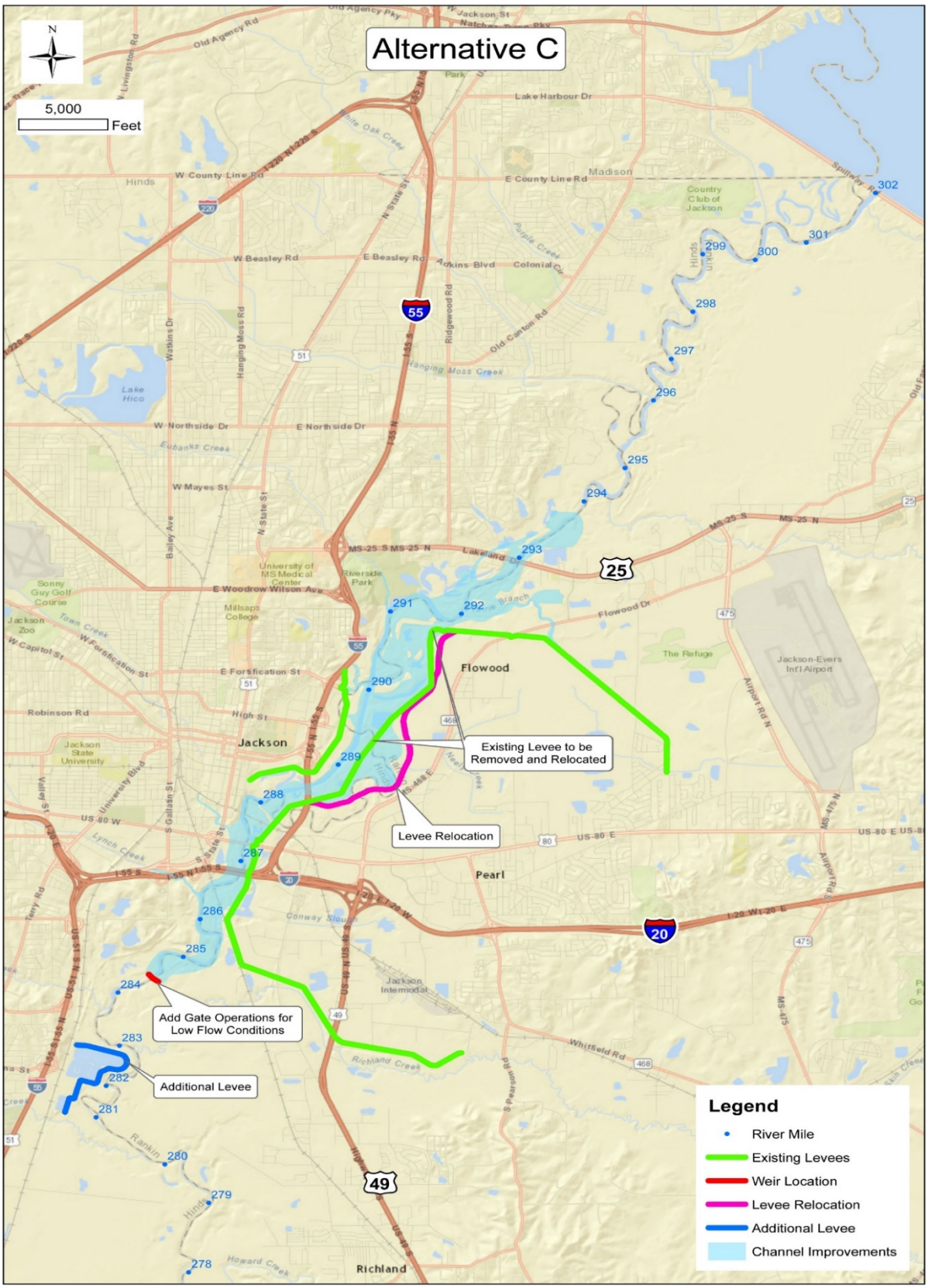

Figure B-5. Alternative C Location Map

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EMERGENCY AND OTHER POST-FLOOD COST CATEGORIES

A flooded community typically incurs a variety of flood-related costs not associated with structural damages. The emergency costs incurred by the Federal, state, and local governments immediately prior to, during and after the storm event are designed to eliminate or reduce the immediate threat to life, public health, or safety.

The emergency costs associated with inundated residential properties include evacuation and subsistence, clean up and reoccupation costs, debris removal, and landscaping. The emergency costs associated with inundated non-residential properties include clean up and restoration costs, recovery of business records, and landscaping. These costs are incurred either by the federal, state, or local governments, the occupants of inundated residential properties, or the owners of inundated non-residential properties. The number of properties affected by structure type for various frequency floods is presented for existing, with Alternative B, and with Alternative C in Table B-7 through Table B-8.

Table B-7
RESIDENTIAL STRUCTURES FLOODED BY RECURRENCE INTERVAL

	Annual Percent Chance Exceedance Flood Event							
	50%	20%	10%	4%	2%	1%	0.5%	0.2%
Existing	86	220	325	960	1,459	2,074	2,889	3,511
Alternative B	32	81	120	355	540	767	1,069	1,299
Alternative C	21	53	78	230	350	498	693	843

Table B-9
MOBILE HOMES FLOODED BY RECURRENCE INTERVAL

	Annual Percent Chance Exceedance Flood Event							
	50%	20%	10%	4%	2%	1%	0.5%	0.2%
Existing	0	0	1	6	11	18	26	29
Alternative B	0	0	0	2	4	7	10	11
Alternative C	0	0	0	1	3	4	6	7

Table B-8
COMMERCIAL ESTABLISHMENTS FLOODED BY RECURRENCE INTERVAL

	Annual Percent Chance Exceedance Flood Event							
	50%	20%	10%	4%	2%	1%	0.5%	0.2%
Existing	63	138	219	404	682	1,069	1,365	1,604
Alternative B	23	51	81	149	252	396	505	593
Alternative C	15	33	53	97	164	257	328	385

Reduction of State and Local Government Emergency Costs - The emergency costs incurred by state and local governments include the increased police and fire personnel costs; costs of emergency measures such as evacuation of hospitals; flood fighting costs such as pumps, sandbags, and other levee enhancement measures and flood fight personnel; and restoration of private, commercial, and public properties. The benefits from reduction of government emergency costs are $63,241 for the Levee Alternative and $76,291 for the Alternative C. This is a result of flood fighting, evacuations, pumping, and emergency personnel cost being greatly reduced due to the reduction in flood risk.

Evacuation and Reoccupation Costs - Evacuation is one of the best ways to avoid human losses during an emergency event. Evacuation and its associated costs can take place before, during, or after a flood event and include transportation out of the floodplain. Even though evacuation costs are typically incurred in a flood event, the cost is usually relatively small compared to infrastructure damages and other emergency costs (Whitehead, 2005). Residents affected by a large flood either self-evacuate or are assisted in evacuation by one or more of a number of public agencies.

Reoccupation is when members of an affected population returns to their residences, and includes travel to settle insurance claims and repair residences (e.g., use of rental trucks and other vehicles). Inhabitants displaced during a large flood event are expected to repopulate the area they left. Dislocated civilians may make multiple visits to their properties for home repair and insurance issues before they resettle. Evacuated populations would use their own means to transport their belongings from storage facilities and temporary housing.

A study conducted by MWH Americas in 2012 for the New Orleans District developed emergency cost information for freshwater and saltwater flooding for selected parishes in south Louisiana. Since the construction type, humidity, etc. in the Jackson area are similar to those in the New Orleans study area referenced above, and floods of four (4) or more feet lasting four (4) or more days are extremely damaging, the data was considered valid as a basis for estimates of the evacuation and reoccupation costs and the other emergency costs described in the following paragraphs. Adjustments made in some calculations are described. The estimate for evacuation and reoccupation of $5,489 per residential structure was used in this analysis. The evacuation and reoccupation benefits are $610,448 for the Alternative B and $734,869 for the Alternative C (Table B-10).

Subsistence Costs - Data developed by the New Orleans District, U.S. Army Corps of Engineers based on the experiences of residents affected by previous flood events were used to estimate the evacuation and subsistence costs incurred by property owners and the Federal government immediately following a storm event. Residents of structures inundated between one and three feet above first floor elevation were evacuated from their homes for approximately three months following the flood event. A 3-5 month time frame is consistent with the experience of many Study Area residents during the 1979 and 1983 flood events.

However, since no data is available on housing arrangements for these evacuated residents, a 45-day timeframe was used in the following analysis. It is assumed that during this period, the residents of evacuated households lived in hotels in the Jackson area. Based on the fiscal year

2014 government per diem for lodging in Jackson the average hotel rate is $83.00 per day, or $3,735 for each inundated household for the 45-day evacuation period.

The average daily subsistence cost per evacuated household was also based on the average government per diem in the cities north and west of the planning area. The fiscal year 2007 average cost for meals prepared outside of the home was $46.00 per person, per day. Since the average household in the Study Area as reported by the U.S. Census in the year 2000 contains 2.6 people, each evacuated household spent an average of $119.60 per day for meals. According to the U.S. Department of Agriculture, each household would have spent $8.54 per person, or $22.20 per household, on meals prepared in the home. Thus, the net additional food expenditure per household totaled approximately $97.40. The total subsistence cost for the 45-day evacuation period was approximately $4,383 per inundated household. The total cost for lodging and subsistence was $8,118 per inundated household. The benefits for lodging and subsistence are $902,826 for the Alternative B and $1,802,975 for the Alternative C (Table B-10).

Table B-10

SUMMARY OF EVACUATION AND REOCCUPATION BENEFITS

Damages	Without Project (Existing Conditions)	With Project Alternative B (Levees)	Damage Reduction Alternative B (Benefits)	With Project Alternative C (Ch. Improvements)	Damage Reduction Alternative C (Benefits)
Evacuation and Reoccupation	$ 967,953	$ 357,505	$ 610,448	$ 233,084	$ 734,869
Lodging and Subsistence	$ 1,431,562	$ 528,735	$ 902,827	$ 344,722	$ 1,086,840
Residential Cleanup & Gutting	$ 2,374,121	$ 877,155	$ 1,496,966	$ 571,146	$ 1,802,975
Mobile Home Cleanup & Gutting	$ 3,838	$ 1,245	$ 2,593	$ 1,245	$ 2,593
Opportunity of Time Costs	$ 331,527	$ 122,447	$ 209,080	$ 79,832	$ 251,695
Debris Removal	$ 105,806	$ 39,079	$ 66,727	$ 25,478	$ 80,328
Non-residential Cleanup and Restoration	$ 3,372,120	$ 1,244,809	$ 2,127,311	$ 809,468	$ 2,562,652
Total Damages	**$8,586,927**	**$3,170,975**		**$2,064,975**	
Total Flood Damage Reduction			**$5,415,952**		**$6,521,952**

(October 2017 Price Levels)

Residential Cleanup Costs - Data developed by the New Orleans District were used to estimate the residential cleanup costs incurred by residential households immediately following a storm event. Included in this category are the costs of interior clean up and dehumidifying the property, and the opportunity cost for the time spent by the resident meeting with the adjustors and contractors and inspecting the repairs. While the rebuilding process will likely last longer than one year, the cleanup and reoccupation costs are based only on the actual hours estimated to be spent by residents on these activities. Since all residents affected by a flood were assumed to stay in the Jackson area, no travel costs were included in this estimate.

The estimated costs incurred by residents to clean up and gut their inundated properties were based on interviews with contractors and repair personnel in the planning area. The tasks involved in this cost category include obtaining permits, employing dehumidifiers, gutting the interior of the structure, sanitizing the salvageable items, and removing mold. A total of $13,500 was applied to each residential structure inundated at least one foot above first floor elevation. For mobile homes inundated at least one foot above first floor elevation, the cleanup and gutting costs totaled $5,000. The cleanup and gutting benefits are $1,496,966 for residences and $2,593 for mobile

homes for the Alternative B and $1,802,975 for residences and $2,593 for mobile homes for the Alternative C (Table B-10).

During their period of evacuation, homeowners will devote many hours applying for governmental assistance, filing insurance claims, scheduling appointments, meeting with insurance adjustors and contractors, and supervising repair work. The opportunity cost associated with the time spent completing these tasks can be measured by the average hourly wage for residents in the Study Area. Based on the New Orleans District data, residents of inundated structures spent an average of 100 hours completing these tasks. The average nonagricultural wage rate in the Study Area was estimated to be $18.80 per hour. Thus, the total opportunity cost for each resident whose property was inundated was determined to be $1,880. The benefits for opportunity of time cost reduction are $209,080 for the Alternative B and $251,695 for the Alternative C (Table B-10).

Debris Removal - The costs associated with the removal of debris from the curbside in front of inundated structures and the transporting of this debris to waste disposal sites were also based on data from the New Orleans District. It was estimated that each inundated residential structure created approximately 30 cubic yards of debris. The cost to remove this debris ranged from $15 to $25 per cubic yard with an average of $20 per cubic yard. Thus, the average cost of debris removal was $600 per inundated residential structure. This amount was applied to all residential structures that incurred flooding. Debris removal benefits are $66,728 for the Alternative B and $80,328 for the Alternative C (Table B-10).

Non-Residential Clean Up and Restoration Costs - Based on the information developed by MWH for the New Orleans District in the report referenced in evacuation and reoccupation costs, the cleanup and restoration costs for non-residential costs were $34,818 per structure. Clean up and restoration costs include the cost of labor and materials to clean the interior and exterior of the building and to remove and dispose of debris. Based on the characteristics and depth of flooding occurring on non-residential property in the Study Area, this amount was considered to be reasonable. The non-residential cleanup and restoration benefits are $2,127,311 for the Alternative B and $2,562,652 for the Alternative C (Table B-10).

FIA Operating Cost - When a flood damage reduction project removes residential structures from the annual 1% chance exceedance flood event floodplain, the owners are no longer required, by law, to have flood insurance. Since there is still some risk of flooding some owners may determine that it is in their best interest to maintain the insurance. For the purpose of this study, it was assumed that 90 percent of residences within the annual 1% chance exceedance flood event floodplain currently have flood insurance and that 75 percent of the residential structures that are no longer in the annual 1% chance exceedance flood event floodplain under with project conditions will no longer maintain flood insurance. This reduction in the number of policies will reduce the cost of operating the flood insurance program. Since the Corps of Engineers has not published FIA Operating Costs since FY 2006, the costs for that year of $192 per policy was used to calculate this benefit category, When the 2006 value is updated to 2013 price levels using the CPI, the cost per operating cost per policy is $223. The benefits from reduced FIA operating costs are presented in Table B-11.

Table B-11
REDUCED FIA OPERATING COSTS

	Residences Flooded by the Annual 1% Chance Exceedance Flood Event	Percent Assumed to Have Insurance	Number of Policies	Operating Cost per Policy	Percent Assumed to Drop Policy	Number of Remaining Policies	Operating Cost of Remaining Policies
Existing	2,092	90%	1,883	$223	0%	1,883	$419,864
Alternative B	1,079	90%	971	$223	75%	243	$54,139
Alternative C	699	90%	629	$223	75%	157	$35,072
(October 2017 Price Levels)							

INFRASTRUCTURE DAMAGES

Floods in the Jackson Metropolitan area cause extensive damage to the infrastructure. This includes physical damages to roads, gas and electric power, telephone, water supplies and conveyance systems, storm water and sewer systems, utilities, sewage treatment plant, public health and safety, education, flood control structures and other critical infrastructure.

Although it is difficult to associate a cost with disrupted electrical and telephone services, it should be noted that three critical substations are located within the existing floodplain and another located within the protected area behind the existing west levee. In addition, critical telecommunications equipment is located in the basement of the providers building in the downtown Jackson area.

Road and Bridge Damage - The overall analysis of transportation facility losses involved determining the number of units adversely impacted by frequency and the application of these data to a loss per unit value for various types of facilities involved. Road profiles from Mobil Lidar, aerial photographs, topographic maps, hydrologic data, and a delineation of the area affected were utilized in this analysis. In order to calculate these damages, stage-frequency and stage-damage curves were developed for each area. The evaluation also incorporated data from interviews with local officials.

The type, location, and number of miles of streets, roads, etc., affected were based on analysis of current Mobil Lidar, and aerial photographs on which the impacted area was delineated. The loss value per mile of road was derived through contacts with the street maintenance personnel and county highway officials in the project area. These officials are very familiar with all aspects of highway/bridge construction, repair, and maintenance cost including those associated with historical flood damage. The evaluated actual cost included estimates of asphalt overlay and minimum patching for roads along with bridge repairs for larger events. Bridge damages were considered minimal for events of the annual 2% chance exceedance and smaller. All loss values are expressed in 2017 dollars. The number of miles of roads flooded by the annual 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% chance exceedance flood events were derived by delineating these events based on recent mobile Lidar. No bridge damages were calculated below the annual 2% chance exceedance flood event. Rerouting traffic costs have occurred from historical flood events and have been estimated for all events where traffic impacts roads of Average Daily Traffic (ADT) of road greater than 10,000. The expected annual damages to roads and bridges were estimated to be $829,626 for existing conditions. Risk and uncertainty procedures are not applied to road and bridge damages since they are based on reliable values provided by other sources. The benefits to reduction in damage to roads and bridges are $414,813 for Alternative B and $705,182 for Alternative C.

Traffic Rerouting Costs - Traffic disruption is a major damage during large flood events in the Jackson Metropolitan area. When streets, roads, and highways are flooded they must be closed and traffic must be rerouted. Traffic rerouting costs include the increased operating costs of increased mileage caused by the detour and the value of time caused by the increased distance and increased traffic congestion. The streets, roads, and highways subject to flooding; average daily traffic count; percent of traffic that is cars; percent that is trucks; length of detour; and time required for detour were provided by the Mississippi Department of Transportation. This information is presented in Table B-12.

Table B-12
TRAFFIC DATA USED IN CALCULATING COST OF TRAFFIC REROUTING

Highway	Average Daily Traffic Count	Percent Cars	Percent Trucks	Length of Detour (mi)	Time Required for Detour (hrs)
Minor Streets	10,000	95%	5%	1	0.50
Lakeland Drive (Eubanks)	66,000	97%	3%	5	1.00
Lakeland Drive (Pearl River)	66,000	97%	3%	30	2.00
I-55 North	115,000	94%	7%	5	1.00
Highway 49	35,000	88%	12%	30	1.00
I-20 East	71,000	80%	20%	50	4.00

The 2013 IRS mileage rate for work of $0.565 per mile was used as the operating cost for cars and an operating cost of $1.38 per mile obtained from http://thetruckerreport.com was used for trucks. The value of time was calculated based on the recommendations of IWR Report 91-R-12, Value of Time Saved For Use In Corps Planning Studies, A Review Of The Literature And Recommendations by David J. Hill and David A. Moser, Ph.D., October 1991 and in accordance with Table B-4 of ER 1105-2-100, Appendix D, Amendment #1, 30 June 2004. A median family income of $42,604 for the Jackson Metropolitan Area for 2012 was used in the analysis. For the risk calculations, the road impacts were assumed to last for 7 to 9 days, depending on the magnitude of the flood event. The benefits from reduction of increased operating costs and time because of reduction in detours are $752,788 for the Alternative B and $1,021,640 for the Alternative C.

Water and Sewer - In addition to damages caused by compromise of the Waste Water Treatment Levee discussed below, additional cost of damages caused by flood waters was estimated. The major damage during flood events is the additional cost of treatment and pumping of the floodwaters entering the waste water system. Additional treatment estimates were made based on capacity and existing treatment cost during storm events. For the different frequency events, estimates for additional treatment volumes were made and calculations were based on the typical cost of treatment, ranging from $1.75-$2.75 per 1000 gallons. The benefits from the reduction of these costs are $109,981 for Alternative B and $132,675 for Alternative C.

Waste Water Treatment Plant - Flood damages and project benefits were determined for the Savanna Street Wastewater Treatment Plant. The WWTP is the wastewater treatment facility for the Jackson Metropolitan Area serving the cities of Jackson, Flowood, Pearl, Richland, and Brandon. The treatment plant is currently protected by a non-federal ring levee. Estimated without- and with-project

damages and benefits were derived through field investigations and consultation with the City of Jackson Department of Public Works (JDPW) and updated cost information based on replacement cost of another similar event to the 1979 event when the levee was compromised. Flood damages were based on updated information from the Draft 2006 report where estimated damages by flood elevation, historical flood damages, and probabilities of levee failures were calculated. It has been stated by representatives familiar with the replacement cost of the WWTP that an event similar to the 1979 flood would cause over $200 Million in damage. Some damage on lower flows is assumed due to seepage and groundwater intrusion. The elevation of most of the plant is approximately 15 feet below the non-certified local levee. Therefore, the entire plant is anticipated to be impacted when this levee is compromised, as it was in 1979 and almost was again in 1983.

Although it was an estimate by the City of Jackson from previous studies and referenced the 1979 flood (equivalent to the annual 0.5% chance exceedance flood event), this information was used to estimate damages on all floods (Table B-13), and then these damages were annualized. No large damages were assumed until the annual 4% chance exceedance flood event, then damages to the plant ranged from $500,000-$200,000,000 for large events that would overtop the existing levee.

Results of the treatment plant evaluation calculated the expected annual damages to the WWTP to be approximately $3.1 million for existing conditions. Flood damages would be reduced by almost 95% percent with the implementation of both the Comprehensive Levee Plan and the channel improvement plan.

Table B-13

ESTIMATED DAMAGES TO SAVANNA STREET WASTEWATER TREATMENT PLANT

	Annual Percent Chance Exceedance Flood Event							
	50%	20%	10%	4%	2%	1%	0.50%	0.20%
Damages	$0	$100,000	$500,000	$1,000,000	$25,000,000	$100,000,000	$200,000,000	$200,000,000
(October 2017 Price Levels)								

Intensification and Location Benefits – According to ER-1105-2-100, Appendix E, intensification benefits are the benefits gained if the use of the floodplain area remains unchanged, due to the increase in market value (increase net income) of land. There are areas in Rankin County that are currently undeveloped due to the amount of fill needed for finish floor elevations. It is believed that lowering the flowline (reducing flood elevations) will intensify the development of these areas. A projected increase in intensity has been used to provide an estimate of these benefits. These benefits will be updated as additional data becomes available. Figure B-6 presents the project areas where intensification benefits are anticipated.

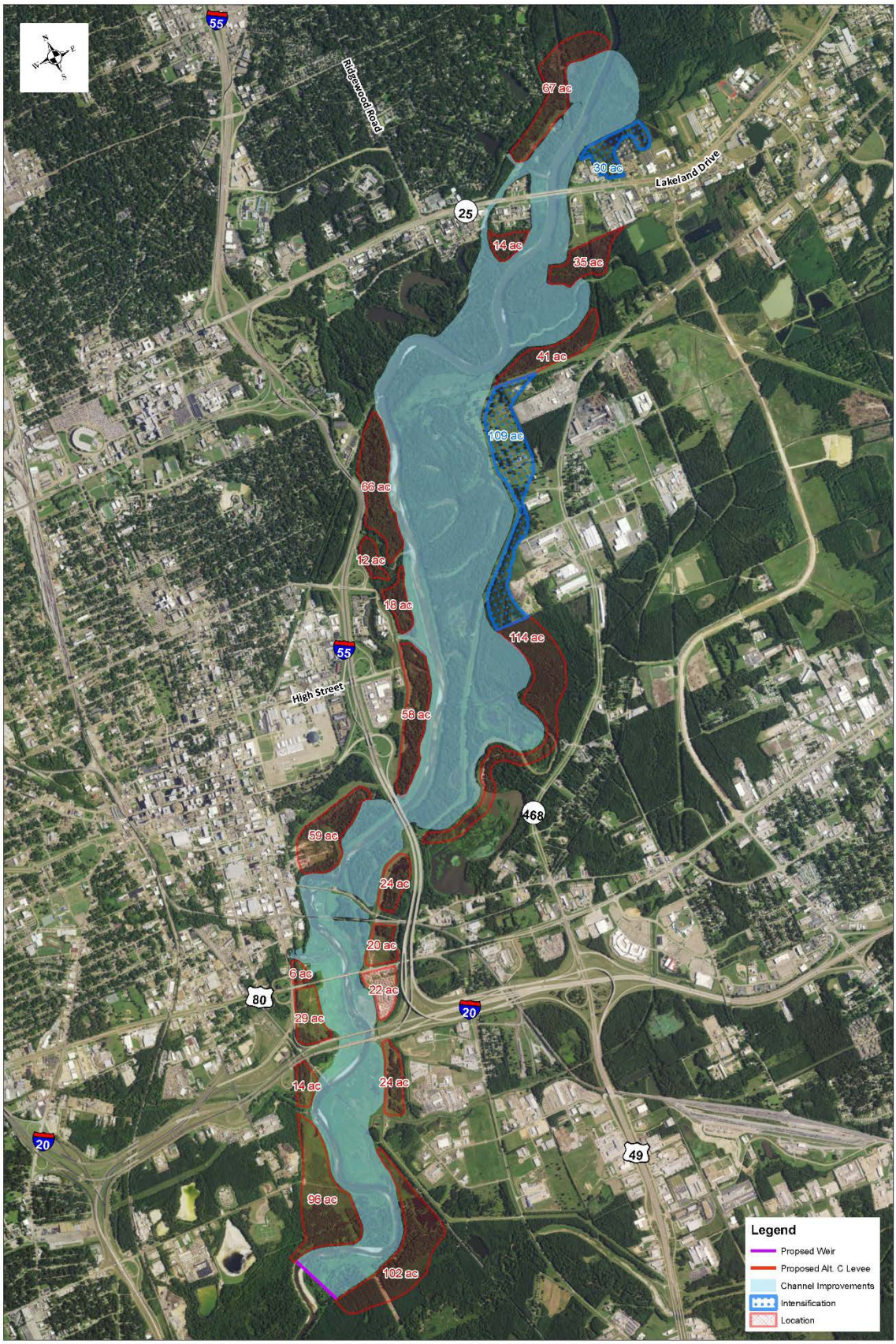

Figure B-6. Intensification and Location Benefits

According to ER-1105-2-100, Appendix E, location benefits are benefits from land use that would be different with and without the floodplain and certain adjacent land. Location benefits are associated with a change in land use or activity added to the floodplain area because of the flood reduction plan. In the case of the Alternative C, the land use changes are due to changing of the floodplain limits and the new land being formed. Although the NED plan was formulated to protect existing development, location benefits would accrue because land use changes would cause an increase in the aggregate net income (economic rent). However, Alternative B does not gain significant benefit from land use value changes since the low areas behind the levees would be utilized as sump area for pumping plants. Additionally, no new large land areas would be produced with the Alternative B. Although a final land use plan is not available at this time, estimates based on planning and land use judgments have been made to assist to obtain a range of these benefits. From discussions with local officials, it is believed lands that will be available next to the expanded river will provide for multi-use developments along with parks and other recreational features developed in the recreational analysis.

1. There will be land available on both Hinds County and Rankin County sides of the expanded Pearl River banks. The elevations of these lands will be greater than the annual 0.2% chance exceedance and therefore, out of the floodplain. No sites with this size acreage in Hinds County located near the Jackson Downtown area can provide this type of development. Flowood developments continue to develop north away from downtown. Flowood has no large sites available to develop except those north on Highway 25. It is not believed alternative sites would be affected in Rankin County due to sites being limited.
2. Due to the location of the project, it will provide unique opportunities along the Pearl River in addition to the unique recreation benefits. Utilities are typically in proximity of the lands outlined on Figure B-6. This proximity offers an opportunity to extend needed utility services to comparable sites in Rankin County to provide the same benefits.
3. Figure B-6 presents the areas discussed in the above paragraphs. Although a final land use plan has not been developed, the unique opportunities these locations will present for future market values is clear.
4. Land values for floodplain and non-floodplain areas have been used to estimate increase in land values where land use is expected to change. In addition, the amount of land estimated to be utilized as park areas was not included in the projections of improved market value.
5. It is understood that land values will not increase instantaneously. The increase in land values have conservatively been assumed to take place over the 50 year period of the project.

Due to the uniqueness of this project, it is possible the location benefits could be underestimated. The benefits will be dependent on land markets at the time of project completion. Intensification and location benefits will be revised as more data becomes available. In an effort to ensure conservative projections and to not overstate the expected location and intensification benefits, which are subject to fluctuating market conditions, only 50% of the estimated benefits were used in the calculations of total net benefits.

With intensification benefits to 139 acres and location benefits to 594 acres, it was estimated that these benefits would be approximately $10.2 million annually within Flowood and Jackson. The

reduction in required fill is estimated to contribute to the annual benefits for areas within both Flowood and Jackson. The land uses would be specific based on the uniqueness of the area and would not significantly reduce economic rent from other areas in the region. Assuming land values increased from $5,000 to $40,000 per acre for a projected land value of $10,000 to $80,000 per acre post-project (Table B-14). This increase (intensification) was assumed to begin immediately and continue over the life of the project. The intensification does not include development cost-only the expected land rent stream based on the value of the raw land.

Table B-14
INTENSIFICATION AND LOCATION BENEFITS (LAND VALUE)

		Undeveloped Land in Floodplain	Land Value/ Unit Value (per/acre)	Land Value Without Project	Land Value/ Unit Value (per/acre)	Land Value With Project	Intensification Benefits
RANKIN	Intensification Benefits	139.0	$40,000	$5,560,000	$80,000	$11,120,000	$5,560,000
RANKIN	Location Benefits	305.6	$5,000	$1,528,000	$80,000	$24,448,000	$22,920,000
	Park Areas (estimated)	76.4	$5,000	$382,000	$10,000	$764,000	$382,000
HINDS	Location Benefits	351.2	$5,000	$1,756,000	$80,000	$28,096,000	$26,340,000
	Park Areas (estimated)	87.8	$5,000	$439,000	$10,000	$878,000	$439,000
TOTAL LOCATION BENEFITS							**$55,641,000**
(October 2017 Price Levels)							

Recreation Benefits - Recreation benefits were calculated using the User Day Value (UDV) and the capacity method as described in Amendment #1 of this Appendix. Based on the climate in the Study Area, the user days calculated based on 70 percent of capacity. The calculation of the recreation benefits is presented in Table B-15. Recreation facilities are proposed for Alternative C only and the estimated annual benefits are $4,208,764.

Table B-15
CALCULATION OF RECREATION BENEFITS

	Typical Unit	Unit Measure	Annual Users Per Unit	Annual Capacity	Proposed Units	User Day Value	Annual Benefit Benefit
RV Pads	1	ea.	720	0.7	150	$9.41	$711,396
Trails	1500	FT	6,125	0.7	53	$9.41	$2,138,305
Fishing Piers	500	sq. ft.	8,045	0.7	6	$9.41	$317,954
Wildlife Viewing	1500	sq. ft.	18,125	0.7	3	$9.41	$358,168
Boat Ramps	1	lanes	17,280	0.7	6	$9.41	$682,940
Total Recreation Benefits							$4,208,764
(October 2017 Price Levels)							

TOTAL BENEFITS, PROJECT COSTS, AND BENEFIT-COST ANALYSIS

Total Benefits - The summaries of all benefits are presented in Table B-16, Table B-17 and Table B-18.

Projects Costs - The project implementation costs; operation, maintenance, and major replacement costs; average annual equivalent cost; benefit-cost ratio; and excess benefits over costs are presented in Table B-17 through Table B-20. The average annual equivalent costs, benefit-cost ratio, and excess benefits over costs are based on a three year construction period, a base year of 2020, a 2 3/4 percent discount rate, and a period of analysis of 50 years. Recreation

costs and benefits are presented for Alternative C, only, and do not include operation and maintenance costs. These costs will be refined for the tentatively selected plan in the final analysis.

Benefit-Cost Analysis - From this analysis, it can be seen that Alternative C, Channel Improvement, is the economically superior plan, providing a much higher benefit cost ratio and excess benefits over costs. Of the plans analyzed, it is the least costly and is also the NED Plan. Alternative C is also the locally preferred plan.

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Table B-16

SUMMARY OF PROJECT BENEFITS

Summary of Project Benefits
Pearl River Basin, Mississippi, Federal Risk
(October 2017 Price Levels)

Damages	Without Project (Existing Conditions)	With Project Alternative B (Levees)	Damage Reduction Alternative B (Benefits)	With Project Alternative C (Ch. Improvements)	Damage Reduction Alternative C (Benefits)
Flood Reduction (FDA)	$ 17,943,790.00	$ 7,050,840.00	$ 10,892,950.00	$ 4,276,840.00	$ 13,666,950.00
Emergency Cost	$ 100,382.39	$ 37,141.48	$ 63,240.90	$ 24,091.77	$ 76,290.61
Evacuation, Reoccupation, Subsistence, Cleanup, Restoration,	$ 8,586,927.10	$ 3,170,974.55	$ 5,415,952.55	$ 2,064,975.59	$ 6,521,951.51
FIA Cost	$ 419,864.40	$ 54,138.83	$ 365,725.58	$ 35,072.33	$ 384,792.08
Road and Bridge	$ 829,625.51	$ 414,812.76	$ 414,812.76	$ 124,443.83	$ 705,181.69
Water and Sewer	$ 190,083.74	$ 70,330.98	$ 119,752.76	$ 45,620.10	$ 144,463.64
WWTP	$ 3,075,798.40	$ 153,789.92	$ 2,922,008.48	$ 153,789.92	$ 2,922,008.48
Traffic	$ 1,075,410.82	$ 322,623.25	$ 752,787.57	$ 53,770.54	$ 1,021,640.28
TOTAL DAMAGES	**$32,221,882**	**$11,274,652**		**$6,778,604**	
TOTAL FLOOD DAMAGE REDUCTION			**$20,947,231**		**$25,443,278**
Recreation Benefits					$ 4,208,763.65
Location Benefits (Land New Use)					$ 10,221,521.06
TOTAL BENFITS			**$20,947,231**		**$39,873,563**

Table B-17

EQUIVALENT ANNUAL BENEFITS AND COST, ALTERNATIVE B

Equivalent Annual Benefits and Cost Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B (October 2017 Price Level, 50-Year Period of Analysis, 2.750 Percent Discount Rate)		
Investment Cost		
Total Project Construction Cost		$729,413,364
Interest During Construction*		$20,242,740
Total Investment Cost		$749,656,104
Average Annual Cost		
Interest/Amortization/Initial Investment		$27,767,951
OMRR&R		$2,200,000
Total Average Annual Cost		$27,767,951
Average Annual Benefits		$20,947,231
Net Annual Benefits		-$6,820,721
Benefit-Cost Ratio		0.75
Benefit-Cost Ratio (computed at 7%)		0.48
*Estimated construction period of 3 years		

Table B-18

EQUIVALENT ANNUAL BENEFITS AND COST, ALTERNATIVE C

Equivalent Annual Benefits and Cost Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative C (October 2017 Price Level, 50-Year Period of Analysis, 2.750 Percent Discount Rate)		
Investment Cost		
Total Project Construction Cost		$345,849,032
Interest During Construction*		$9,629,973
Total Investment Cost		$355,479,005
Average Annual Cost		
Interest/Amortization/Initial Investment		$13,209,902
OMRR&R		$650,000
Total Average Annual Cost		$13,859,902
Average Annual Benefits		$39,164,442
Net Annual Benefits		$25,304,540
Benefit-Cost Ratio		2.83
Benefit-Cost Ratio (computed at 7%)		1.41
*Estimated construction period of 3 years		

Table B-19
COST SUMMARY, ALTERNATIVE B

Cost Summary Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B (October 2017 Price Levels)		
Construction Item		**Cost**
Lands and Damages		$ 71,900,008
Elements		
Relocations		$ 15,685,964
Levees		$ 235,435,532
Floodway and Diversions		$ 33,815,134
Pumping Plants		$ 311,609,907
Mitigation		$ 7,361,814
Pre Construction Engineering		$ 41,974,624
Construction Management		$ 11,630,380
Total First Cost		**$729,413,364**

Table B-20
COST SUMMARY, ALTERNATIVE C

Cost Summary Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative C (October 2017 Price Levels)		
Construction Item		**Cost**
Lands and Damages		$ 23,056,200
Elements		
Relocation		$ 13,076,870
Channels and Levee Improvements		$ 198,911,978
Weir		$ 43,854,534
Recreation		$ 12,581,204
Mitigation		$ 17,400,000
Pre Construction Engineering		$ 30,241,493
Construction Management		$ 6,726,753
Total First Cost		**$345,849,032**

APPENDIX B, AMENDMENT 1
LEVEE FRAGILITY CURVES

Causes of failure other than overtopping or sources of uncertainty for existing levees include surface erosion, internal erosion (piping), underseepage, and slides within the levee embankment or foundation soils. Information on levee performance during past floods and review of previous studies indicate the likely modes of levee failure would be through seepage or overtopping for the existing levees. Fragility curves were developed using existing performance data from past events, including the 1979 flood.

Table B-21: FRAGILITY CURVES, EXISTING CONDITIONS

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Existing Conditions West Levee River Mile 288.15 Levee Top 278.4	
Elevation	**Failure Chance (%)**
275.5	0
277.4	5
277.6	25
277.9	50
278.1	75
278.4	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Existing Conditions East Levee River Mile 289.29 Levee Top 279.6	
Elevation	**Failure Chance (%)**
277.2	0
279.2	5
279.3	25
279.4	50
279.5	75
279.6	100

Table B-22: FRAGILITY CURVES, ALTERNATIVE B

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Existing West Levee River Mile 288.15 Proposed Levee Top 282.8	
Elevation	**Failure Chance (%)**
275.7	0
279.8	5
280.6	10
281.3	25
282.1	50
282.8	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Existing East Levee River Mile 289.29 Proposed Levee Top 284.7	
Elevation	**Failure Chance (%)**
277.3	0
281.7	5
282.5	10
283.2	25
284.0	50
284.7	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Flowood Levee River Mile 297.18 Proposed Levee Top 290.7	
Elevation	**Failure Chance (%)**
283.5	0
287.7	5
288.5	10
289.2	25
290.0	50
290.7	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Lefleur Levee River Mile 290.95 Proposed Levee Top 285.8	
Elevation	**Failure Chance (%)**
278.3	0
282.8	5
283.6	10
284.3	25
285.1	50
285.8	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B I-20 Levee River Mile 287.39 Proposed Levee Top 280.5	
Elevation	**Failure Chance (%)**
274.0	0
277.5	5
278.3	10
279.0	25
279.8	50
280.5	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Northeast Jackson 1 River Mile 295.2 Proposed Levee Top 289.5	
Elevation	**Failure Chance (%)**
282.0	0
286.5	5
287.3	10
288.0	25
288.8	50
289.5	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Northeast Jackson 2 River Mile 297.99 Proposed Levee Top 291	
Elevation	**Failure Chance (%)**
283.9	0
288.0	5
288.8	10
289.5	25
290.3	50
291.0	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Lakeland West Levee River Mile 292.21 Proposed Levee Top 286.3	
Elevation	**Failure Chance (%)**
278.9	0
283.3	5
284.1	10
284.8	25
285.6	50
286.3	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Belhaven Levee River Mile 290.02 Proposed Levee Top 285.3	
Elevation	**Failure Chance (%)**
277.8	0
282.3	5
283.1	10
283.8	25
284.6	50
285.3	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative B Treatment Plant Levee River Mile 282.68 Proposed Levee Top 276.2	
Elevation	**Failure Chance (%)**
270.1	0
273.2	5
273.9	10
274.7	25
275.4	50
276.2	100

Table B-23: FRAGILITY CURVES, ALTERNATIVE C

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative C Exisitng West Levee River Mile 288.15 Proposed Levee Top 280.2	
Elevation	**Failure Chance (%)**
275.5	0
277.4	5
278.1	25
278.8	50
279.5	75
280.2	100

Fragility Curves Pearl River Basin, Mississippi, Federal Risk Reduction Project, Alternative C Existing East Levee River Mile 289.29 Proposed Levee Top 280.6	
Elevation	**Failure Chance (%)**
277.2	0
279.2	5
279.5	25
279.9	50
280.2	75
280.6	100

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APPENDIX B, AMENDMENT 2
PERFORMANCE STATISTICS

One Lake Project Performance
by Plans and Damage Reaches by Analysis Year 2013
(Stages in ft.)
Version 1.4.1, May 2016; Less Simple Method (0.010)

Without Project Base Year Performance Target Criteria:
Event Exceedance Probablility = 0.01
Residual Damage = 5.00 %

Plan Name	Stream Name	Damage Reach Name	Damage Reach Description	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
					Median	Expected	10	30	50	10%	4%	2%	1%	.4%	.2%
Without	Pearl River	Belhaven Levee		278.01	0.0179	0.0207	0.1884	0.4655	0.6479	0.9997	0.8600	0.5418	0.3108	0.1005	0.0487
		Ex East Levee		279.60 g	0.0014	0.0031	0.0308	0.0895	0.1447	1.0000	0.9997	0.9820	0.9416	0.7653	0.5984
		Ex West Levee		278.40 g	0.0083	0.0116	0.1097	0.2943	0.4406	1.0000	0.9758	0.8028	0.5787	0.2674	0.1577
		Flowood		281.05	0.0328	0.0343	0.2944	0.6487	0.8251	0.9993	0.6085	0.3071	0.1479	0.0367	0.0106
		I-20 Levee		270.69	0.0545	0.0544	0.4285	0.8134	0.9391	0.9537	0.3716	0.1370	0.0452	0.0056	0.0015
		Lakeland West		276.61	0.0343	0.0365	0.3105	0.6722	0.8441	0.9983	0.5790	0.2808	0.1309	0.0306	0.0116
		Lefleur Levee		275.57	0.0435	0.0452	0.3701	0.7500	0.9008	0.9880	0.4596	0.2075	0.0886	0.0183	0.0062
		NE Jackson 1		279.57	0.0582	0.0569	0.4433	0.8275	0.9465	0.9369	0.3437	0.1604	0.0711	0.0135	0.0034
		NE Jackson 2		278.86	0.1274	0.1230	0.7309	0.9805	0.9986	0.3620	0.0615	0.0517	0.0302	0.0044	0.0000
		Old Fannin		283.34	0.0230	0.0245	0.2199	0.5254	0.7112	0.9997	0.7876	0.4469	0.2371	0.0681	0.0213
		Richland Levee		266.86	0.0421	0.0445	0.3659	0.7450	0.8974	0.9869	0.4750	0.1903	0.0695	0.0112	0.0030
		Ridgeland		283.74	0.0308	0.0321	0.2781	0.6239	0.8040	0.9997	0.6428	0.3316	0.1657	0.0388	0.0107
		South Jackson		269.40	0.0348	0.0370	0.3140	0.6772	0.8481	0.9980	0.5762	0.2536	0.1014	0.0207	0.0062
		Treatment Plant		260.32	0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Levee Plan	Pearl River	Belhaven Levee		285.30 g	0.0027	0.0047	0.0456	0.1308	0.2083	1.0000	0.9969	0.9643	0.8739	0.6435	0.4540
		Ex East Levee		284.70 g	0.0002	0.0006	0.0056	0.0167	0.0277	1.0000	0.9998	0.9984	0.9950	0.9766	0.9440
		Ex West Levee		282.90 g	0.0023	0.0042	0.0411	0.1183	0.1893	1.0000	0.9973	0.9711	0.8919	0.6770	0.5043
		Flowood		290.70 g	0.0021	0.0039	0.0382	0.1104	0.1771	1.0000	0.9983	0.9756	0.9026	0.6992	0.5242
		I-20 Levee		280.50 g	0.0018	0.0035	0.0341	0.0988	0.1591	1.0000	0.9973	0.9711	0.9204	0.7547	0.5895
		Lakeland West		286.30 g	0.0027	0.0047	0.0457	0.1311	0.2087	1.0000	0.9971	0.9642	0.8726	0.6503	0.4488
		Lefleur Levee		285.80 g	0.0028	0.0048	0.0472	0.1350	0.2147	1.0000	0.9967	0.9617	0.8670	0.6381	0.4391
		NE Jackson 1		289.50 g	0.0035	0.0056	0.0544	0.1545	0.2441	1.0000	0.9951	0.9490	0.8349	0.5813	0.3976
		NE Jackson 2		291.00 g	0.0022	0.0039	0.0386	0.1115	0.1789	1.0000	0.9982	0.9756	0.9004	0.6951	0.5176
		Old Fannin		283.34	0.0243	0.0259	0.2310	0.5452	0.7310	0.9997	0.7623	0.4217	0.2220	0.0547	0.0172
		Richland Levee		266.86	0.0421	0.0445	0.3658	0.7449	0.8974	0.9869	0.4751	0.1903	0.0695	0.0112	0.0030
		Ridgeland		283.74	0.0286	0.0301	0.2634	0.6003	0.7831	0.9997	0.6795	0.3526	0.1792	0.0381	0.0110
		South Jackson		269.40	0.0349	0.0371	0.3146	0.6781	0.8488	0.9980	0.5762	0.2500	0.0987	0.0182	0.0050
		Treatment Plant		276.20 g	0.0013	0.0028	0.0279	0.0815	0.1320	1.0000	0.9979	0.9779	0.9384	0.8024	0.6648
One Lake	Pearl River	Belhaven Levee		278.01	0.0026	0.0046	0.0447	0.1282	0.2044	0.9998	0.9991	0.9634	0.8901	0.6305	0.4289
		Ex East Levee		280.60 g	0.0002	0.0007	0.0068	0.0202	0.0335	1.0000	0.9998	0.9983	0.9944	0.9668	0.9226
		Ex West Levee		280.20 g	0.0015	0.0029	0.0287	0.0838	0.1357	1.0000	0.9994	0.9832	0.9472	0.7792	0.6134
		Flowood		281.05	0.0067	0.0097	0.0932	0.2544	0.3870	0.9998	0.9858	0.8572	0.6621	0.3055	0.1326
		I-20 Levee		270.69	0.0280	0.0296	0.2596	0.5941	0.7775	0.9997	0.6989	0.3437	0.1509	0.0396	0.0142
		Lakeland West		276.61	0.0050	0.0076	0.0731	0.2038	0.3160	0.9997	0.9942	0.9012	0.7634	0.4295	0.2442
		Lefleur Levee		275.57	0.0071	0.0104	0.0996	0.2701	0.4083	0.9997	0.9827	0.8273	0.6431	0.2987	0.1489
		NE Jackson 1		279.57	0.0153	0.0189	0.1736	0.4356	0.6146	0.9997	0.8858	0.5960	0.3603	0.1018	0.0299
		NE Jackson 2		278.86	0.0553	0.0566	0.4417	0.8260	0.9458	0.9074	0.3563	0.1519	0.0647	0.0077	0.0016
		Old Fannin		283.34	0.0076	0.0107	0.1020	0.2758	0.4159	0.9997	0.9853	0.8282	0.6113	0.2701	0.1144
		Richland Levee		266.86	0.0421	0.0445	0.3658	0.7449	0.8974	0.9869	0.4751	0.1903	0.0695	0.0112	0.0030
		Ridgeland		283.74	0.0175	0.0203	0.1855	0.4596	0.6415	0.9997	0.8674	0.5491	0.3178	0.0901	0.0266

***** - Computations have not been completed.
\+ - Something has changed and computations need to be redone.

One Lake Project Performance
by Plans and Damage Reaches by Analysis Year 2013
(Stages in ft.)
Version 1.4.1, May 2016; Less Simple Method (0.010)

Without Project Base Year Performance Target Criteria:
Event Exceedance Probablility = 0.01
Residual Damage = 5.00 %

Plan Name	Stream Name	Damage Reach Name	Damage Reach Description	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
					Median	Expected	10	30	50	10%	4%	2%	1%	.4%	.2%
		Ex West Levee		278.40 g	0.0083	0.0116	0.1097	0.2943	0.4406	1.0000	0.9758	0.8028	0.5787	0.2674	0.1577
		Flowood		281.05	0.0328	0.0343	0.2944	0.6487	0.8251	0.9993	0.6085	0.3071	0.1479	0.0367	0.0106
		I-20 Levee		270.69	0.0545	0.0544	0.4285	0.8134	0.9391	0.9537	0.3716	0.1370	0.0452	0.0056	0.0015
		Lakeland West		276.61	0.0343	0.0365	0.3105	0.6722	0.8441	0.9983	0.5790	0.2808	0.1309	0.0306	0.0116
		Lefleur Levee		275.57	0.0435	0.0452	0.3701	0.7500	0.9008	0.9880	0.4596	0.2075	0.0886	0.0183	0.0062
		NE Jackson 1		279.57	0.0582	0.0569	0.4433	0.8275	0.9465	0.9369	0.3437	0.1604	0.0711	0.0135	0.0034
		NE Jackson 2		278.86	0.1274	0.1230	0.7309	0.9805	0.9986	0.3620	0.0615	0.0517	0.0302	0.0044	0.0000
		Old Fannin		283.34	0.0230	0.0245	0.2199	0.5254	0.7112	0.9997	0.7876	0.4469	0.2371	0.0681	0.0213
		Richland Levee		266.86	0.0421	0.0445	0.3659	0.7450	0.8974	0.9869	0.4750	0.1903	0.0695	0.0112	0.0030
		Ridgeland		283.74	0.0308	0.0321	0.2781	0.6239	0.8040	0.9997	0.6428	0.3316	0.1657	0.0388	0.0107
		South Jackson		269.40	0.0348	0.0370	0.3140	0.6772	0.8481	0.9980	0.5762	0.2536	0.1014	0.0207	0.0062
		Treatment Plant		260.32	0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Levee Plan	Pearl River	Belhaven Levee		285.30 g	0.0027	0.0047	0.0456	0.1308	0.2083	1.0000	0.9969	0.9643	0.8739	0.6435	0.4540
		Ex East Levee		284.70 g	0.0002	0.0006	0.0056	0.0167	0.0277	1.0000	0.9998	0.9984	0.9950	0.9766	0.9440
		Ex West Levee		282.90 g	0.0023	0.0042	0.0411	0.1183	0.1893	1.0000	0.9973	0.9711	0.8919	0.6770	0.5043
		Flowood		290.70 g	0.0021	0.0039	0.0382	0.1104	0.1771	1.0000	0.9983	0.9756	0.9026	0.6992	0.5242
		I-20 Levee		280.50 g	0.0018	0.0035	0.0341	0.0988	0.1591	1.0000	0.9973	0.9711	0.9204	0.7547	0.5895
		Lakeland West		286.30 g	0.0027	0.0047	0.0457	0.1311	0.2087	1.0000	0.9971	0.9642	0.8726	0.6503	0.4488
		Lefleur Levee		285.80 g	0.0028	0.0048	0.0472	0.1350	0.2147	1.0000	0.9967	0.9617	0.8670	0.6381	0.4391
		NE Jackson 1		289.50 g	0.0035	0.0056	0.0544	0.1545	0.2441	1.0000	0.9951	0.9490	0.8349	0.5813	0.3976
		NE Jackson 2		291.00 g	0.0022	0.0039	0.0386	0.1115	0.1789	1.0000	0.9982	0.9756	0.9004	0.6951	0.5176
		Old Fannin		283.34	0.0243	0.0259	0.2310	0.5452	0.7310	0.9997	0.7623	0.4217	0.2220	0.0547	0.0172
		Richland Levee		266.86	0.0421	0.0445	0.3658	0.7449	0.8974	0.9869	0.4751	0.1903	0.0695	0.0112	0.0030
		Ridgeland		283.74	0.0286	0.0301	0.2634	0.6003	0.7831	0.9997	0.6795	0.3526	0.1792	0.0381	0.0110
		South Jackson		269.40	0.0349	0.0371	0.3146	0.6781	0.8488	0.9980	0.5762	0.2500	0.0987	0.0182	0.0050
		Treatment Plant		276.20 g	0.0013	0.0028	0.0279	0.0815	0.1320	1.0000	0.9979	0.9779	0.9384	0.8024	0.6648
One Lake	Pearl River	Belhaven Levee		278.01	0.0026	0.0046	0.0447	0.1282	0.2044	0.9998	0.9991	0.9634	0.8901	0.6305	0.4289
		Ex East Levee		280.60 g	0.0002	0.0007	0.0068	0.0202	0.0335	1.0000	0.9998	0.9983	0.9944	0.9668	0.9226
		Ex West Levee		280.20 g	0.0015	0.0029	0.0287	0.0838	0.1357	1.0000	0.9994	0.9832	0.9472	0.7792	0.6134
		Flowood		281.05	0.0067	0.0097	0.0932	0.2544	0.3870	0.9998	0.9858	0.8572	0.6621	0.3055	0.1326
		I-20 Levee		270.69	0.0280	0.0296	0.2596	0.5941	0.7775	0.9997	0.6989	0.3437	0.1509	0.0396	0.0142
		Lakeland West		276.61	0.0050	0.0076	0.0731	0.2038	0.3160	0.9997	0.9942	0.9012	0.7634	0.4295	0.2442
		Lefleur Levee		275.57	0.0071	0.0104	0.0996	0.2701	0.4083	0.9997	0.9827	0.8273	0.6431	0.2987	0.1489
		NE Jackson 1		279.57	0.0153	0.0189	0.1736	0.4356	0.6146	0.9997	0.8858	0.5960	0.3603	0.1018	0.0299
		NE Jackson 2		278.86	0.0553	0.0566	0.4417	0.8260	0.9458	0.9074	0.3563	0.1519	0.0647	0.0077	0.0016
		Old Fannin		283.34	0.0076	0.0107	0.1020	0.2758	0.4159	0.9997	0.9853	0.8282	0.6113	0.2701	0.1144
		Richland Levee		266.86	0.0421	0.0445	0.3658	0.7449	0.8974	0.9869	0.4751	0.1903	0.0695	0.0112	0.0030
		Ridgeland		283.74	0.0175	0.0203	0.1855	0.4596	0.6415	0.9997	0.8674	0.5491	0.3178	0.0901	0.0266
		South Jackson		269.40	0.0349	0.0370	0.3141	0.6773	0.8482	0.9980	0.5762	0.2535	0.1013	0.0207	0.0062
		Treatment Plant		260.32	0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

***** - Computations have not been completed.
\+ - Something has changed and computations need to be redone.

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APPENDIX B, AMENDMENT 3
RECREATION BENEFITS

Recreation benefits are estimated in this analysis based on the User Day Value (UDV) methodology. The UDV methodology provides guidelines for assigning points to the value of the recreation experience. There are five criteria in the UDV methodology used to establish the value of the recreation experience. The five criteria are the quality of the recreation experience, availability of opportunity, carrying capacity, accessibility, and environmental quality (Table 1). For each criteria there are five judgment factors that provide the basis for determining the point value of the recreation experience offered by recreation facilities.

The following assessments of the judgment factors for each of the five criteria were used to assign point values for the recreation opportunities that would be provided by the recreation facilities of Alternative C.

The following assessments of the judgment factors were used for assigning point values for the five criteria outlined in Table 1.

- The Alternative C proposed recreation facilities would provide an area specific, unique recreation opportunity afforded by the project setting. The site offers solitude and panoramic views in a growing metropolitan area, and would provide specific recreation amenities for a growing metropolitan population that will experience increased demands. The multi-use recreation areas will provide panoramic view sheds. The point value rating of 10 out of 30 in the judgment factor scale was assigned because of the several general activities and recreation experiences that would be offered by the proposed facilities in the relatively densely populated metropolitan area.
- The availability of opportunity rating is based upon there being one or two similar recreation facilities within 1-hour travel time and none within 45 minutes travel time from the Project proposed recreation facilities. The score for this judgment factor was 14 out of 18.
- Alternative C proposed facilities carrying capacity point values are relatively high at 10 out of 14 because the proposed recreation facilities provide optimum facilities to conduct activity at site potential. The general recreation values are based on the optimum use of the site potential, without overuse of the proposed recreation resources. Good water resources and access to them for environmental observation comprise a large part of the projected recreation resources use. According to Making Strides, the MS comprehensive outdoor recreation plan (ORP), one of Mississippi's greater assets is a generally warm and pleasant climate. Most of the people engage in outdoor recreational activities throughout the 12 months of the year due to a climate classified as sub-tropical. Therefore, use is expected to occur throughout the 12 months of the calendar year.
- The accessibility rating is based upon the availability of local highways, roads and streets in good condition that would provide access to the proposed recreation facilitates. The accessibility rating is scored high at 16 out a possible 18 because there is good access with high standard roads to site, and the proposed facilities will provide good access within site.

- The environmental quality rating is based on the aesthetic values of the Project environmental setting and the ease of correcting any limiting aesthetic factors. Any limiting aesthetic factors that currently exist would be eliminated by the project. The proposed site would possess panoramic views. The best aesthetics of Alternative C Project area would be views of the riverfront and shorelines. Due to the high aesthetic quality with no factors that lower environmental quality, the environmental quality rating was scored at 13 out of 20.

The total points for all five criteria is 63 points.

Table 1. Guidelines for Assigning Points for General Recreation

Criteria	**Judgment factors**				
Recreation experience[1] Total Points: 30	Two general activities[2]	Several general activities	Several general activities: one high quality value activity[3]	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Point Value: 10	0–4	5–10	11–16	17–23	24–30
Availability of opportunity[4] Total Points: 18	Several within 1-hour travel time; a few within 30 minutes travel time	Several within 1-hour travel time; none within 30 minutes travel time	One or two within 1-hour travel time; none within 45 minutes travel time	None within 1-hour travel time	None within 2-hour travel time
Point Value: 14	0–3	4–6	7–10	11–14	15–18
Carrying capacity[5] Total Points: 14	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Point Value: 10	0–2	3–5	6–8	9–11	12–14

Criteria	**Judgment factors**				
Accessibility Total Points: 18	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Point Value: 16	0–3	4–6	7–10	11–14	15–18
Environmental quality Total Points: 20	Low esthetic factors[6] that significantly lower quality[7]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Point Value: 13	0–2	3–6	7–10	11–15	16–20
Total Point Value					**63**

Source: Economics Guidance Memorandum, 17-03, Unit Day Method, Table 1: Guidelines for Assigning Points for General Recreation.

1. Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
2. General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.
3. High quality value activities include those that are not common to the region and/or Nation, and that are usually of high quality.
4. Likelihood of success at fishing and hunting.
5. Value should be adjusted for overuse.
6. Major esthetic qualities to be considered include geology and topography, water, and vegetation.
7. Factors to be considered to lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Conversion of points to dollar value

The point values assigned were converted to dollar values based on the EGM 17-03, Unit Day Values for Recreation, 2017, which is based on ER 1105-2-100. Values provided for FY 2017 may be used to convert points to a UDV dollar amount if the point assignment method is used. The table was adjusted from Table K-31, *Federal Register* Vol. 44, No. 242, p. 72962, December 14, 1979, and the subsequent Table VIII-3-1 "Conversion of Points to Dollar Values," Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, March 10, 1983, using the Consumer Price Index (CPI) factors published by the Bureau of Labor Statistics. The CPI basis of Table VIII-3-1 from Principles and Guidelines is July 1, 1982 (CPI value = 97.5). The FY 2017 CPI basis is September 2016 (CPI value = 241.428).

Table 2 displays the point value conversion to a unit day value in fiscal year 2017 (FY17) dollars. The 63 total points from Table 2 falls between the General Recreation Point values for 60 points and 70 points. The General Recreation Dollar Value for 60 points is $9.16 and for 70 points is $9.66. The difference between $9.66 and $9.16 is $0.50. The 63 total points represents 30 percent of the $0.50 difference. Therefore, 30 percent of the $0.50, or $0.15 was added to $9.16 to produce the UDV of $9.31 for the 63 General Recreation Point Value.

Table 2. Conversion of Points to Dollar Values

General Recreation Point Values	General Recreation Dollar Values
0	$3.96
10	4.70
20	5.20
30	594
40	7.43
50	8.42
60	9.16
70	9.66
80	10.65
90	11.39
100	11.89

Source: Economic Guidance Memorandum, 17-03, Unit Day Values for Recreation for Fiscal Year 2017.

Most likely recreation participation user day scenario

The MS ORP does not provide recreation user-day guidelines for resource based outdoor recreation activities. The capacity method is an alternative method of estimating use according to USACE Economic Guidance Memorandum (EGM), 17-03, Unit Day Values for Recreation for Fiscal Year 2017: "The capacity procedure involves the estimation of annual recreation use under without-project and with-project conditions through the determination of resource or facility capacities (taking into consideration instantaneous rates of use, turnover rates, and weekly and seasonal patterns of use). Seasonal use patterns are dependent on climate and culture and probably account for the greatest variation in use estimates derived through this method. In general, annual use of outdoor recreation areas, particularly in rural locations and in areas with pronounced seasonal variation, is usually about 50 times the design load, which is the number of visitors to a recreation area or site on an average summer Sunday. In very inaccessible areas and in those known for more restricted seasonal use, the multiplier would be less; in urban settings or in areas with less pronounced seasonal use patterns, the multiplier would be greater. In any case, the actual estimation of use involves an analytical procedure using instantaneous capacities, daily turnover rates, and weekly and seasonal use patterns as specific data inputs."

"Because the capacity method does not involve the estimation of site-specific demand, its use is valid only when it has been otherwise determined that sufficient demand exists in the market area of project alternatives to accommodate the calculated capacity. Its greatest potential is therefore in urban settings where sufficient demand obviously exists. Additionally, its use should be limited to small projects with (1) a facility orientation (as opposed to a resource attraction), and (2) restricted market areas that would tend to make the use of alternative use estimating procedures less useful or efficient."

The guidance provided in EGM 17-03 to estimate reasonable user rate projections requires determination of resource or facility capacities and assumes that adequate demand exists. As mentioned in EGM 17-03, use is valid if it is determined that sufficient demand exists in the market area of project alternatives to accommodate the calculated capacity. Its greatest potential is therefore in urban settings where sufficient demand obviously exists like the Pearl River Basin, MS, Federal Flood Risk Reduction Project. According to the Mississippi ORP, Mississippi's population and recreation demands continue to grow. Population in the state was projected to increase by approximately 3% every five years, and the trend is predicted to continue. The demand for recreation facilities is also rising quickly. In addition, demands for recreation are rising as the baby boomer generation ages and facilities fail to keep up with the growth. The top four recreation demands in Mississippi are for picnic areas, trails, hiking/jogging/biking, and boating/fishing. The recreation facilities proposed for the Channel Improvements Alternative (Alternative C) would help address these needs.[1]

According to the MS ORP, one of Mississippi's greater assets is a generally warm and pleasant climate. Most of the people engage in outdoor recreational activities throughout the 12 months of the year due to a climate classified as sub-tropical. Therefore, use is projected to occur throughout the 12 months of the calendar year, and 365 user days were selected as the number of days available annually for outdoor recreation for this analysis. Weekends account for 104 user days plus 11 Federal Holidays in Mississippi results in 115 days available for peak use. The remaining 250 user days for the rest of year are identified as off peak use days. Daily turnover rates were estimated to be two per day for peak use days and one per day for off peak use days. The number of units provided times the daily turnover rate times the peak use days or off peak use days provides the expected user days shown in Table 3.

The EGM for Unit Day Value states that the application of the selected value to estimated annual use over the project life, in the context of the with- and without-project framework of analysis, provides the estimate of recreation benefits. The starting point of the evaluation is the value in the without project condition. This report estimates that all the without project values for all criteria equals zero, because under without-project conditions the area is not very suitable for any recreation activities. The next step was the point evaluation of the with-project recreation facilities.

[1] Making Strides, Mississippi Outdoor Recreation Plan 2015-2019, July 15, 2014

The difference in points between the without-project and with-project conditions is the basis for the benefits.

Proposed Recreation Facilities

- Boat Ramp-Benefits per lane with "X" number of parking spots
- RV Camping-"X" number of pads with hook-ups, bath house, playground, etc.
- Tent Camping-"X" number of camp sites with bath house, playground, etc.
- Cabins
- Fishing Piers
- Nature/hiking trails-Benefits per foot/mile
- Wildlife Viewing

Assumptions

In this relatively densely populated urban setting the multiplier is estimated as the instantaneous capacity. The estimation of use involves an analytical procedure using instantaneous capacities, daily turnover rates, and weekly and seasonal use patterns as specific data inputs. Instantaneous capacity was estimated as the design capacity of the recreation facilities. The instantaneous capacity is the expected number of users and is stated below. The following assumptions were made to estimate the recreation benefits that would accrue to the proposed recreation facilities. The calculations are summarized in Table 3.

Peak Activity Days per year are assumed to be Weekends and Federal Holidays equaling 115 days and Off Peak Activity Days per year are the rest of the days of the year. For the boat ramps, RV camping, cabin rentals, and tent camping, half of the facility users would be couples and half would be families of four resulting in the average number of users per occasion being three persons. Fishing, nature/hiking trails, and wildlife viewing were assumed to be individual users so the number of users per occasions was one.

<u>Boat Ramp-Benefits per lane with "X" number of parking spots</u>

Peak Activity Days: Two boats per hour would launch or take out per day during 12 hour days, 24 launches/take outs X 3 persons per occasion = 72 users per day.

Off Peak Activity Days: One boat per hour would launch or take out per day during 12 hour days, 12 launches/take outs X 3 persons = 36 users per day.

<u>RV Camping - "X" number of pads with hook-ups, bath house, playground, etc.</u>

Peak Activity Days: One RV per day X 3 persons = 3 users per day.

Off Peak Activity Days: One RV every other day or one half RV per day 0.5 X 3 persons = 1.5 users per day.

<u>Tent Camping-"X" number of camp sites with bath house, playground, etc.</u>

Peak Activity Days: One Camping Group per day X 3 persons = 3 users per day.

Off Peak Activity Days: One Camping Group every other day or one half Camping Group per day, 0.5 X 3 persons = 1.5 users per day.

Cabins

Peak Activity Days: One Cabin Rental per day, 1 cabin X 3 persons = 3 users per day.
Off Peak Activity Days: One Cabin Rental every other day or one half Cabin Rental per day, 0.5 X 3 persons =1.5 users per day.

Fishing Pier (500 sq. ft.)

Peak Activity Days: One person per 15 square feet per day, 500 sq. ft. /15 sq. ft. = 33 users per day.
Off Peak Activity Days: One person per 30 square feet per day, 500 sq. ft. /30 sq. ft. = 17 users per day.

Nature/hiking trails-Benefits (1,500 linear ft.)

Peak Activity Days: One person per 60 feet, 1,500 linear ft. /60 linear ft. = 25 users per day.
Off Peak Activity Days: One person per 120 linear feet, 1,500/120 linear ft. = 13 users per day.

Wildlife Viewing (1,500 sq. ft.)

Peak Activity Days: One person per 20 sq. ft., 1,500 sq. ft. / 20 = 75 users per day.
Off Peak Activity Days: One person per 40 sq. ft., 1,500 sq. ft. /40 sq. ft. = 38 users per day.

Table 3. Most Likely Recreation Participation User Day Projection Scenario

Activity	Units Provided	Daily Turnover Rates	Average Number of Users per Occasion	User Days	Expected Number of Users
Boat Ramp-Benefits per lane with "X" number of parking spots	1	24 Peak Activity Days	3	115	8,280
Boat Ramp-Benefits per lane with "X" number of parking spots	1	12 Off Peak Activity Days	3	250	9,000
RV Camping-"X" number of pads with hook-ups, bath house, playground, etc.	1	1 Peak Activity Days	3	115	345
RV Camping-"X" number of pads with hook-ups, bath house, playground, etc.	1	0.5 Off Peak Activity Days	3	250	375
Tent Camping-"X" number of camp sites with bath house, playground, etc.	1	1 Peak Activity Days	3	115	345
Tent Camping-"X" number of camp sites with bath house, playground, etc.	1	0.5 Off Peak Activity Days	3	250	375
Cabins	1	1 Peak Activity Days	3	115	345
Cabins	1	0.5 Off Peak Activity Days	3	250	375
Fishing Piers	500 sq. ft.	1/15 sq. ft. Peak Activity Days	33	115	3,795
Fishing Piers	500 sq. ft.	1/30 ft. Off Peak Activity Days	17	250	4,250

Activity	Units Provided	Daily Turnover Rates	Average Number of Users per Occasion	User Days	Expected Number of Users
Nature/hiking trails	1,500 linear ft.	1/60 linear ft. Peak Activity Days	25	115	2,875
Nature/hiking trails	1,500 linear ft.	1/120 linear ft. Off Peak Activity Days	13	250	3,250
Wildlife Viewing	1,500sq. ft.	1/20 sq. ft. Off Peak Activity Days	75	115	8,625
Wildlife Viewing	1,500sq. ft.	1/40 sq. ft. Off Peak Activity Days	38	250	9,500
Annual Recreation User Days Total					51,735

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