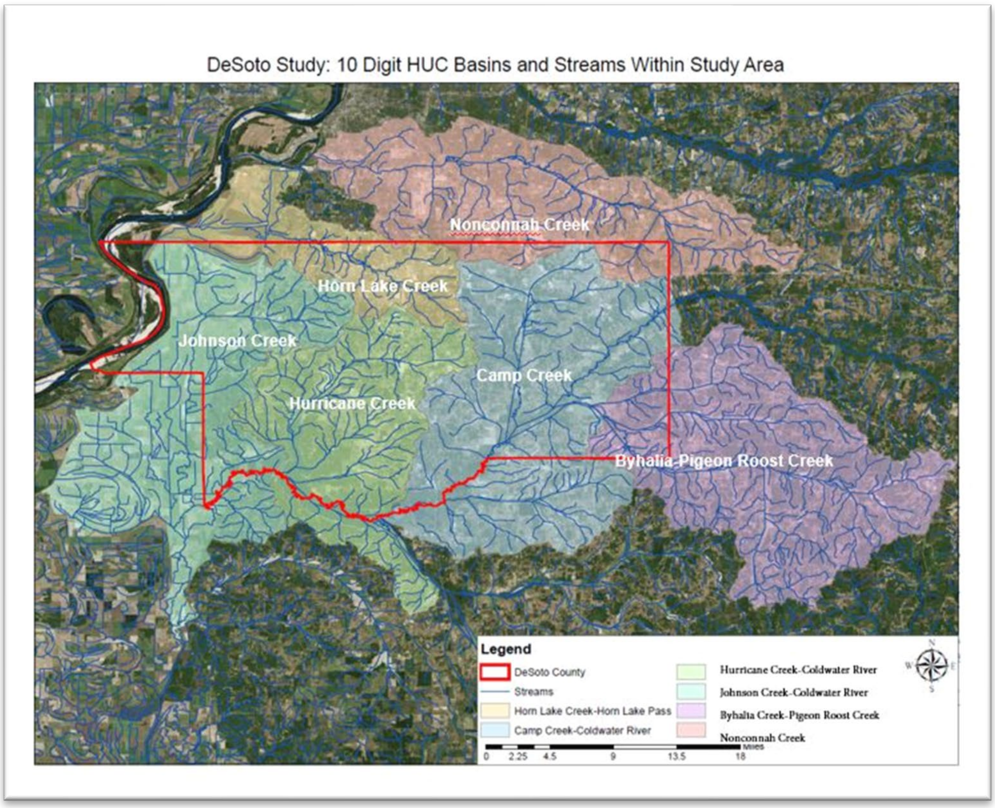
MEMPHIS METROPOLITAN STORMWATER-NORTH DESOTO FEASIBILITY STUDY, DESOTO COUNTY MISSISSIPPI



APPENDIX L-ECONOMICS

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REVISED DRAFT FEASIBILITY REPORT
DRAFT Economics Appendix

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1.0 BACKGROUND INFORMATION

1.1 INTRODUCTION

This appendix presents an economic evaluation of the riverine flood risk reduction measures for the DeSoto County Feasibility Study. The evaluation area includes multiple watersheds within DeSoto County, Mississippi. The report was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, and ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies. The National Economic Development Procedures Manual for Flood Risk Management and Coastal Storm Risk Management, prepared by the Water Resources Support Center, Institute for Water Resources, was also used as a reference, along with the User's Manual for the Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA).

The economic appendix consists of a description of the methodology used to analyze the damages and benefits across the National Economic Development (NED), Regional Economic Development (RED), and Other Social Effects (OSE) accounts for comparison of proposed alternatives. Estimated project costs provided by the USACE Memphis District Cost Engineering Brach are incorporated into the analysis to weigh against the benefits (reduction in damages). The damages and costs were calculated using FY 2022 price levels. Costs were annualized using the FY 2022 Federal discount rate of 2.25 percent and a period of analysis of 50 years with the year 2025 as the base year. The expected annual damage and benefit estimates were compared to the annual construction costs and the associated OMRR&R costs for each of the project measures.

NED Benefit Categories Considered.

The NED procedure manuals for riverine and urban areas recognize four primary categories of benefits for flood risk management measures: inundation reduction, intensification, location, and employment benefits. The majority of the benefits attributable to a project measure 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 and indirect losses to the national economy.

Physical Flood Damage Reduction.

Physical flood damage reduction benefits include the decrease in potential damages to residential and non-residential structures, their contents, and the privately owned vehicles associated with these structures.

NED Benefit Categories NOT Considered.

The following NED benefit categories were not addressed in this economic appendix prior to selection of a Tentatively Selected Plan (TSP) include the following:

- Indirect losses to the national economy as a result of disruptions in the production of goods and services by industries affected by the storm or riverine flooding
- Increased cost of operations for industrial facilities following a flood event relative to normal business operations
- Physical loss of agricultural crops grown to be sold for commercial profit
- Emergency Cost Reduction
- Traffic Detour Transit Delay Reduction

Regional Economic Development

When the economic activity lost in a flooded region can be transferred to another area or region in the national economy, these losses cannot be included in the NED account. However, the impacts on the employment, income, and output of the regional economy are considered part of the RED account. The input-output macroeconomic model RECONS can be used to address the impacts of the construction spending associated with the project alternatives and will be used on this project.

Other Social Effects

The other social effects (OSE) account includes impacts to life safety, vulnerable populations, local economic vitality, and community optimism. Impacts on these topics are a natural outcome of civil works projects and are most commonly qualitatively discussed in the OSE account. Life loss modeling software such as LifeSim has the ability to quantify loss of life for a given alternative to determine if life safety risk decreases or is induced as a result of federal investment. The OSE account is addressed qualitatively in the draft report, and the final report will examine depth x velocity flood forces on critical streets to determine if a detailed quantitative OSE study is required.

1.2 DESCRIPTION OF THE STUDY AREA

Geographic Location

North DeSoto County study area is located on the border of Southern Tennessee and Northern Mississippi with includes the cities of Horn Lake, Southaven, Olive Branch, and Hernando. The North DeSoto County measures for the study area will be analyzed in this part of the Economics Appendix. An inventory of residential and non-residential structures was developed using the National Structure Inventory (NSI) version 2.0 for the portions of the county impacted by riverine flooding associated with the future without project condition. Figure L:1-1 shows the structure inventory and the boundaries of the counties.

The structure inventory for the economic analysis started with the entire study area (gray dots), but after applying the effective Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), the economics team found a limited number of structures exposed to riverine flood hazards. For this study, the structure inventory was modified to include two major basins: Horn Lake and Coldwater. Horn Lake includes the streams of Horn Lake Creek, Rocky Creek, Cow Pen Creek, and Lateral D. Coldwater includes the streams of Coldwater, Camp, Licks, and Nolehoe. Other streams such as Hurricane, Short Fork, Pigeon Roost, Red Banks, Short Fork, Short, and Bean Patch were analyzed, but no flood prone structures existed at the time of the analysis.

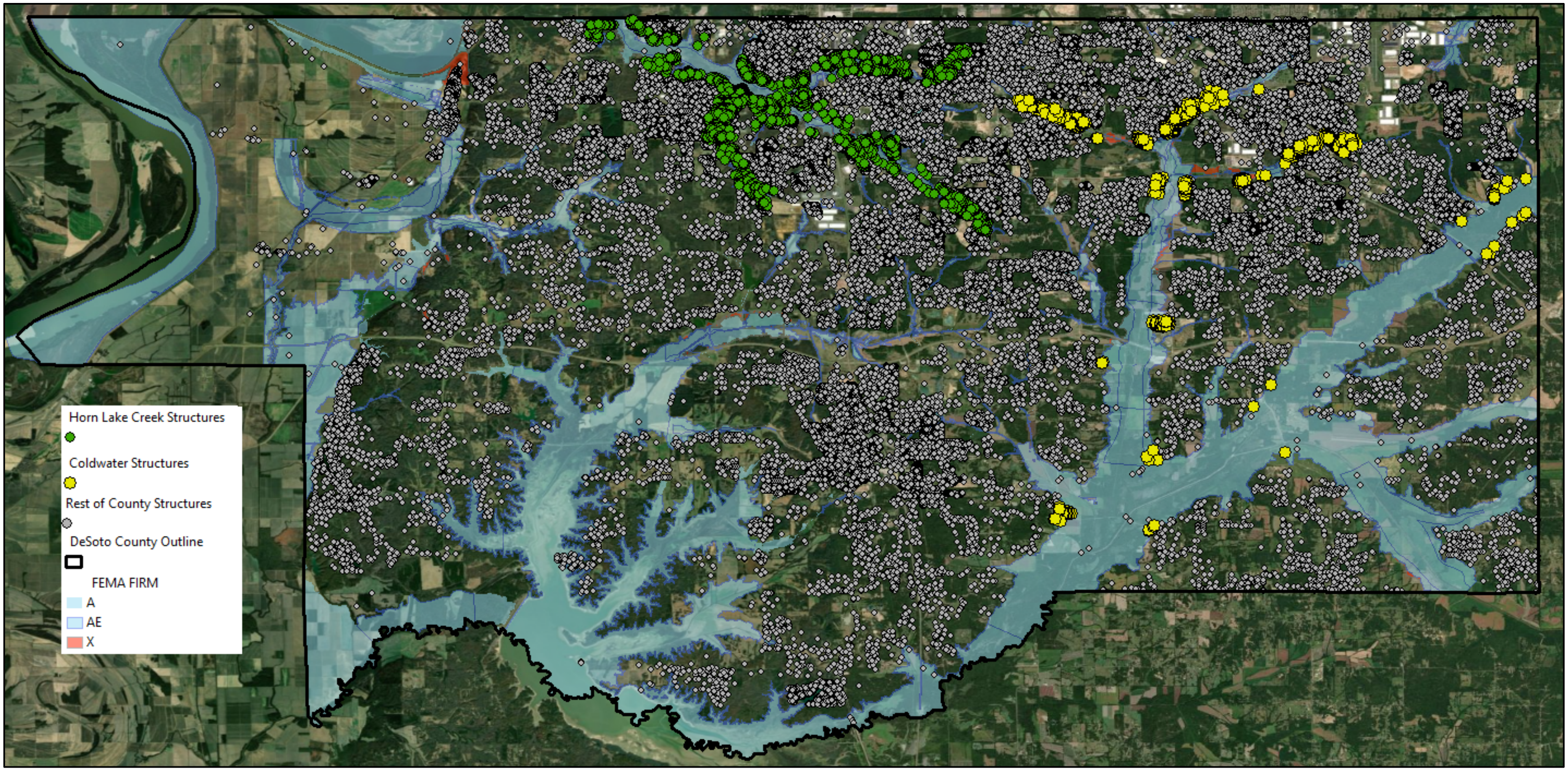

Figure L:1-1. *North DeSoto County Boundary and Structure Inventory*

The study area was divided into reaches, which are reaches designed by the hydraulic engineer to contain areas that experienced similar hydraulic conditions or further broken down in areas with high concentrations of structures. Some reaches are small, designating rapidly changing hydraulic conditions across the study area. Other clusters of reaches are larger, designating more consistent water surface profiles. Structures located within each reach were assigned that area. Figure L:1-2 shows the study area reach boundaries for Horn Lake Basin. Figure 3 shows the study area reach boundaries for Coldwater Basin. Table L:1-1 and Table L:1- 2 shows a structure count by reach, split by the structure being either residential or non-residential, which includes commercial, industrial, and public structures. The study area has a total of 2,722 structures in Horn Lake Basin and 973 structures in Coldwater Basin located across the combined 28 study area reaches. Total investment value of structures in Horn Lake Basin is approximately $670 million, $490 million of which is residential and $180 million non-residential. Total investment value of structures in Coldwater Creek is about $200 million, $130 million of which is residential and $70 million non-residential.

Table L:1-1. Horn Lake Creek Reach Designations & Structure Count

Reach	Upstream Station	Downstream Station	Residential Count	Non-Residential Count	Total Structure Count
		HORN LAKE CREEK BASIN			
Horn Lake 1	8.30	15.30	114	6	120
Horn Lake 2	15.30	18.20	119	0	119
Horn Lake 3	18.20	18.94	180	20	200
Horn Lake 4	18.94	19.73	5	78	83
Horn Lake 5	19.73	21.50	12	17	29
Horn Lake 6	21.50	22.31	110	1	111
Horn Lake 7	22.31	23.81	90	0	90
Horn Lake 8	23.81	25.98	128	0	128
Rocky Creek 1	0.08	1.32	47	6	53
Rocky Creek 2	1.32	3.41	400	11	411
Rocky Creek 3	3.41	5.42	162	2	164
Cow Pen Creek 1	0.51	2.48	740	18	758
Cow Pen Creek 2	2.48	4.47	300	0	300
Lateral D 1	0.20	1.06	154	2	156
lateral D 2	1.06	2.57	0	0	0
		Total	2,561	161	2,722

Table L:1-2. Coldwater Basin Reach Designations & Structure Count

Reach	**Upstream Station**	**Downstream Station**	**Residential Count**	**Non-Residential Count**	**Total Structure Count**
		COLDWATER BASIN			
Coldwater 1	85741	119094	19	0	19
Coldwater 2	119094	186088	31	0	31
Camp 1	26161	32103	91	0	91
Camp 2	32103	53051	44	1	45
Camp 3	53051	64018	150	0	150
Camp 4	64018	71823	113	44	157
Nolehoe 1	4216	12221	27	4	31
Nolehoe 2	12221	15818	112	5	117
Nolehoe 3	15818	19401	28	11	39
Licks 1	9456	16311	14	19	33
Licks 2	16311	20565	86	5	91
Licks 3	20565	25141	169	0	169
		Total	884	89	973

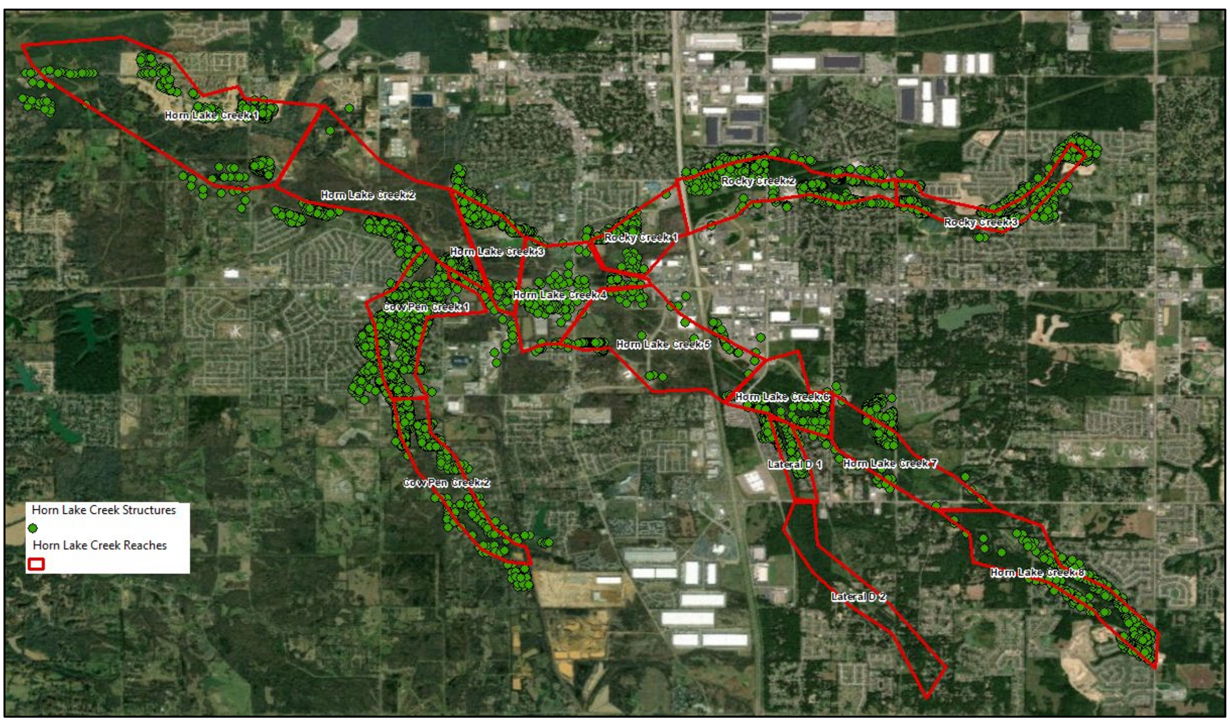

Figure L: 1-2. *Horn Lake Creek Reaches*

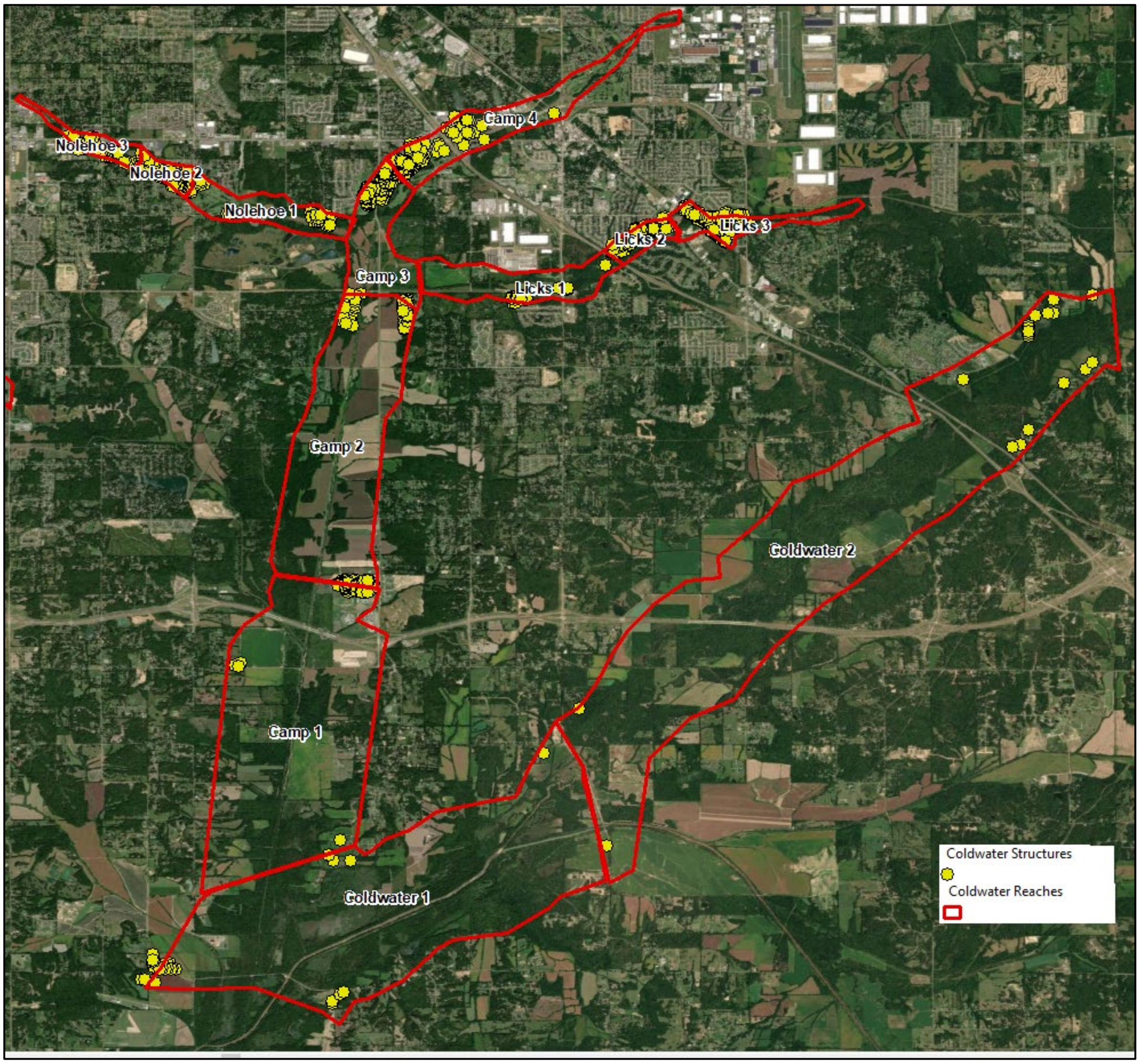

Figure L:1-3. Coldwater Basin Reaches

Land Use.

As shown in the Table L:1-3, 18 percent of DeSoto County are currently developed land. The rest of the land use is split between agricultural land, which includes pasture and hay, and undeveloped land. Undeveloped land is primarily classified as forest, wetlands, and shrubs.

Table L: 1-3. Land Use in DeSoto County, MS

Land Class Name	**Percentage**
Developed Land	18%
Agricultural Land	36%
Undeveloped Land	46%
Total	100%

Source: USGS National Land Cover Database

1.3 SOCIOECONOMIC SETTING

The socioeconomic setting for DeSoto County and Mississippi are reflected in the following section that includes statistics associated with population, households, employment, payroll, and per capita income and provides reviewers with a comparison of the study area (DeSoto County) with the state (Mississippi). While the study area does not reflect the entire county, it does account for the municipalities of Southaven, Olive Branch, and Horn Lake, which represents 67% of the population according to 2017 Census Bureau estimates. This section assumes that DeSoto County socioeconomic statistics reflect the study area.

Population, Number of Households, and Employment.

Table L:1- 4 shows the population trend in DeSoto County and in the State of Mississippi from 1970 to 2010 and projections through 2040. DeSoto County has rapidly grown since 1990 and is forecast to continue growing through 2040. Total number of households also shows a steady increasing trend from 1970 to 2010 and projections through 2040. The 2000 and 2010 estimates for population, number of households and employment are from the U.S. Census and the projections were developed by Moody's Analytics (ECCA) Forecast, which has projections to the year 2045.

Table L: 1-4. Historical and Projected Population

Total Population (Thousands)								
U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast								
	Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
DeSoto County	36.0	54.1	68.6	108.7	161.8	188.0	217.9	246.3
Mississippi	2,221.1	2,526.7	2,578.9	2,848.4	2,970.3	3,009.5	3,079.6	3,155.1

Sources: 2000, 2010, 2017 from U.S. Census Bureau; 2025, 2045 from Moody's Analytics (ECCA) Forecast

Table L:1-5. Existing Condition and Projected Households

Number of Households: Total (Thousands)								
U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast								
	Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
DeSoto County	9.3	16.3	23.5	39.4	58.0	69.2	83.6	97.9
Mississippi	638.1	829.1	913.3	1050.0	1118.0	1176.6	1248.1	1310.7

Sources: 2000, 2010, 2017 from U.S. Census Bureau; 2025, 2045 from Moody's Analytics (ECCA) Forecast

Table L:1-6 shows the growth of non-farm payroll over the last four decades and projections through 2040. Total nonfarm payroll employment is the number of paid US workers in all businesses, excluding those who work for farms, serve in the military, volunteer for nonprofit organizations, and perform unpaid work in their own household. Self-employed, unincorporated individuals are excluded as well. The leading employment sectors for DeSoto County are Trade, Transportation and Utilities; Leisure and Hospitality; Government; and Education & Health Services. Table L: 1-7 and L:1-8 show the Labor Force, Employment, Unemployment, and Unemployment Rate for DeSoto County and the State of Mississippi, respectively. DeSoto County has consistently had a lower unemployment rate than the State of Mississippi. The labor force shows a steady increase over the period and projected through 2040.

Table L:1-6. DeSoto County Non-farm Payrolls

Employment: Non-farm Payroll, (Thousands)								
DeSoto County (MS)								
U.S. Bureau of Labor Statistics: Census of Employment & Wages (QCEW - ES202); Moody's Analytics (ECCA) Forecast								
	Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Natural Resources and Mining	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02
Construction	0.22	0.68	0.98	1.90	1.86	2.32	2.83	3.54
Manufacturing	2.65	3.76	6.24	7.07	3.68	4.64	5.04	5.48
Trade; Transportation; and Utilities	1.14	2.59	5.10	9.13	14.29	20.74	24.56	28.89
Information	0.05	0.07	0.13	0.21	0.19	0.25	0.30	0.35
Financial Activities	0.35	0.46	0.69	1.06	1.64	1.61	1.95	2.34
Professional and Business Services	0.53	0.77	1.90	3.11	4.03	6.87	8.77	11.17
Education & Health Services	0.09	0.31	1.24	2.57	5.57	7.25	9.14	11.19
Leisure and Hospitality	0.46	0.79	1.47	4.00	6.99	10.27	12.89	16.03
Other Services (except Public Administration)	0.15	0.22	0.41	1.19	1.40	1.77	2.06	2.34
Government	1.60	2.09	2.37	3.84	6.75	7.57	8.94	10.17
Total Nonfarm payroll	7.28	11.76	20.54	34.08	46.42	63.30	76.49	91.52

Table L:1-7. DeSoto County Employment

Labor Force, Employment, Unemployment, and Unemployment Rate						
Desoto County						
BLS; Moody's Analytics (ECCA) Forecast						
	Dec-1990	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Labor Force, (Ths.)	37.38	59.23	79.62	89.12	103.05	119.81
Employment, (Ths.)	35.39	57.81	73.68	84.88	98.02	114.02
Unemployment, (Ths.)	2.00	1.42	5.94	4.24	5.03	5.79
Unemployment Rate, (%)	5.34	2.39	7.46	4.75	4.88	4.83

Table L:1-8. State of Mississippi Employment

Labor Force, Employment, Unemployment, and Unemployment Rate						
State of Mississippi BLS; Moody's Analytics (ECCA) Forecast						
	Dec-1990	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Labor Force, (Ths.)	1,183.98	1,319.27	1,306.61	1,269.67	1,312.42	1,389.67
Employment, (Ths.)	1,094.04	1,248.24	1,170.88	1,187.34	1,224.16	1,296.76
Unemployment, (Ths.)	89.94	71.03	135.73	82.33	88.26	92.90
Unemployment Rate, (%)	7.60	5.38	10.39	6.48	6.73	6.69

Income.

Table 9 shows the actual and projected per capita personal income levels for DeSoto County from 1970 through 2040.

Table L:1-9. DeSoto County per Capita Income ($)

Income: Per Capita, ($)							
U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast DeSoto County, MS							
Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
3,003	8,405	16,666	26,480	31,722	41,159	52,607	69,432

Compliance with Policy Guidance Letter (PGL) 25 and Executive Order 11988

Based on the socioeconomic data, DeSoto County has experienced significant population, employment, and income growth since 1990 and forecasts show this growth is expected to continue. Given continued growth, it is expected that development will continue to occur in the study area with or without riverine flood risk reduction measures and will not conflict with PGL 25 and EO 11988, which states that the primary objective of a flood risk reduction project is to protect existing development, rather than to make undeveloped land available for more valuable uses. However, the overall growth rate is anticipated to be the same with or without the project in place. Thus, the project will not induce development, but would rather reduce the risk of the population being displaced after a major riverine flood event.

1.4 FEMA FLOOD INSURANCE RATE MAPS (FIRMS)

Flood insurance rate maps from FEMA were utilized in this study to help evaluate flood risk in riverine areas. The effective date of the FIRM maps varies throughout the study area from June 2007 to May 2014.

The FEMA FIRMs were utilized during the plan formulation process to compare and help calibrate the existing condition hydraulic data. The effective base flood elevations were utilized when formulating the nonstructural methodology regarding elevating residential structures to help determine if that mitigation investment will reduce future flood insurance requirements for residential homeowners. Figure L:1-4 shows the effective riverine floodplains for the study area for Horn Lake and Coldwater Basins.

Figure L: 1-4. DeSoto County FEMA FIRM

1.5 CRITICAL INFRASTRUCTURE

The critical infrastructure identified within the North DeSoto study area is comparable to other study areas of similar economic characteristics. There are no significant industries within the study area that influence the existing condition critical infrastructure inventory. The critical infrastructure present includes hospitals, schools, electric substations, and emergency services (fire, police, EMS).

The structure inventory developed for the North DeSoto study area included all applicable critical infrastructure that has a damageable footprint with an associated depth-damage curve available. Excluded critical infrastructure from the structure inventory included electric substations, and some wastewater treatment plants. Figure L:1-5 and Figure L 1-6 show the critical infrastructure inventory for the Horn Lake and Coldwater Basins and is overlaid with the current FEMA flood mapping (1% and 0.2% AEP flood boundaries).

As shown in these figures, the only critical infrastructure threatened by the 1% or 0.2% AEP floodwaters are a few schools and an electric substation. The schools at risk are the Horn Lake Elementary School, located along Cow Pen Creek, and Concorde Career College, located along Rocky Creek. Recent channel improvements have reduced the flood risk to Horn Lake Elementary School, but the egress routes to both the north and south are modeled to be inundated to the point that egress vehicle traffic would be impeded, leading to limited evacuation routes through the residential neighborhood to the east.

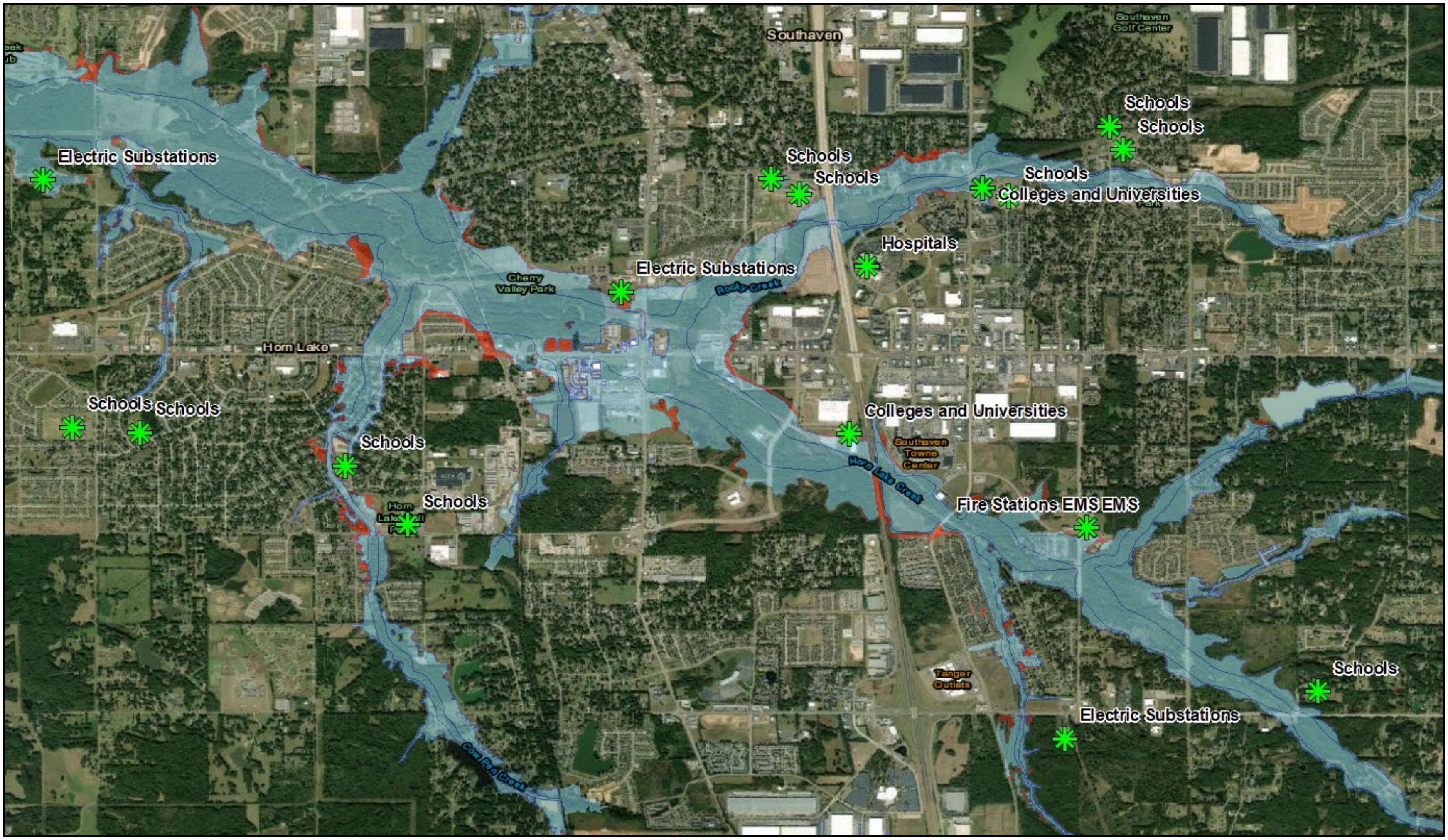

Figure L: 1- 5. Horn Lake Basin Critical Infrastructure

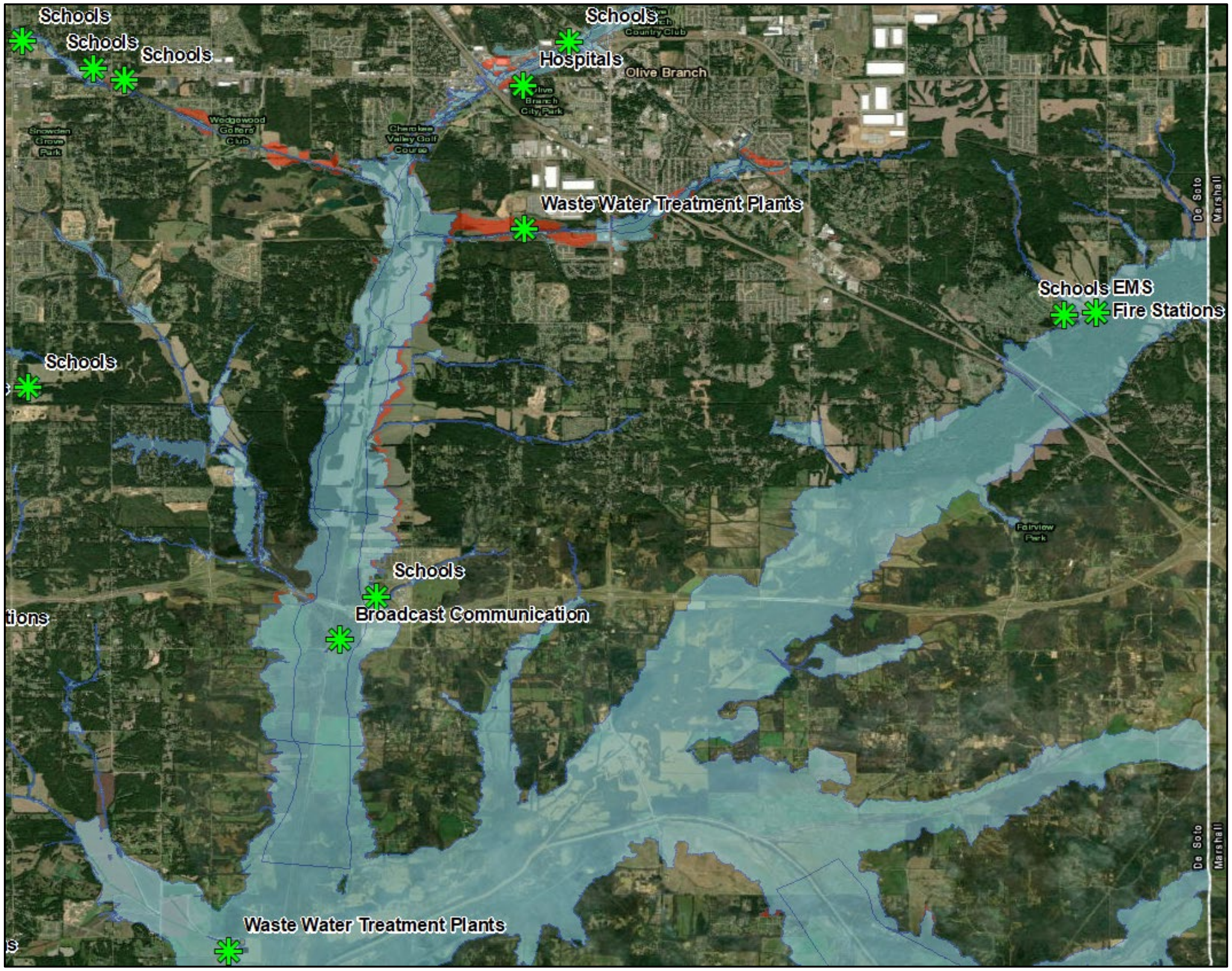

Figure L :1-6. Coldwater Basin Critical Infrastructure

1.6 SCOPE OF THE STUDY

Problem Description. The Horn Lake Creek and Coldwater Basins include both rural and urban areas that are encroaching floodplain boundaries. While there is limited available open space to be developed within the floodplain, the fringe and upland areas continue to be converted to impervious surfaces, leading to increased discharges to streams.

A total of 26 structural management measures plans were initially identified as options to reduce the risk of riverine flooding in either Horn Lake Creek or Coldwater Basins. Out of the 26 structural management measures, 18 plans were identified, and 6 alternatives were created that optimized costs and benefits the individual measures within each alternative. Measures carried forward to the focused array of alternatives include the following:

Table L: 1-10. Horn Lake Basin Focused Array

Horn Lake Basin Focused Array	**Plan Name**
Existing Without Project Condition for Horn Lake Basin	Existing Condition
25YR Horn Lake Creek Basin Nonstructural Aggregation	25YR
50YR Horn Lake Creek Basin Nonstructural Aggregation	50YR
100YR Horn Lake Creek Basin Nonstructural Aggregation	100YR
2005 Feasibility Report Design Features	Plan 7
Rocky Creek Detention	Plan 9
Horn Lake Creek Detention at Elmore	Plan 10
Lateral D Detention	Plan 11
Cow Pen Creek Detention	Plan 12
Horn Lake Creek Levee Without Channel Enlargement	Plan 14
Horn Lake Creek Bullfrog Corner Levee with Horn Lake Detention	Plan 16
Bullfrog Corner Levee with Detention on Rocky, Lateral D, Cow Pen, and Horn Lake Creeks	Plan 17
Horn Lake Creek Channel Enlargement (RM 18.86 – 19.41)	Plan 18
Detention on Rocky, Lateral D, Cow Pen, and Horn Lake Creeks	Plan 19
Detention on Rocky, Lateral D, and Cow Pen Creeks	Plan 20
Horn Lake Creek Channel Enlargement with Detention on Rocky, Lateral D, Cow Pen Creeks	Plan 21
Extended Horn Lake Channel Enlargement	Plan 22
Extended Horn Lake Channel Enlargement with Lateral D Detention	Plan 23
Extended Horn Lake Channel Enlargement with Cow Pen Detention	Plan 24
Extended Horn Lake Channel Enlargement with Rocky Detention	Plan 25
Extended Horn Lake Channel Enlargement with Cow Pen and Lateral D Detention	Plan 26

Extended Horn Lake Channel Enlargement with Cow Pen, Lateral D, and Rocky Detention	Plan 27

Table L:1-11. Coldwater Basin Focused Array

Coldwater Basin Focused Array	**Plan Name**
Existing Without Project Condition for Coldwater Basin	Existing Condition
25YR Coldwater Basin Nonstructural Aggregation	25YR
50YR Coldwater Basin Nonstructural Aggregation	50YR
100YR Coldwater Basin Nonstructural Aggregation	100YR

Of the 18 plans within the focused array, 4 were carried forward to the final array based on the updated 1D/2D hydraulic model. There are currently no justified plans within the Coldwater Basin within any of the final array alternatives.

Table L: 1-12. Final Array of Alternatives

Mixed Basin Final Array	**Plan Name**
Combined Existing Without Project Condition for Horn Lake and Coldwater Basins	Existing Condition
Extended Horn Lake Creek Channel Enlargement	Final 5
Extended Channel Enlargement and Lateral D Detention	Final 6
Extended Channel Enlargement, Lateral D, Cow Pen, Rocky Detentions	Final 7
Levee with Nonstructural Mitigation	Final 8

Nonstructural.

For nonstructural alternatives considered in the focused array, residential structures are elevated up to the future year 1% AEP stage, not to exceed 13 feet and non-residential structures are floodproofed up to 3 feet. A floodplain aggregation methodology was utilized that grouped structures together based on their flood depth relative to first floor elevation during various riverine events (4%, 2%, and 1% AEP). For example, all structures with flood depths greater than the first-floor elevation during the 4% AEP (25-year) event would be grouped together into a “25-Year Aggregation” nonstructural plan. Evaluating a group of structures together instead of individually helps remove bias related to structure values, building type, social status, or any other contributing factor besides the combination of flood frequency and magnitude.

While the non-residential floodproofing is limited to 3 feet, the height of elevating structures can be variable up to 13 feet. There are several factors that were utilized to come up with the assumption of elevating to the future year 1% AEP stage. The first factor deals with the long-term performance that any nonstructural alternative selected will be effective for at least 50 years. A significant portion of the cost to elevate residential structures is based on mobilization, and therefore to the extent possible, the elevation recommendations should be high enough to limit the likelihood that a structure would have to be re-elevated prior to the 50-year project life being concluded. The second factor deals with feedback from the public about the ability to afford to live in the study area given high flood insurance premiums. By ensuring that structures are raised to an elevation that exceeds the base flood elevation, the study is assisting locals with the ability to maintain affordable housing and neighborhood cohesion. The study will optimize heights associated with elevating residential to ensure they reasonably maximize net benefits by the final report.

No all-nonstructural alternatives have been carried forward to the final array. The costs associated with the 25-year nonstructural aggregation were too high to justify economically, even if all damages in the study area were removed, according to the existing condition damages in the 1D/2D hydraulic model. Alternative aggregation methods using the 1D/2D hydraulic model may result in a justified nonstructural aggregation and will be analyzed post-TSP. Nonstructural floodproofing of 29 structures is included in plan 8 to mitigate inducements from the levee.

2.0 ECONOMIC AND ENGINEERING INPUTS TO THE HEC-FDA MODEL

2.1 HEC-FDA MODEL

Model Overview.

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.4.3 Corps-certified model was used to calculate the damages and benefits for the North DeSoto County evaluation. The economic and engineering inputs necessary for the model to calculate damages for the project base year (2025) include the existing condition structure inventory, contents-to-structure value ratios, vehicles, first floor and ground elevations, and depth-damage relationships, and without-project and with-project stage-probability relationships.

The uncertainty surrounding each of the economic and engineering variables was also entered into the model. Either a normal probability distribution, with a mean value and a standard deviation, or a triangular probability distribution, with a most likely, a maximum and a minimum value, was entered into the model to quantify the uncertainty associated with the key economic variables. A normal probability distribution was entered into the model to quantify the uncertainty surrounding the ground elevations. The number of years that stages were recorded at a given gage was entered for each study area reach to quantify the hydrologic uncertainty or error surrounding the stage-probability relationships.

The following economic inputs section is divided into four primary components:

1) **Structure Inventory** – discusses methodology, structural value estimation, content-to-structure value ratios, vehicle value estimation, and flood related damages and costs

2) **Elevation Data & Sampling** – discusses ground surface elevation, foundation heights, first floor elevations, and sampling structural attributes

3) **Structure Inventory Uncertainty** – discusses the uncertainty distributions surrounding structure values, content-to- structure value ratios, vehicle values, and flood related damages and costs, and how the distributions were generated

4) **Depth Damage Relationships** – discusses the depth damage relationships, uncertainty and how the distributions were generated

2.2 ECONOMIC INPUTS TO THE HEC-FDA MODEL

Structure Inventory

A structure inventory of residential and non-residential structures for the SCCL study area was obtained using the National Structure Inventory (NSI), version 2.0. NSI was originally created by USACE to simplify the GIS pre-processing workflow for the Modeling Mapping and Consequence center (MMC) and was recently upgraded to version 2 using upgraded data sources and algorithms. The NSI 2.0 database was significantly improved through various techniques further described in subsequent sections.

NSI 2.0 sources its structural attribute data from tax assessed parcel data (available through CoreLogic), business location data available through Esri/Infogroup, and HAZUS (where other datasets were unavailable). NSI 2.0 data is not an exact representation of reality, but rather contains many county-level, state-level, or regional assumptions applied to individual structures, often by random assignment. As such, while county or other large aggregations of structures will be accurate on average, individual structure characteristics may not be accurate. Although these and other accuracy issues exist, the NSI 2.0 dataset functions as an available common and consistent standard for the United States. The chief advantage of NSI 2.0 over other national datasets is its spatial accuracy, which is a significant improvement over the census block level accuracy that NSI 1.0 relied on.

Occupancy Types

The NSI 2.0 database comes with its own list of occupancy types, which describes the type of structure more than simply residential or non-residential. Occupancy types are important because they eventually are used to assign depth-damage relationships to determine the rate at which a structure is damaged given a depth of water. The North DeSoto Feasibility study utilized these three different occupancy types:

1. **NSI 2.0** – these occupancy type descriptions came with the original NSI 2.0 data and were the starting point for the study. The NSI 2.0 occupancy types were verified during sampling that was performed, especially in areas where high existing condition damages exist, such as bullfrog corner.

2. **RS Means** – to estimate costs per square foot for structures, the NSI 2.0 occupancy types were converted to RS Means occupancy types. In general, there was a unique RS Means occupancy type to match to each NSI 2.0 occupancy type, but certain structures were generalized, such as multi-occupancy apartment buildings. Professional judgment was used when combining occupancy types based on how the structure would be

damaged.

3. **Depth-Damage Relationships** – Neither the NSI 2.0 nor RS Means occupancy types matched the occupancy types required to use for the depth-damage relationships that were selected for the local flooding conditions found in the North DeSoto study area. Professional judgment was used again to sort each structure type into the most representative occupancy type that the depth damage relationships offered.

Table L 2-1 shows the conversion process of moving structures through the three different occupancy types. Further descriptions of each occupancy type can be found in subsequent sections of the report.

Table L: 2-1. Occupancy Type Conversions

RS Means OccType	NSI 2.0 OccType	Depth-Damage OccType
Post Frame Barn	AGR1	Barn
Store, Retail	COM1	Retail
Warehouse	COM2	StorageCom/StorageInd
Garage, Service Station	COM3	StorageCom
Office, 1 Story	COM4	OfficeCom
Bank	COM5	OfficeCom
Hospital, 2-3 Story	COM6	Pub2
Medical Office, 1 Story	COM7	OfficeCom
Restaurant	COM8	Restaurant
School, Elementary	EDU1	School
Office, 1 Story	GOV1	Pub2
Police Station	GOV2	Pub2
Office, 1 Story	IND6	OfficeInd
1 Story Residential	RES1-1SNB	Oreswoutbsmt
2 Story Residential	RES1-2SNB	Treswoutbsmt
Mobile Home	RES2	MobHome
1 Story Residential	RES3A	Apt1
Apartment, 1-3 Story	RES3B	Apt1
Apartment, 1-3 Story	RES3C	Apt1
Apartment, 1-3 Story	RES3D	Apt1
Apartment, 1-3 Story	RES3E	Apt1
Motel, 1 Story	RES4	Apt1

Structure Values

As previously identified in the description of NSI 2.0, the national database has limitations and oversimplifications that lead to unacceptable levels of uncertainty for a feasibility level study. To overcome the limitations and reduce uncertainty, RS Means was used to reevaluate the depreciated replacement values and multiple statistically significant samples were performed to ensure an accurate representation of structural attributes. This process is further described in the “Sample Structural Attributes” section.

Application of RS Means – Residential Structures

The 2020 RS Means Square Foot Costs Data catalog was used to assign a depreciated replacement cost per square foot value to residential structures. The RS Means system of valuation provides the user to customize the following primary items: exterior wall type, build quality, additions, depreciation, and regional factors.

- Exterior Wall Type - Replacement costs per square foot were provided for four exterior walls types (wood frame, brick veneer, stucco, or masonry) and an **average** cost per square foot for the **four exterior wall types** was computed since there was not enough information to determine the exact wall types per structure.

- Build Quality – Build quality of a structure helps determine how high the starting cost per square foot should be for structures. Based on windshield surveys (using Google Street View), it was determined that the characteristics of the structures in the area were consistent with those of the **average build quality** (economy and luxury/custom homes existed but were in the minority).

- Depreciation – Depreciation of a structure is based on the observed condition (effective age) of the structure and can be described as the structures wear and tear since it was constructed or last rehabilitated. Based on windshield surveys (using Google Street View), it was determined that the average condition of residential structures in the area was **20 years old**, and therefore structure values were **depreciated on average 20 percent** based on RS Means depreciation schedule. See the “Structure Value Uncertainty” on how uncertainty in observed condition impacts the uncertainty surrounding structure values.

- Region - A regional adjustment factor was applied to the cost per square foot to account for construction costs (**0.85 for residential**) consistent with the **Memphis, Tennessee area**. Memphis was the closest adjustment factor to the North DeSoto study area and was applied to the depreciated cost per square foot.

- Additions – RS Means allows for users to enter additional structural features that may be present beyond the default features. Based on windshield surveys (using Google Street View), it was determined that a half-bath and attached one-car garage was appropriate to add for both one-story and two-story residential structures. This adjustment represented approximately a 10% increase in the base cost per square foot estimate.

Application of RS Means – Non-residential Structures

The 2022 RS Means Square Foot Costs Data catalog was used to assign a depreciated replacement cost per square foot value to non-residential structures. The RS Means system of valuation provides the user to customize the following primary items: exterior wall type, build quality, additions, depreciation, and regional factors.

- Exterior Wall Type - Replacement costs per square foot were provided for six exterior wall types (decorative concrete with steel frame and with bearing walls frame, face brick with concrete block back-up with steel frame and with bearing walls frame, metal sandwich panel with steel frame, and precast concrete panel with bearing walls frame), and an **average** cost per square foot for the **six exterior wall types** was computed since there was not enough information to determine the exact wall types per structure.

- Build Quality – Build quality of a structure helps determine how high the starting cost per square foot should be for structures. Based on windshield surveys (using Google Street View), it was determined that the characteristics of the structures in the area were consistent with those of the **average build quality**, which is the only option for non-residential structures.

- Depreciation – Depreciation of a structure is based on the observed condition (effective age) of the structure and can be described as the structures wear and tear since it was constructed or last rehabilitated. Based on windshield surveys (using Google Street View), it was determined that the average condition of non-residential structures in the area was **20 years old**, and therefore structure values were **depreciated on average 25 percent** based on RS Means depreciation schedule. See the “Structure Value Uncertainty” on how uncertainty in observed condition impacts the uncertainty surrounding structure values.

- Region - A regional adjustment factor was applied to the cost per square foot to account for construction costs (**0.86 for non-residential**) consistent with the **Memphis, Tennessee area**. Memphis was the closest adjustment factor to the North DeSoto study area and was applied to the depreciated cost per square foot.

- Additions – RS Means allows for users to enter additional structural features that may be present beyond the default features. No additional features were added to non-residential structures.

The formula to determine depreciated replacement value for structures is simplified as follows:

$$Avg.\,Cost\ per\ sq\ ft * Avg.\ depreciation\ factor *\ Regional\ adjustment\ factor$$

The mean final cost per square foot by occupancy type was then applied to every structure in the inventory to determine depreciated replacement values. The square footage for each of the individual residential structures was multiplied by the size-specific depreciated cost per square for the average construction class to obtain a total depreciated cost. Finally, the Marshall and Swift Valuation Service was used to calculate a depreciated replacement cost per square foot for the manufactured or mobile homes in the Southern Louisiana area since mobile homes are not included in the RS Means catalog.

Square Foot Estimation

Square foot estimates were sampled using structures within the 0.2% AEP aggregation. Microsoft Building Footprints were utilized to improve the data source of the square foot estimate. Microsoft Building Footprints is a GIS outline of each structure generated from an algorithm that recognizes building pixels on aerial imagery and converts the building pixels into polygons. While Microsoft estimates that the error of such estimates is only 1.15%, the pixels detected include the overhang of the roof, and therefore overestimate the square footage for buildings with eaves. Historical USACE studies using Microsoft Building Footprints have used GIS measurement techniques to determine that the overestimation is approximately 10% to 20%. Square foot estimates for SCCL were reduced by 20% to account for roof overhang. Additional adjustments using professional judgement were made to account for occupancy types with more than one story since the footprints only measure a single floor.

Final square footage estimates per building footprint were spatially joined to the underlying structure points in GIS. Each occupancy type received an average square footage estimate based on the individual structures included within that occupancy type. The square footages sampled for each occupancy type have not been compared to other square footage estimates within the region or country but will be by the final report.

Table L: 2-2 shows the structure count and distribution of square foot estimates for each of the RS Means and NSI 2.0 occupancy types. Table 14 shows the results of the RS Means valuation analysis, which is the triangular distribution of cost per square foot by occupancy type. More information on RS Means triangular distribution is provided in subsequent sections.

Table L:2-2. RS Means Structure Inventory Statistics

			RS Means Cost per Sq Ft		
Occupancy Type (NSI 2 - RS Means)	Count	Avg. Square Ft	Minimum	Most Likely	Maximum
AGR1 - Post Frame Barn	8	3,900	29	36	44
COM1 - Store, Retail	107	12,900	70	88	108
COM3 - Garage, Parking	1	11,500	44	55	67
COM2 - Warehouse	53	9,900	66	82	101
COM3 - Garage, Service Station	86	5,200	115	144	176
COM4 - Office, 1 Story	120	13,101	92	115	141
COM5 - Bank	9	4,300	135	169	208
COM6 - Hospital, 2-3 Story	5	127,900	177	221	271
COM7 - Medical Office, 1 Story	25	7,300	104	130	160
COM8 - Restaurant	48	9,800	112	140	172
EDU1 - School, Elementary	6	77,100	96	120	147
GOV2 - Police Station	1	2,800	154	192	236
IND1-4 - Factory, 1 Story	11	7,001	75	94	116
REL1 - Church	22	30,700	94	118	145
RES1-1SNB - 1 Story Residential	3,166	1,387	72	105	122
RES1-2SNB - 2 Story Residential	1,726	2,854	55	80	93
RES1-2SNB - Bi-Level Residential	126	1,333	70	102	118
RES2 - Mobile Home	16	1,300	24	50	73
RES3 - Apartment, 1-3 Story	42	9,669	105	131	161
RES4 - Motel, 1 Story	6	18,600	76	95	117
RES6 - Nursing Home	2	13,300	122	153	188

Structure Inventory Uncertainty

The uncertainty surrounding the residential structure values includes the depreciation percentage applied based on the effective age and condition of the structures as well as the four exterior wall types. A triangular probability distribution was developed for residential structures using the following RS Means information:

- Minimum Depreciation – Effective Age: 10 Years & Good Condition
- Most Likely Depreciation – Effective Age: 20 Years & Average Condition
- Maximum Depreciation – Effective Age: 30 Years & Poor Condition

Effective age for this uncertainty analysis was defined as the average observed age of a structure as recorded during the windshield survey. These values were then converted to a percentage of the most-likely value with the most-likely value equal to 100 percent of the average value for each exterior wall type and occupancy category. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values in each residential occupancy category.

The uncertainty surrounding the non-residential structure values was based on the depreciation percentage applied to the average replacement cost per square foot calculated from the six exterior wall types. A triangular probability distribution was developed for non-residential structures using the following RS Means information:

- Minimum Depreciation – Effective Age: 10 Years & Masonry on Masonry/Steel
- Most Likely Depreciation – Effective Age: 20 Years & Masonry on Wood
- Maximum Depreciation – Effective Age: 30 Years & Frame

These values were then converted to a percentage of the most-likely value with the most-likely value being equal to 100 percent and the minimum and maximum values equal to percentages of the most-likely value. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values for each non-residential occupancy category. Table L: 2-3 shows the minimum and maximum percentages of the most-likely structure values assigned to the various structure categories.

Table L:2-3. RS Means Structure Value Uncertainty Factors

	RS Means Cost per Sq Ft Factor		
RS Means Occupancy Type	Minimum	Most Likely	Maximum
Non-Residential	0.80	1.00	1.23
1 Story Res	0.69	1.00	1.16
2 Story Res	0.69	1.00	1.16
Mobile Home	0.48	1.00	1.47

Residential and Non-Residential Content-to-Structure Value Ratios.

Based on Economic Guidance Memorandum (EGM), 04-01, dated 10 October 2003, a content-to-structure value ratio (CSVR) of 100 percent was applied to all of the residential structures in the structure inventory and the error associated with CSVR was set to zero. The EGM states that the 100 percent CSVR is to be used with the generic depth-damage relationships developed for residential structures, which were also used for this study.

The content-to-structure value ratios (CSVRs) applied to the non-residential structure occupancies were taken from the 1996 Jefferson-Orleans report titled, "Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Jefferson and Orleans Flood Control Feasibility Studies." The study contracted with Gulf Engineers and Consultants (GEC) to develop unique depth-damage relationships and CSVRs for nonresidential structures. Depth-damage relationships for structures and contents were assigned to various structure categories in freshwater and saltwater environments with long-duration and short-duration variants.

Content-to-Structure Value Ratio Uncertainty. For each occupancy type, a mean CSVR and a standard deviation was calculated and entered into the HEC-FDA model using the information gathered from the Jefferson-Orleans study. A normal distribution was used to describe the uncertainty surrounding the CSVR for each content category. The expected CSVR percentage values and standard deviations for each of the occupancy types are shown in Table L:2-4.

Table L:2-4. Content-to-Structure Value Ratios and Uncertainty

Occupancy Type	Average	Standard Deviation
1-Story Res	100%	0%
2-Story Res	100%	0%
Mobile Home	114%	79%
OfficeCom	43%	13.8%
StorageCom	168%	98.3%
Retail	142%	93.2%
Restaurant	114%	48.2%
Barn	200%	5%
Pub2	114%	71.5%
OfficeInd	168%	98.3%
School	114%	71.5%
Apt1	37%	14.3%

Vehicle Inventory Values

Based on 2017 Census information for the Memphis area, there are an average of 1.76 vehicles associated with each household (owner occupied housing or rental unit). According to the Southeast Louisiana Evacuation Behavioral Report published in 2006 following Hurricanes Katrina and Rita, approximately 70 percent of privately owned vehicles are used for evacuation during storm events. The remaining 30 percent of the privately owned vehicles remain parked at the residences and are subject to flood damages. According to Edmund, the average value of a used car was $19,700 as of June 2018. Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $10,400 ($19,657 x 1.76 x 0.30) was assigned to each individual residential automobile structure record in the HEC-FDA model. The $11,041 value has been indexed to FY22 price levels. Only vehicles associated with residential structures were included in the analysis. Vehicles associated with non-residential properties were not included in the evaluation.

Vehicle Value Uncertainty

The uncertainty surrounding the values assigned to the vehicles in the inventory was determined using a triangular probability distribution function. The average value of a used car, $19,700, was used as the most-likely value. The average value of a new vehicle, $33,560, before taxes, license, and shipping charges was used as the maximum value, while the average 10-year depreciation value of a vehicle, $3,000 was used as the minimum value. The percentages were developed for the most-likely, minimum, and the maximum values with the most-likely equal to 100 percent, and the minimum and the maximum values as percentages of the most-likely value (minimum=16%, most-likely=100%, maximum=180%). These percentages were entered into the HEC-FDA model as a triangular probability distribution to represent the uncertainty surrounding the vehicle value for both residential and non-residential vehicles.

Elevation Data & Sampling

Elevation data associated with the ground surface, foundation heights, and first floors of structures are critical to the economic analysis and feasibility of studies. Given the low-resolution of foundation height data provided with the NSI 2.0 database, a statistically significant sample was calculated to inform a windshield survey to improve the estimates associated with foundation and subsequent first floor elevations. The sample was also utilized to measure a hand-full of other structural attributes, detailed later in this section.

Two Google Street View windshield surveys were conducted:

1. The first was a preliminarily survey completed prior to calculating the formula in Figure 5 to determine the standard deviation of the average residential and commercial structures foundation height (S).

2. Once the standard deviation was estimated, it was entered into the formula in Figure 5 to determine how many structures to sample based on the designated stratification. The second windshield survey was the final survey performed.

The first (preliminary) survey in Google Street view was conducted using a baseline of regional averages for the inputs into the statistically significant sample formula. The primary assumption included the maximum and minimum foundation height expected by occupancy type in the case of North DeSoto County, 85 structures were sampled, which included 27 residential, 24 pubic, 10 commercial, and 24 industrial structures. The information gathered from the preliminary survey, such as the range (max – min) of foundation heights by construction category (S) informed how many additional structures would need to be sampled to meet the statistically significant threshold based on the Z-Value and allowable error used in the formula (See Figure 5).

The second survey resulted in adding an additional 28 residential (19 one-story, 5 two-story, 4 apartments), 28 commercial, 14 public, and 4 commercial structures to the sample count already identified in the first (preliminary) survey. The sample was randomly generated using a GIS-based sampling design tool developed by the National Oceanic and Atmospheric Administration (NOAA) to generate a geographically random sample of structures split between the occupancy types.

A third windshield survey was conducted on approximately 500 structures to collect data on foundation height, structure type, and structure placement.

See Figure L:2-1 for the statistically significant sample size formula utilized for this study.

$$n = \left(\frac{Z * S}{E}\right)^2 \text{, where}$$

n = Sample size

Z = Z-Value (1.96)

$$S = \frac{Foundation\ Height_{High} - Foundation\ Height_{Low}}{6}$$

E = Allowable error (0.20 feet)

Figure L:2-1. Statistically Significant Sample Size Formula

The allowable error within the formula deviated from 0.20 feet but was limited to 20% to 30% of the standard deviation of the foundation height to reduce the amount of uncertainty in the structural attributes being sampled.

The standard deviation of the final survey was compared to the preliminary survey and verified that the number of structures sampled exceeded the minimum calculated in the formula. The variables sampled included:

- Foundation height – measured from the bottom of the front door to adjacent ground, each step was assumed to be 8 inches
- Foundation type – designated as either slab on grade or crawlspace
- Story count – measured as either one- or two or more-story height
- Existing condition – qualitative judgment of the condition of the exterior of the structure condition
- Verification of occupancy type – confirmation of the occupancy being one of the 10 occupancy types
- Square footage – approximated square footage to be compared with estimates provided by Microsoft building footprints

Ground Surface Elevations

Topographical data based on Light Detection and Ranging (LiDAR) data using NAVD 88 vertical datum was processed by the United States Geological Survey (USGS) and provided in a 4-meter resolution raster format. The 4-meter LiDAR data were used to assign ground elevations to structures, vehicles, and roadways.

First Floor Elevations. The ground elevation was added to the height of the foundation of the structure above the ground in order to obtain the first-floor elevation of each structure in the study area. Vehicles were assigned to the ground elevation of the adjacent residential structures and did not include adjustments for foundation heights.

Elevation Uncertainty. There are two sources of uncertainty surrounding the first-floor elevations: the use of the LiDAR data for the ground surface elevations, and the measurement error associated with the structure foundation heights above ground elevation. A third source of uncertainty, the instrument error of Google Street View windshield survey, has not been quantified prior to the final report. The error surrounding the LiDAR data was determined to be plus or minus 0.5895 feet at the 95 percent level of confidence. This uncertainty was normally distributed with a mean of zero and a standard deviation of 0.3 feet.

The uncertainty surrounding the foundation heights for the residential and commercial structures was estimated by calculating the standard deviations surrounding the sampled mean values. An overall weighted average standard deviation for the four structure groups was computed for each structure category. Table 15 on the previous page shows the distribution of the foundation height uncertainty for each occupancy type.

The standard deviations for the ground elevations and foundation heights were combined, which resulted in a 0.35 feet standard deviation for residential slab and crawlspace structures. For commercial structures, the combined standard deviation was calculated to be 0.36 feet for slab structures. For industrial structures, the combined standard deviation was calculated to be 0.58 feet for slab structures. For public structures, the combined standard deviation was calculated to be 0.48 feet for slab structures Table L:2-5 displays the calculations used to combine the uncertainty surrounding the ground elevations with uncertainty surrounding the foundation height elevations to derive the uncertainty surrounding the first-floor elevations of residential, commercial, public, and industrial structures.

Table L:2-5. First Floor Stage Uncertainty Standard Deviation (SD) Calculation

Ground Elevation - LiDAR		
(conversion cm to inches to feet)		
+/- 18 cm @ 95% confidence		18cm
	x	0.393
z = (x - u)/ std. dev.		7.074in
	÷	12
1.96 = (0.5895 - 0)/ std.dev.		0.5895ft
0.3007 = std.dev.		

Foundation Height Elevation (shown in feet)			
Residential	Commercial	Public	Industrial
Slab	All	All	All
0.72	0.4	0.58	0.47

Combined First Floor Elevation

(shown in feet)

Residential	Commercial	Public	Industrial	
Slab	All	All	All	
0.3	0.3	0.3	0.3	ground elevation std. dev.
0.09	0.09	0.09	0.09	ground elevation std. dev. squared
0.18	0.2	0.38	0.5	1st floor elevation std dev.
0.03	0.04	0.14	0.25	1st floor elevation std. dev. squared
0.12	0.13	0.23	0.34	Sum of Squared
0.35	**0.36**	**0.48**	**0.58**	**Square Root of Sum of Squared = Combined Std. Dev.**

Note 1: Mobile Homes are assigned the same uncertainty as residential.
Note 2: Autos do not have foundations, so only ground uncertainty is used.

Depth-Damage Relationships

Each occupancy type has its own depth-percent of value damaged curves for structure and contents. The USACE generic depth-damage relationships for one-story and two-story residential structures with no basement from the Economic Guidance Memorandum (EGM), 04-01, dated 10 October 2003, were used in the analysis.

Site-specific non-residential depth-damage relationships were not available for the North DeSoto County study area. The depth-damage functions for non-residential structures were based on the data presented from the Jefferson-Orleans study conducted by GEC. The short-duration, freshwater relationships were used for this analysis. These relationships were deemed appropriate for North DeSoto due to similarities in the structure types and the study areas' geography.

The vehicle depth-damage functions were based on the generic depth-damage curves from EGM, 09-04, generic depth-damage relationships for vehicles, dated 22 June 2009. Based on low-clearance to high-clearance ratios used in HEC-LifeSim of 50/50, a weighted average depth-damage function was created using Sedan and Truck (pickups) generic values. The weighted average curve better represents a mean value for estimating vehicle damages within the study area.

Depth-damage relationships indicate the percentage of the total structure value that would be damaged at various depths of flooding. For residential structures, damage percentages were provided at each one-foot increment from two feet below the first-floor elevation to 16 feet above the first-floor elevation for the structural components and the content components. For non-residential structures, 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. Vehicle damage relationships were provided from one-half foot above the ground to 10 feet above the ground.

Uncertainty Surrounding Depth-Damage Relationships

For residential structures, a normal distribution with a standard deviation for each damage percentage provided at the various increments of flooding was used to determine the uncertainty surrounding the generic depth-damage relationships used for residential structures and vehicles. This information for residential structures was also sourced from EGM 04-01. For non-residential structures, the Jefferson-Orleans study was utilized to source a normal distribution.

Section 6 of this appendix (supplemental tables) shows the damage relationships for structures, contents, vehicles, other flood related damages and costs. The tables contain the damage percentages at each depth of flooding along with the uncertainty surrounding the damage percentages.

Summary of the HEC-FDA Model Uncertainty. The tables contain the damage percentages at each depth of flooding along with the uncertainty surrounding the damage percentages. Table L:2-6 shows a summary of all of the variables included within the HEC-FDA model that have uncertainty associated with them.

Table L:2-6. Summary of North DeSoto County Structure Inventory Uncertainty Distributions by Occupancy Type

Occupancy Type	**Foundation Height Error**	**LiDAR Error**	**First Floor Stage Error**	**Structure Value**			**Vehicle Value**		
				Triangular			Triangular		
	Normal	Normal	Normal	Min	Most Likely	Max	Min	Most Likely	Max
Oreswoutbsmt	18%	30%	35%	69%	100%	116%	16%	100%	180%
Treswoutbsmt	18%	30%	35%	69%	100%	116%	16%	100%	180%
Apt1	20%	30%	36%	80%	100%	123%	16%	100%	180%
MobHome	18%	30%	35%	48%	100%	147%	16%	100%	180%
Restaurant	20%	30%	36%	80%	100%	123%	N/A		
StorageCom	20%	30%	36%	80%	100%	123%			
OfficeCom	20%	30%	36%	80%	100%	123%			
OfficeInd	34%	30%	58%	80%	100%	123%			
School	48%	30%	48%	80%	100%	123%			
Pub2	48%	30%	48%	80%	100%	123%			
Barn	20%	30%	36%	80%	100%	123%			
Retail	20%	30%	36%	80%	100%	123%			

2.3 ENGINEERING INPUTS TO THE HEC-FDA MODEL

Stage-Probability Relationships

Stage-probability relationships in a geospatial depth-grid format were provided for the existing without-project and with-project conditions alternatives (2025). Future condition hydraulics will be anlayzed post-TSP.

The HEC-RAS model provided water surface profiles for eight annual exceedance probability (AEP) events ranging from the 0.99 (1-year) to the 0.002 (500-year) events. The depth grid values were extracted to the structures in the structure inventory for the 0.99 (1-year), 0.50 (2-year), 0.20 (5-year), 0.10 (10-year), 0.04 (25-year), 0.02 (50-year), 0.01 (100-year), and 0.002 (500-year) events. The without-project water surface profiles were based on riverine flood events.

Uncertainty Surrounding the Stage-Probability Relationships

A 20-year equivalent record length was used to quantify the uncertainty surrounding the stage-probability relationships for each study area reach in both Horn Lake and Coldwater Basins. Based on this equivalent record length, the HEC-FDA model calculated the confidence limits surrounding the stage-probability functions.

3.0 NATIONAL ECONOMIC DEVELOPMENT (NED) FLOOD DAMAGE AND BENEFIT CALCULATIONS

3.1 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 15 study area reaches in Horn Lake Creek Basin and 12 study area reaches in Coldwater Basin for which a structure inventory had been created. 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 reach 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.

3.2 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 (2025). The possible occurrences of each economic variable were derived through the use of Monte Carlo simulation. A total of 1,000 iterations were executed in the model for the stage-damage relationships. 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.

3.3 STAGE-PROBABILITY RELATIONSHIPS WITH UNCERTAINTY

The HEC-FDA model used an equivalent record length of 25 years for each study area reach to generate a stage-probability relationship with uncertainty for the without-project condition under base year (2025) conditions through the use of graphical analysis. 20 years was selected by the hydraulic engineer to represent the length of records analyzed during the calibration process that the hydraulic model underwent. The model used the eight stage-probability events together with the equivalent record length to define the full range of the stage-probability functions by interpolating between the data points. Confidence bands surrounding the stages for each of the probability events were also provided.

3.4 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 alternative, the expected annual damages (EAD) were totaled for each study area reach to obtain the total without-project EAD under base year (2025) conditions. Table L:3-1 through Table L:3-9 displays the number and type of structures that are damaged by each of annual exceedance probability events for the year 2025 under without-project conditions. These values were taken from the HEC-FDA structure detail output, and therefore the expected damages calculations are derived from point estimates of the most-likely or mean values for the variables used in the expected damages calculations, without uncertainty. The tables are split by basin and creek.

Table L:3-1. Count of Structures Damaged by Stream and Probability Events in 2025 ($1,000s)
(Horn Lake Creek Basin)

Annual Exceedance Probability (AEP)	**Cow Pen Creek**	**Horn Lake Creek**	**Lateral D**	**Rocky Creek**
Existing Condition (2026)				
1.00 (1 yr.)	-	-	-	-
0.50 (2 yr.)	-	-	-	-
0.20 (5 yr.)	21	20	1	12
0.10 (10 yr.)	38	28	1	16
0.04 (25 yr.)	83	52	4	47
0.02 (50 yr.)	134	72	4	75
0.01 (100 yr.)	179	102	6	121
0.002 (500 yr.)	332	190	21	187

Table L:3-2. Total Economic Damage by Probability Events in 2025 ($1,000s)
Cow Pen Creek (Horn Lake Creek Basin)

Annual Exceedance Probability (AEP)	**Residential**	**Non-Residential**	**Total**
Existing Condition (2026)			
1.00 (1 yr.)	$0	$0	$0
0.50 (2 yr.)	$0	$0	$0
0.20 (5 yr.)	$598	$0	$598
0.10 (10 yr.)	$1,128	$0	$1,128
0.04 (25 yr.)	$2,309	$22	$2,331
0.02 (50 yr.)	$4,128	$57	$4,185
0.01 (100 yr.)	$5,702	$141	$5,844
0.002 (500 yr.)	$11,147	$646	$11,793

Table L:3-3. Total Economic Damage by Probability Events in 2025 ($1,000s)
Horn Lake Creek (Horn Lake Creek Basin)

Annual Exceedance Probability (AEP)	**Residential**	**Non-Residential**	**Total**
Existing Condition (2026)			
1.00 (1 yr.)	$0	$0	$0
0.50 (2 yr.)	$0	$0	$0
0.20 (5 yr.)	$0	$0	$0
0.10 (10 yr.)	$0	$0	$0
0.04 (25 yr.)	$401	$3,035	$3,436
0.02 (50 yr.)	$514	$4,343	$4,857
0.01 (100 yr.)	$1,203	$7,032	$8,234
0.002 (500 yr.)	$2,933	$10,950	$13,883

Table L:3-4. Total Economic Damage by Probability Events in 2025 ($1,000s)
Rocky Creek (Horn Lake Creek Basin)

Annual Exceedance Probability (AEP)	**Residential**	**Non-Residential**	**Total**
Existing Condition (2026)			
1.00 (1 yr.)	$0	$0	$0
0.50 (2 yr.)	$0	$0	$0
0.20 (5 yr.)	$0	$0	$0
0.10 (10 yr.)	$0	$0	$0
0.04 (25 yr.)	$684	$684	$1,369
0.02 (50 yr.)	$959	$959	$1,918
0.01 (100 yr.)	$1,775	$2,848	$4,624
0.002 (500 yr.)	$2,712	$4,598	$7,310

Table L:3-5 Total Economic Damage by Probability Events in 2025 ($1,000s)
Lateral D (Horn Lake Creek Basin)

Annual Exceedance Probability (AEP)	**Residential**	**Non-Residential**	**Total**
Existing Condition (2026)			
1.00 (1 yr.)	$0	$0	$0
0.50 (2 yr.)	$0	$0	$0
0.20 (5 yr.)	$0	$0	$0
0.10 (10 yr.)	$0	$0	$0
0.04 (25 yr.)	$20	$20	$40
0.02 (50 yr.)	$27	$27	$53
0.01 (100 yr.)	$93	$93	$186
0.002 (500 yr.)	$114	$114	$228

Table L:3-6. Total Economic Damage by Probability Events in 2025 ($1,000s)
Camp Creek (Coldwater Basin)

Annual Exceedance Probability (AEP)	Residential	Non-Residential	Total
Existing Condition (2026)			
0.50 (2 yr.)	0	0	0
0.20 (5 yr.)	67	9	76
0.10 (10 yr.)	259	33	292
0.04 (25 yr.)	554	82	636
0.02 (50 yr.)	1,060	236	1,297
0.01 (100 yr.)	2,151	797	2,948
0.005 (200 yr.)	3,885	2,310	6,194
0.002 (500 yr.)	9,391	12,140	21,531

Table L:3-7 Total Economic Damage by Probability Events in 2025 ($1,000s)
Coldwater Creek (Coldwater Basin)

Annual Exceedance Probability (AEP)	Residential	Non-Residential	Total
Existing Condition (2026)			
0.50 (2 yr.)	0	-	0
0.20 (5 yr.)	341	-	341
0.10 (10 yr.)	488	-	488
0.04 (25 yr.)	600	-	600
0.02 (50 yr.)	678	-	678
0.01 (100 yr.)	764	-	764
0.005 (200 yr.)	869	-	869
0.002 (500 yr.)	1,989	-	1,989

Table L:3-8. Total Economic Damage by Probability Events in 2025 ($1,000s)
Licks Creek (Coldwater Basin)

Annual Exceedance Probability (AEP)	Residential	Non-Residential	Total
Existing Condition (2026)			
0.50 (2 yr.)	0	3	3
0.20 (5 yr.)	8	349	358
0.10 (10 yr.)	43	1,307	1,350
0.04 (25 yr.)	388	2,184	2,572
0.02 (50 yr.)	1,678	2,843	4,521
0.01 (100 yr.)	6,452	3,738	10,190
0.005 (200 yr.)	14,031	4,945	18,975
0.002 (500 yr.)	23,040	7,013	30,053

Table L:3-9. Total Economic Damage by Probability Events in 2025 ($1,000s) Nolehoe Creek (Coldwater Basin)

Annual Exceedance Probability (AEP)	**Residential**	**Non-Residential**	**Total**
Existing Condition (2026)			
0.50 (2 yr.)	3	3	6
0.20 (5 yr.)	5	5	10
0.10 (10 yr.)	5	6	12
0.04 (25 yr.)	10	12	22
0.02 (50 yr.)	88	127	215
0.01 (100 yr.)	659	735	1,393
0.005 (200 yr.)	2,907	2,880	5,787
0.002 (500 yr.)	9,005	9,531	18,536

3.5 STRUCTURE INVENTORY ADJUSTMENTS FOR HIGH FREQUENCY INUNDATION

Adjustments were made to the structure inventory to reflect the most-likely future without-project and with-project conditions more accurately. Under without-project and with-project conditions, residential and non-residential structures that were identified as being inundated above the first-floor elevation from the 0.99 (1-year) and 0.50 (2-year) AEP events were modified to have the 1-year and 2-year stages below the ground surface elevation by at least three feet to ensure high frequency damages were mitigated in the existing and future without-project conditions. This adjustment is consistent with the FEMA floodplain regulations that require residents to rebuild above the base flood elevation after a structure receives greater than 50 percent damage to the structural components as a result of a flood.

3.6 EXPECTED ANNUAL DAMAGES

Each of the focused array's plans were run through HEC-FDA, which allows for determining damages reduced by damage category. Table L:3-10 through Table L3-11 show the damages reduced and residual damages for each plan.

Table L:3-12 and TableL:3-13 shows the without project condition and with project condition expected annual damages for the Horn Lake Basin and Coldwater Basin focused arrays. Table 3-15 shows the final array, which does not include Coldwater Basin damages since there were found to not be any economically justified alternatives in that basin. The tables help illustrate that existing condition damages are primarily focused in residential and commercial structures, and that channel enlargement may be effective at reducing flood risk, while the levee is most effective. Figure L:3-1 shows expected annual damages for Horn Lake Creek Basin.

The focused array was analyzed using a 1D hydraulic model, with the final array was analyzed using the refined 1D/2D hydraulic model.

Table L:3-10. *Horn Lake Basin Focused Array Expected Annual Damages by Damage Category ($1,000's)*

Plan Name	Plan Description	Damage Categories					With Project Damages	Damages Reduced
		AUTO	COM	IND	PUB	RES		
Without	Without Project Condition	308	2,746	202	17	1,717	4,990	-
25YR	4% AEP (25-YR) Nonstructural Aggregation	308	967	17	0	666	1,958	3,032
50YR	2% AEP (50-YR) Nonstructural Aggregation	308	875	15	0	567	1,765	3,225
100YR	1% AEP (100-YR) Nonstructural Aggregation	308	954	15	0	473	1,750	3,241
Plan 7	2005 Feasibility Report Design Features	304	855	67	17	1,703	2,946	2,045
Plan 9	Rocky Creek Detention	225	2,184	166	5	1,360	3,940	1,051
Plan 10	Horn Lake Creek Detention at Elmore	227	1,533	124	8	1,001	2,894	2,097
Plan 11	Lateral D Detention	194	2,234	142	9	945	3,524	1,466
Plan 12	Cow Pen Creek Detention	248	2,626	199	17	1,513	4,603	387
Plan 14	Horn Lake Creek Levee Without Channel Enlargement	304	2,944	200	60	1,678	5,186	(195)
Plan 16	Horn Lake Creek Bullfrog Corner Levee with HLC Detention	246	1,368	107	7	1,196	2,924	2,067
Plan 17	Bullfrog Corner Levee with Detention on Rocky, Lateral D, Cow Pen, and Horn Lake Creeks	121	1,050	68	6	735	1,981	3,010
Plan 18	Horn Lake Creek Channel Enlargement (RM 18.86 – 19.41)	302	1,030	105	17	1,646	3,101	1,889
Plan 19	Detention on Rocky, Lateral D, Cow Pen, and Horn Lake Creeks	121	1,016	68	5	742	1,952	3,038
Plan 20	Detention on Rocky, Lateral D, and Cow Pen Creeks	156	1,822	121	5	999	3,103	1,888
Plan 21	HLC Enlargement with Detention on Rocky, Lat D, Cow Pen	155	535	42	5	932	1,669	3,321
Plan 22	Extended HLC Enlargement (RM 18.6 – 19.41)	290	964	101	16	1,574	2,945	2,046
Plan 23	Extended HLC Enlargement with Lateral D Detention	241	772	67	16	1,366	2,463	2,528
Plan 24	Extended HLC Enlargement with Cow Pen Detention	238	902	102	17	1,476	2,735	2,256
Plan 25	Extended HLC Enlargement with Rocky Detention	275	735	72	5	1,393	2,481	2,510
Plan 26	Extended HLC Enlargement with Cow Pen and Lateral D Detention	172	702	67	17	1,175	2,134	2,857
Plan 27	Extended HLC Enlargement with Cow Pen, Lateral D, and Rocky Detention	143	484	40	5	901	1,573	3,417

Table L:3-11. Coldwater Basin Focused Array Expected Annual Damages by Damage Category ($1,000's)

Plan Name	Plan Description	Damage Categories					With Project Damages	Damages Reduced
		AUTO	COM	IND	PUB	RES		
Without	Without Project Condition	-	119	41	15	970	1,145	-
25YR	4% AEP (25-YR) Nonstructural Aggregation	-	119	41	15	912	1,087	58
50YR	2% AEP (50-YR) Nonstructural Aggregation	-	119	41	15	807	982	163
100YR	1% AEP (100-YR) Nonstructural Aggregation	-	119	41	15	785	960	185

Note 1: Vehicles (Auto) were not included in the Coldwater Basin structure inventory

Table L:3-11. Horn Lake Basin Final Array Expected Annual Damages by Damage Category ($1,000's)

Plan Name	Plan Description	Damage Categories					With Project Damages	Damages Reduced
		AUTO	COM	IND	PUB	RES		
Without	Without Project Condition	43	1,881	143	39	1,099	3,204	-
Final 5	Extended Channel Enlargement	35	1,617	126	35	777	2,590	615
Final 6	Extended Channel Enlargement and Lateral D Detention	37	1,695	130	31	810	2,702	502
Final 7	Extended Channel Enlargement, Lateral D, Rocky Creek, Cow Pen Detentions	28	1,307	92	36	542	2,006	1,199
Final 8	Levee with Nonstructural Mitigation	38	141	3	7	1,050	1,239	1,966

Table L:3-12. Horn Lake Basin Focused Array Expected Annual Damages Reduced by Measure ($1,000's)

Plan Name	**Plan Description**	**Expected Annual Damage**			**Probability Damage Reduced Exceeds Indicated Values**		
		Total Without Project	Total With Project	Damage Reduced	0.75	0.5	0.25
Without	Without Project Condition	4,990	4,990	(0)	-	-	-
25YR	4% AEP (25-YR) Nonstructural Aggregation	4,990	1,958	3,032	2,218	2,913	3,787
50YR	2% AEP (50-YR) Nonstructural Aggregation	4,990	1,765	3,225	2,324	3,159	4,246
100YR	1% AEP (100-YR) Nonstructural Aggregation	4,990	1,750	3,240	2,377	3,259	4,411
Plan 7	2005 Feasibility Report Design Features	4,990	2,946	2,044	1,341	1,878	2,617
Plan 9	Rocky Creek Detention	4,990	3,940	1,050	643	904	1,350
Plan 10	Horn Lake Creek Detention at Elmore	4,990	2,894	2,096	1,353	1,893	2,610
Plan 11	Lateral D Detention	4,990	3,524	1,466	1,075	1,373	1,744
Plan 12	Cow Pen Creek Detention	4,990	4,603	387	230	286	478
Plan 14	Horn Lake Creek Levee Without Channel Enlargement	4,990	5,186	(196)	(48)	(170)	(302)
Plan 16	Horn Lake Creek Bullfrog Corner Levee with HLC Detention	4,990	2,924	2,066	1,275	1,839	2,661
Plan 17	Bullfrog Levee with Det. on Rocky, Lateral D, Cow Pen, and HLC	4,990	1,981	3,009	1,857	2,698	3,894
Plan 18	Horn Lake Creek Channel Enlargement (RM 18.86 – 19.41)	4,990	3,101	1,889	1,277	1,706	2,359
Plan 19	Detention on Rocky, Lateral D, Cow Pen, and Horn Lake Creeks	4,990	1,952	3,038	1,876	2,723	3,928
Plan 20	Detention on Rocky, Lateral D, and Cow Pen Creeks	4,990	3,103	1,887	1,194	1,674	2,398
Plan 21	HLC Enlargement with Detention on Rocky, Lat D, Cow Pen	4,990	1,669	3,321	2,153	3,033	4,254
Plan 22	Extended HLC Enlargement (RM 18.86 - 20.01)	4,990	2,945	2,045	1,398	1,804	2,500
Plan 23	Extended HLC Enlargement with Lateral D Detention	4,990	2,463	2,527	1,745	2,307	3,124
Plan 24	Extended HLC Enlargement with Cow Pen Detention	4,990	2,735	2,255	1,480	2,040	2,867
Plan 25	Extended HLC Enlargement with Rocky Detention	4,990	2,481	2,509	1,665	2,294	3,182
Plan 26	Extended HLC Enlargement with Cow Pen and Lateral D Detention	4,990	2,134	2,856	1,867	2,610	3,650
Plan 27	Extended HLC Enlargement with Cow Pen, Lat D, and Rocky Det	4,990	1,573	3,417	2,190	3,122	4,401

Table L:3-13. Coldwater Basin Focused Array Expected Annual Damages Reduced by Measure ($1,000's)

Plan Name	Plan Description	Expected Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
		Total Without Project	Total With Project	Damage Reduced	0.75	0.5	0.25
Without	Without Project Condition	1,145	1,145	-	-	-	-
25YR	4% AEP (25-YR) Nonstructural Aggregation	1,145	1,087	58	43	53	81
50YR	2% AEP (50-YR) Nonstructural Aggregation	1,145	982	163	120	148	227
100YR	1% AEP (100-YR) Nonstructural Aggregation	1,145	960	185	136	168	258

Table L:3-14. Horn Lake Basin Final Array Expected Annual Damages Reduced by Measure ($1,000's)

Plan Name	Plan Description	Expected Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
		Total Without Project	Total With Project	Benefits	0.75	0.5	0.25
Without	Without Project Condition	3,204	3,204	(0)	-	-	-
Final 5	Extended Channel Enlargement	3,204	2,590	615	298	555	850
Final 6	Extended Channel Enlargement and Lateral D Detention	3,204	2,702	502	1	367	834
Final 7	Extended Channel Enlargement, Lateral D, Rocky Creek, Cow Pen Detentions	3,204	2,006	1,199	571	1,075	1,665
Final 8	Levee with Nonstructural Mitigation	3,204	1,239	1,966	898	1,651	2,653

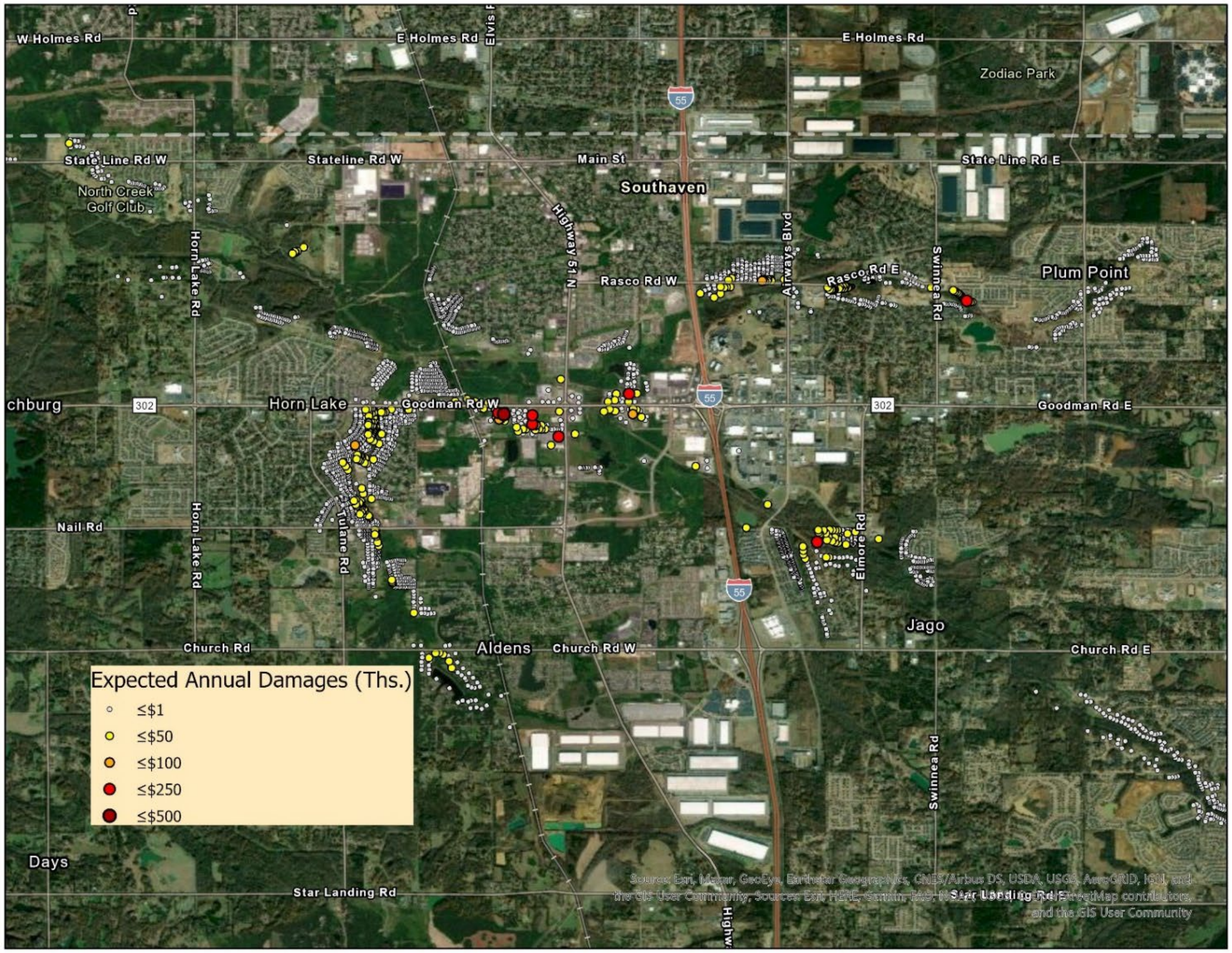

Figure L:3-1. Expected Annual Damages

4.0 PROJECT COSTS

Construction Schedule

For the purposes of computing interest during construction (IDC), construction of the nonstructural components of the plans is expected to begin in the year 2025 and will continue for a period of three months. The construction period of three months is designated by PB 2019-03, and is not a complete construction schedule required to fully implement the tentatively selected plan. Construction of the structural alternatives, including levees, channel enlargement, or detention basins are expected to last two years and can be constructed concurrently.

Structural Costs

Structural cost estimates for the final array were developed by the Memphis District Cost Engineering Branch and were commensurate with a level 4 cost estimate. An abbreviated cost risk analysis was completed to determine the contingencies used for all structural and nonstructural measures.

Interest during constructed was calculated for each of the structural alternatives and assumed the construction period lasts two years. Interest during construction was calculated using an end of year payment schedule and 2.25% discount rate.

Nonstructural Costs – Elevation & Floodproofing

Nonstructural cost estimates for the final array were developed through a joint effort between Economics, Real Estate, and Cost Engineering Branches. A 43.49% contingency was applied to all nonstructural cost estimates to represent the uncertainty regarding the cost and schedule risk of these measures.

Interest during constructed was calculated for each of the nonstructural alternatives and assumed the construction period lasted three months, as provided by the USACE National Nonstructural Committee BPG 2020-01_Rev1. Interest during construction was calculated on a mid-period quarterly basis payment schedule and 2.25% discount rate.

Real estate costs were included in the nonstructural analysis, if applicable, which included costs associated with relocation assistance costs, and administrative costs. A 25% contingency was applied to the real estate costs, which is separate from the contingency applied to the square foot cost estimates for elevation and floodproofing. A detailed cost analysis can be found in Section 10 of the Real Estate Plan.

Non-residential Structures

The floodproofing measures were applied to all non-residential structures. Separate cost estimates were developed to floodproof non-residential structures based on their relative square footage. Table L:4-1 shows a summary of square footage costs for floodproofing. These costs were developed for the Draft Nonstructural Alternatives

Feasibility Study, Donaldsonville LA to the Gulf evaluation (September 14, 2012) by contacting local contractors and were adopted for this study due to the similarity in the structure types between the two study areas. Again, final cost estimates were indexed to FY 2022 prices.

Table L:4-1 Nonstructural Floodproofing Costs for Non-residential Structures ($)

Square Footage	**Cost**
1,000	153,006
10,000	153,006
20,000	153,006
30,000	361,536
40,000	361,536
50,000	361,536
60,000	361,536
70,000	361,536
80,000	361,536
90,000	361,536
100,000	361,536
>= *110,000*	893,720

Annual Project Costs

Life cycle cost estimates were provided for the nonstructural measures in FY22 price levels. The initial construction costs (first costs) and the schedule of expenditures were used to determine the interest during construction and gross investment cost at the end of the installation period (2025). The FY 2022 Federal interest rate of 2.25 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis.

Operations, maintenance, relocations, rehabilitation, and repair (OMRR&R) costs associated with each of the structural measures was estimated by the cost engineering branch. There is no OMRR&R assumed to be associated with the nonstructural measures.

Table L:4-2 through Table L:4-6 summarize the construction, environmental, real estate, cultural, IDC, and O&MRRR costs for each of the alternatives and basins.

Table L:4-2. Summary of Costs for Horn Lake Basin Focused Array (1 of 3)

Horn Lake Basin Focused Array (1 of 3)	**25YR**	**50YR**	**100YR**	**Plan 7**	**Plan 9**	**Plan 10**	**Plan 11**	**Plan 12**	**Plan 14**
Construction First Cost	63,944,321	89,166,958	107,515,141	21,193,628	16,044,387	39,374,500	11,066,500	9,724,108	1,174,418
Environmental Mitigation Cost					284,000	2,314,000	410,000	96,000	-
Real Estate Cost	-	-	-	-	-	-	-	-	-
Cultural Cost	-	-	-	-	-	-	-	-	-
Interest During Construction	197,674	275,646	332,366	1,374,000	229,000	492,000	138,000	130,000	16,000
Total Cost	64,141,995	89,442,604	107,847,507	22,567,628	16,557,387	42,180,500	11,614,500	9,950,108	1,190,418
Annualized O&MRRR	-	-	-	-	407,000	1,238,000	295,000	163,000	-
Total Average Annual Cost	2,262,000	3,154,000	3,802,000	796,000	991,000	2,725,000	705,000	514,000	44,000

Table L:4-3. Summary of Costs for Horn Lake Basin Focused Array (2 of 3)

Horn Lake Basin Focused Array (2 of 3)	**Plan 16**	**Plan 17**	**Plan 18**	**Plan 19**	**Plan 20**	**Plan 21**	**Plan 22**	**Plan 23**	**Plan 24**
Construction First Cost	40,548,918	56,593,305	5,946,810	76,209,495	36,834,995	42,781,805	6,546,189	17,875,739	16,754,554
Environmental Mitigation Cost	2,314,000	2,598,000	7,410,696	3,104,000	790,000	8,200,696	7,410,696	7,820,696	7,506,696
Real Estate Cost	-	-	-	-	-	-	-	-	-
Cultural Cost	-	-	-	-	-	-	-	-	-
Interest During Construction	261,000	737,000	74,000	989,000	497,000	571,000	82,000	223,000	219,000
Total Cost	43,123,918	59,928,305	13,431,506	80,302,495	38,121,995	51,553,501	14,038,885	25,919,435	24,480,250
Annualized O&MRRR	1,248,000	1,655,000	337,000	2,103,000	865,000	1,202,000	337,000	632,000	500,000
Total Average Annual Cost	2,768,000	3,768,000	811,000	4,934,000	2,209,000	3,020,000	832,000	1,546,000	1,363,000

Table L:4-4. Summary of Costs for Horn Lake Basin Focused Array (3 of 3)

Horn Lake Basin Focused Array (3 of 3)	**Plan 25**	**Plan 26**	**Plan 27**
Construction First Cost	23,987,815	28,199,104	44,243,491
Environmental Mitigation Cost	7,694,696	7,916,696	8,200,696
Real Estate Cost	-	-	-
Cultural Cost	-	-	-
Interest During Construction	323,000	366,000	601,000
Total Cost	32,005,511	36,481,800	53,045,187
Annualized O&MRRR	744,000	795,000	1,202,000
Total Average Annual Cost	1,872,000	2,081,000	3,072,000

TableL:4-5. Summary of Costs for Coldwater Basin Focused Array

Coldwater Basin Focused Array	**25YR**	**50YR**	**100YR**
Construction First Cost	2,218,319	6,413,244	12,101,346
Environmental Mitigation Cost	-	-	-
Real Estate Cost	-	-	-
Cultural Cost	-	-	-
Interest During Construction	7,175	21,524	41,612
Total Cost	2,225,494	6,434,768	12,142,958
Annualized O&MRRR	-	-	-
Total Average Annual Cost	78,000	227,000	428,000

Table L:4-6. Summary of Costs for Horn Lake Basin Final Array

Final Array	**Final 5**	**Final 6**	**Final 7**	**Final 8**
Construction First Cost	$8,458,000	$17,817,000	$51,967,000	$18,887,000
Interest During Construction	$191,000	$402,000	$1,173,000	$426,000
Total Cost	$8,649,000	$18,219,000	$53,140,000	$19,313,000
Annualized O&MRRR	$362,000	$683,000	$1,337,000	$407,000
Total Average Annual Cost	$652,000	$1,294,000	$3,118,000	$1,054,000

Reference:
Final Array 5 – Extended Channel Enlargement
Final Array 6 – Extended Channel Enlargement and Lateral D Detention
Final Array 7 – Extended Channel Enlargement, Cow Pen, Rocky, Lateral D Detentions
Final Array 8 – Levee with Nonstructural Mitigation

5.0 RESULTS OF THE ECONOMIC ANALYSIS

5.1 NET BENEFIT ANALYSIS

Calculation of Net Benefits

The expected annual benefits attributable to the final array of measures were compared to the annual costs to develop a benefit-to-cost ratio for the measures. The net benefits for the measures were calculated by subtracting the annual costs from the expected annual benefits. The net benefits were used to determine the economic justification of the project measures. Net benefit calculations for the with-project condition were computed using the HEC-FDA that contained the stage frequency-damage relationships for the study.

After the TSP milestone, analysis of the future without and with-project conditions will be conducted. The total average annual benefits were computed in HEC-FDA and include structural, content, and vehicle damages reduced. Table 40 shows the net benefits for the Horn Lake Basin focused array, Table L:5-1 shows the net benefits for the Coldwater Basin focused array, and Table L:5-2 shows the net benefits for the final array.

Alternative 14 is a structural levee on Horn Lake Creek along a drainage berm and results in induced damages. As a result, the average annual benefits were not processed through the BCR analysis since there are no positive damages reduced.

Table L:5-1. Horn Lake Basin Focused Array Economic Net Benefits and BCR

Plan	**Horn Lake Basin Focused Array**			
	Total Average Annual Cost	Total Average Annual Benefits	Net Benefits	BCR
25YR	2,262,000	3,032,000	770,000	1.34
50YR	3,154,000	3,225,000	71,000	1.02
100YR	3,802,000	3,241,000	(561,000)	0.85
Plan 7	796,000	2,042,330	1,246,330	2.57
Plan 9	991,000	1,048,360	57,360	1.06
Plan 10	2,725,000	2,094,560	(630,440)	0.77
Plan 11	705,000	1,463,820	758,820	2.08
Plan 12	514,000	384,980	(129,020)	0.75
Plan 14	44,000	N/A	N/A	N/A
Plan 16	2,768,000	2,064,560	(703,440)	0.75
Plan 17	3,768,000	3,007,270	(760,730)	0.80
Plan 18	811,000	1,887,180	1,076,180	2.33
Plan 19	4,934,000	3,035,940	(1,898,060)	0.62
Plan 20	2,209,107	1,887,000	(322,107)	0.85
Plan 21	3,020,000	3,321,000	301,000	1.10

Plan 22	832,000	1,957,000	1,125,000	2.35
Plan 23	1,546,000	2,528,000	982,000	1.64
Plan 24	1,363,000	2,253,410	890,410	1.65
Plan 25	1,872,000	2,507,580	635,580	1.34
Plan 26	2,081,000	2,854,420	773,420	1.37
Plan 27	3,072,000	3,415,080	343,080	1.11

Table. L:5-2 Coldwater Basin Focused Array Economic Net Benefits and BCR

Plan	**Coldwater Basin Focused Array**			
	Total Average Annual Cost	Total Average Annual Benefits	Net Benefits	BCR
25YR	78,000	58,000	(20,000)	0.74
50YR	227,000	153,000	(74,000)	0.67
100YR	428,000	153,000	(275,000)	0.36

Table L:5-3 Mixed Basin Final Array Summary Economic Net Benefits and BCR

Plan	**Horn Lake Basin Final Array**			
	Total Average Annual Cost	Total Average Annual Benefits	Net Benefits	BCR
Final 5	$652,000	$615,000	$(37,000)	0.94
Final 6	$1,294,000	$502,000	$(792,000)	0.39
Final 7	$3,118,000	$1,199,000	$(1,919,000)	0.38
Final 8	$1,054,000	$1,966,000	$912,000	1.87

The plan that reasonably maximizes net benefits is currently Final 8, which is a levee with nonstructural mitigation. Final 8 will hereto be referenced as the NED plan.

Table L:5-4 below shows the cost and benefit summaries of the NED and LPP plans. Table L:5-5 breaks down the nonstructural feature of the TSP by floodproofing and elevation components. Figures L:5-1 –L:5-3show 4%, 2%, and 1% AEP damages reduced on structures for the NED and LPP plans.

Table L:5-4. Summary of the Tentatively Selected Plan (TSP)

Item	NED Plan (Final 6B)
Structure, Contents, Vehicles, and Other	**$1,966,000**
Total Annual Benefits	$1,966,000
First Costs	$18,887,000
Interest During Construction	$426,000
Annual Operation & Maintenance Costs	$407,000
Total Annual Costs	$1,054,000
B/C Ratio	1.87
Expected Annual Net Benefits	$912,000

Table L:5-5. Summary of the Nonstructural Feature of the Tentatively Selected Plan (TSP)

Nonstructural Measure	**NED Plan (Final 6B)**
Dry Floodproofing (Commercial)	29
Acquisition (Commercial)	1

Figure L:5-1 shows the expected annual benefits of the NED plan.

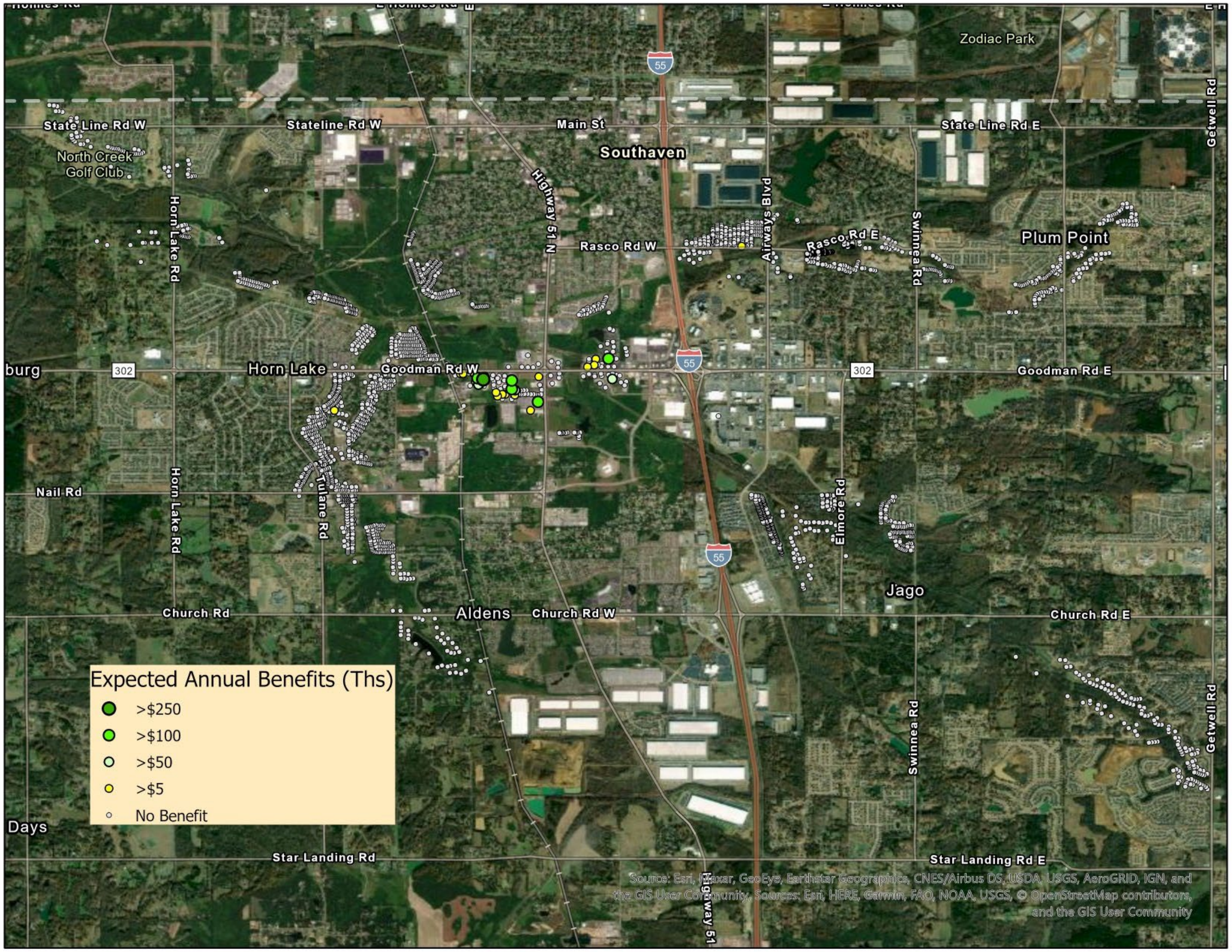

Figure L:5-1. NED Plan Expected Annual Benefits

5.2 RISK ANALYSIS

The risk analysis is a section of the report that discusses the risk and uncertainty associated with the HEC-FDA model and the economic benefits. The HEC-FDA model was utilized for the existing condition and with project alternatives. The risk analysis uses expected annual damages instead of equivalent annual damages since future with project conditions were not yet incorporated into this study.

5.3 BENEFIT EXCEEDANCE PROBABILITY RELATIONSHIP

The HEC-FDA model incorporates the uncertainty surrounding the economic and engineering inputs to generate results that can be used to assess the performance of proposed plans. The HEC-FDA model was used to calculate expected annual without-project and with-project damages and the damages reduced for each of the project alternatives. Table L:5-6 shows the mean expected annual benefits and the benefits at the 75, 50, and 25 percentiles for the NED and LPP plans. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values. The table indicates the percent chance that the expected annual benefits will exceed the expected annual costs therefore the benefit cost ratio is greater than one and the net benefits are positive.

Table L:5-6 can be interpreted as there is a 75% chance that the expected annual damages reduced (annual benefits) of the NED plan will exceed $898,000, and therefore a 75% chance that the BCR will exceed .85.

Table L: 5-6. Probability Benefits Exceed Costs

NED Plan (Final 6B)	**75%**	**50%**	**Mean**	**25%**
Total Average Annual Cost	$1,054,000	$1,054,000	$1,054,000	$1,054,000
Total Average Annual Benefits	898,000	1,651,000	1,966,000	2,653,000
Net Benefits	($156,000)	$597,000	$912,000	$1,599,000
BCR	0.85	1.57	1.87	2.52

5.3 PROJECT PERFORMANCE

Project performance is traditionally measured using HEC-FDA model puts that include long-term annual exceedance probability (AEP) and the conditional non-exceedance probability (assurance) values for various flood events. At this point in the study target stages, and other required variables to compute project performance data remains incomplete.

5.4 RESIDUAL RISK

The flood risk that remains in the floodplain after the proposed alternatives are implemented is known as the residual flood risk. For North DeSoto County, the residual risk is best illustrated from Table L:5-7, which shows the residual damages for the final array of alternatives. All values are displayed in average annual damages. The NED plan, alternative 8, is also the plan the minimizes residual risk.

Table L:5-7. Residual Damages

Average Annual Damages	Extended Channel Enlargement (ECE, 5)	ECE + Lateral D Detention (6)	ECE + DBs (7)	Levee with Nonstructural Mitigation (8)
Without-Project Damages	$ 3,204,000	$ 3,204,000	$ 3,204,000	$ 3,204,000
Benefits (Damages Reduced)	$ 615,000	$ 502,000	$ 1,199,000	$ 1,966,000
Residual Damages	$ 2,589,000	$ 2,702,000	$ 2,005,000	$ 1,238,000

Life Safety

A risk assessment is currently being conducted using LifeSim and will be complete post-TSP, the results of which will be reported in a separate life safety appendix. This appendix will consider the existing condition life safety risk according to risk to structures in terms of flood depths (1D/2D hydraulic model) and velocities (1D hydraulic model). This report assumes that the occupant is able to reach the highest floor of the structure, including above floor spaces such as the attic or roof. Roadway analysis and velocities will be analyzed post-TSP.

Floodprone Structure Analysis.

Multiple windshield surveys within the study area found that the average residential structure was built or rehabilitated within the last 30 years and tends to be in good condition. Residential structures are a mixture between one story and two-story structures. Non-residential structures follow the same trend and as a result, there are opportunities for vertical evacuation and given the urban area, ample evacuation routes exist.

Flood depths relative to first floor elevation within the study area max out at about 2.7 feet during the 4% AEP, about 3 feet during the 1% AEP, and about 4 feet during the 0.2% AEP event, according to the 1D/2D hydraulic model. With these depths, overland velocities on structures are expected to be limited to between one and three feet per second, according to the 1D hydraulic model. Referencing Figure L:5-2 that shows the structural stability threshold, a combined depth times velocity force of 3 feet and 12 feet per second squared would not lead to a structural collapse. Based on this, this report concludes that life safety inside structures is minimal and therefore none of the structural alternatives reduce the risk of life loss in structures enough to impact plan selection. According to Figure 19, velocities on structures would have to exceed 8 feet per second for structural collapse to become a concern. Further analysis of life safety risk on structures will be conducted post-TSP using an all 1D-2D hydraulic model. Figures L:5-3 – L:5-5 show flood depths on structures in the existing condition for the 4%, 1%, and 0.2% AEP events.

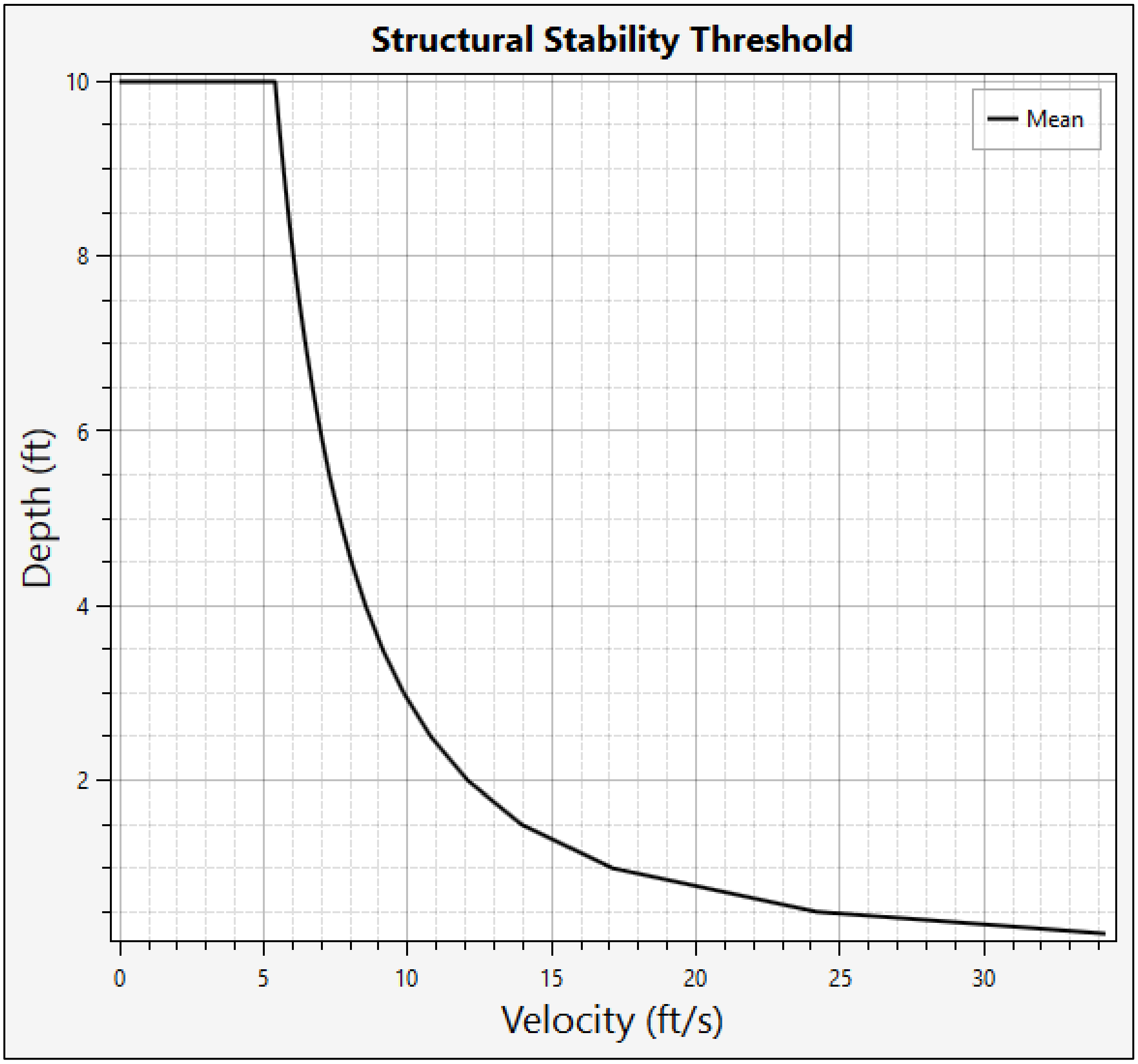

Figure L:5-2. HEC-LifeSim One-story Residential Wood Frame Stability Function

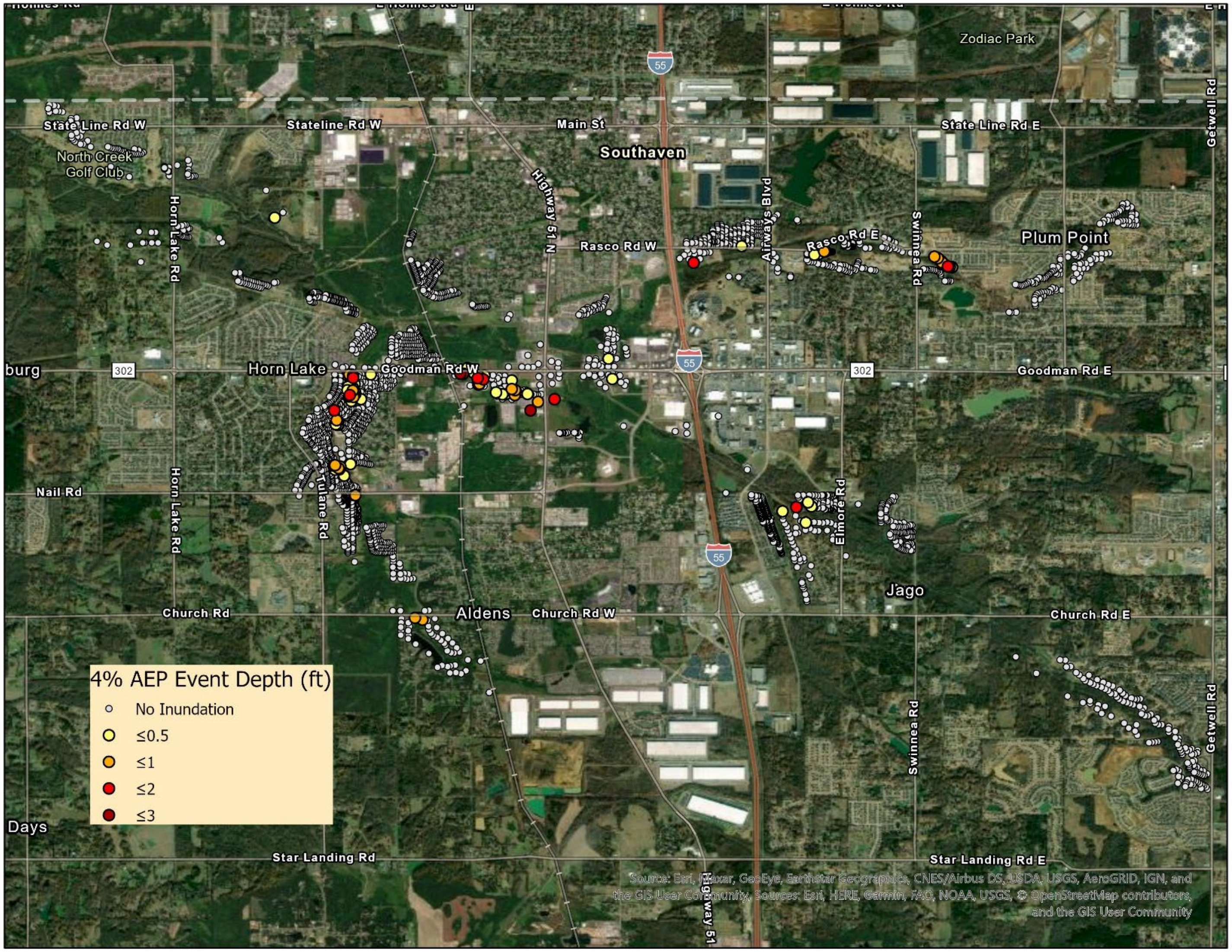

Figure L:5-3. Existing Condition 4% AEP Depths on Structures

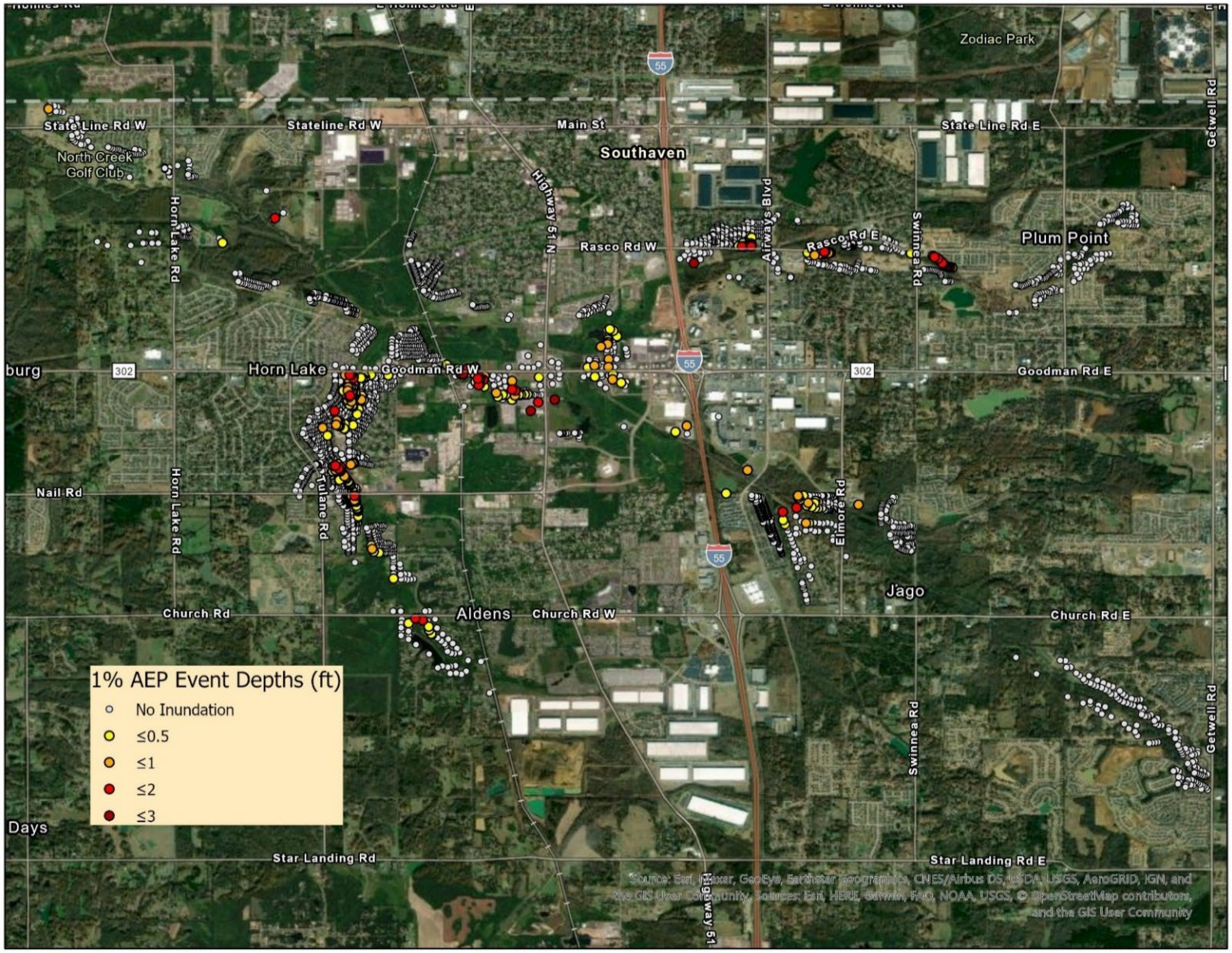

Figure L:5-4. Existing Condition 1% AEP Depths on Structures

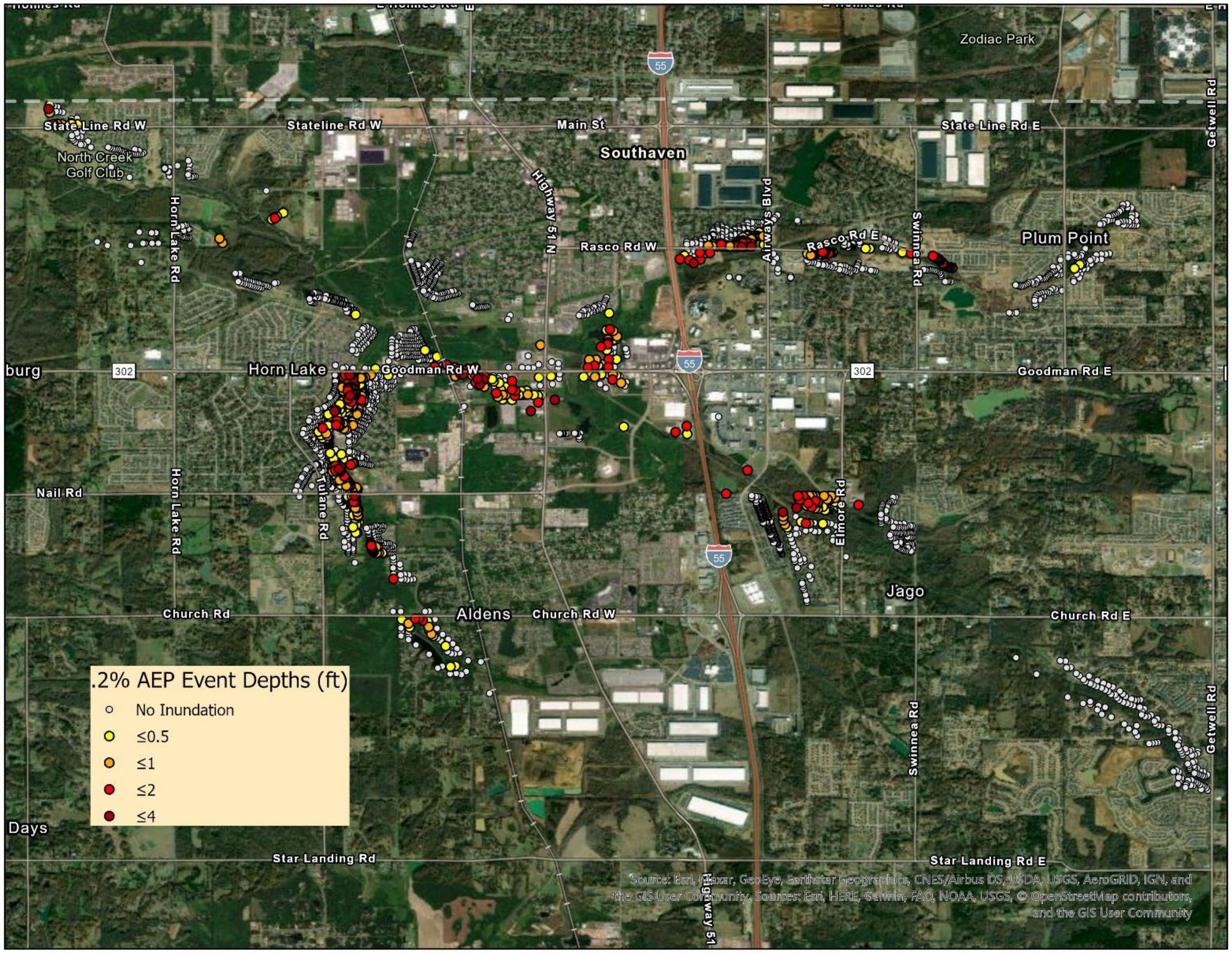

Figure L: 5-5 Existing Condition 0.2% AEP Depths on Structures

5.5 COMPLIANCE WITH SECTION 308 OF WRDA 1990

Section 308 of the Water Resource Development Act (WRDA) 1990 limits structures built or substantially improved after July 1, 1991, in designated floodplains not elevated to the 1% AEP flood elevation from being included in the benefit base of the economic analysis.

To ensure compliance with the act, the economist reviewed the county assessed parcel data provided by DeSoto County and relied on the year-built attribute field. For parcels inside the designated floodplain with a year built post-1991, structures were flagged for further analysis. Flagged structures were evaluated for ground surface elevation, foundation heights, and first floor elevations to determine if the structures were properly built above the base flood elevation. The study found that while not all structures flagged were built above the effective (current) base flood elevation, they were built to the base flood elevation that was in effect at the time of construction. As a result, there are structures within the HEC-FDA model that were built post-1991 that met all local floodplain ordinances at the time of construction and were outside the floodplain for the known flood risk at the time. Some of these flagged structures currently receive flooding prior to a 1% AEP flood event, but damages are limited to less frequent events given prior effective FIRM maps being enforced by local officials.

While not part of the Community Rating System (CRS), DeSoto County and its floodprone communities currently do not have any National Flood Insurance Program (NFIP) issues and to this reports knowledge, has never been suspended from the NFIP program. This report assumes that all communities are actively enforcing development within the floodplain to the locally authorized standards. See Table L:5-8 for a summary of CRS/NFIP status.

Table L:5-8. CRS/NFIP Status

Community Name	CRS Community	NFIP Issue	Initial Compliance Date	Initial FIRM
Unincorporated DeSoto	No	No	1990	1990
Horn Lake	No	No	1990	1990
Southaven	No	No	1987	1987
Olive Branch	No	No	1987	1987

6.0 RESULTS OF THE REGIONAL ECONOMIC DEVELOPMENT ANALYSIS (RED)

When the economic activity lost in a flooded region can be transferred to another area or region in the national economy, these losses cannot be included in the NED account. However, the impacts on the employment, income, and output of the regional economy are considered part of the RED account. The input-output macroeconomic model RECONS can be used to address the impacts of the construction spending associated with the project alternatives. The RECONS model utilizes a total construction cost of a project that is attributable to contracts being awarded to complete the construction of the project. This cost excludes USACE labor associated with planning, engineering, and design, as well as economic costs like interest during construction. The costs also include real estate and cultural resources costs since this disbursement of federal funds are expected to be spent within the region of the study area. An example of this would be using Uniform Relocation Act funding to pay a tenant to temporarily relocate to a hotel while their home is being elevated.

The project first cost input into the RECONS model for Plan 4 (Nonstructural) was $63,944,000, which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified, 71.8 percent will be captured within the local study area. The remainder of the expenditures will be captured within the state or national level. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in Table 48. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $63,944,000 support a total of 691.2 full-time equivalent jobs, $46,173,053 in labor income, $53,817,057 in the gross regional product, and $90,020,143 in economic output in the local impact area. More broadly, these expenditures support 1,106.9 full-time equivalent jobs, $78,511,090 in labor income, $102,194,717 in the gross regional product, and $171,946,367 in economic output in the nation.

Table L:6-1. Plan 4 RECONS Impacts to Local, State, and National Economy's

Area	**Local Capture**	**Output**	**Jobs**	**Labor Income**	**Value Added**
		Local			
Direct Impact		$45,883,864	433.5	$31,207,979	$28,880,855
Secondary Impact		$44,136,278	257.7	$14,965,074	$24,936,202
Total Impact	$45,883,864	$90,020,143	691.2	$46,173,053	$53,817,057
		State			
Direct Impact		$51,669,066	484.9	$36,104,232	$34,199,526
Secondary Impact		$50,779,170	293.4	$16,926,139	$28,352,360
Total Impact	$51,669,066	$102,448,236	778.2	$53,030,371	$62,551,887
		National			
Direct Impact		$61,558,233	578.9	$43,102,372	$41,657,720
Secondary Impact		$110,388,134	528.0	$35,408,718	$60,536,997
Total Impact	$61,558,233	$171,946,367	1,106.9	$78,511,090	$102,194,717

Table L:6-2. Plan 4 RECONS Impacts to Specific Industries

IMPLAN Sectors	**Industries**	**Output**	**Jobs**	**Labor Income**	**Value Added**
	Direct Impacts				
29	Sand and gravel mining	$162,093	1.2	$31,712	$53,347
52	Construction of new power and communication structures	$639,421	3.8	$270,958	$332,237
54	Construction of new highways and streets	$639,377	3.3	$237,374	$289,653
55	Construction of new commercial structures, including farm structures	$638,770	4.7	$321,311	$344,339
56	Construction of other new nonresidential structures	$10,853,041	133.7	$9,545,185	$4,033,548
57	Construction of new single-family residential structures	$639,439	4.2	$301,255	$360,451
203	Cement manufacturing	$362,411	0.6	$31,905	$74,842
215	Iron and steel mills and ferroalloy manufacturing	$47,816	0.1	$3,871	$6,707
269	All other industrial machinery manufacturing	$2,617	0.0	$411	$579
331	Switchgear and switchboard apparatus manufacturing	$8,582	0.0	$1,979	$3,398

395	Wholesale - Machinery, equipment, and supplies	$43,813	0.1	$14,555	$26,878
400	Wholesale - Other nondurable goods merchant wholesalers	$626,942	1.8	$162,457	$361,284
401	Wholesale - Wholesale electronic markets and agents and brokers	$145,456	1.5	$213,184	$132,170
414	Air transportation	$2,898	0.0	$622	$2,123
415	Rail transportation	$139,184	0.3	$32,173	$69,390
416	Water transportation	$6,055	0.0	$828	$1,521
417	Truck transportation	$530,435	2.8	$214,655	$253,494
444	Insurance carriers, except direct life	$325,624	0.4	$43,306	$146,393
453	Commercial and industrial machinery and equipment rental and leasing	$1,444,316	4.2	$388,965	$896,455
457	Architectural, engineering, and related services	$4,951,059	26.3	$2,103,773	$2,550,055
463	Environmental and other technical consulting services	$224,946	2.6	$155,042	$130,491
470	Office administrative services	$4,277,090	72.9	$3,536,162	$1,077,771
515	Commercial and industrial machinery and equipment repair and maintenance	$3,825,918	23.7	$1,914,035	$2,387,169
544	* Employment and payroll of federal govt, non-military	$9,591,600	43.0	$5,927,302	$9,591,600
5001	Private Labor	$5,754,960	102.4	$5,754,960	$5,754,960
	Direct Impact	**$45,883,864**	**433.5**	**$31,207,979**	**$28,880,855**
	Secondary Impact	**$44,136,278**	**257.7**	**$14,965,074**	**$24,936,202**
	Total Impact	**$90,020,143**	**691.2**	**$46,173,053**	**$53,817,057**

The project first cost input into the RECONS model for Plan 5 (Extended Channel Enlargement) was $5,918,000, which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified, 71.8 percent will be captured within the local study area. The remainder of the expenditures will be captured within the state or national level. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in Table L:6-3. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $5,918,000 support a total of 64.0 full-time equivalent jobs, $4,273,304 in labor income, $4,980,754 in the gross regional product, and $8,331,340 in economic output in the local impact area. More broadly, these expenditures support 102.5 full-time equivalent jobs, $7,266,180 in labor income, $9,458,094 in the gross regional product, and $15,913,590 in economic output in the nation.

Table L:6-3. Plan 5 RECONS Impacts to Local, State, and National Economy's

Area	**Local Capture**	**Output**	**Jobs**	**Labor Income**	**Value Added**
		Local			
Direct Impact		$4,246,539	40.1	$2,888,290	$2,672,915
Secondary Impact		$4,084,801	23.9	$1,385,014	$2,307,839
Total Impact	$4,246,539	$8,331,340	64.0	$4,273,304	$4,980,754
		State			
Direct Impact		$4,781,958	44.9	$3,341,437	$3,165,157
Secondary Impact		$4,699,599	27.2	$1,566,510	$2,624,003
Total Impact	$4,781,958	$9,481,557	72.0	$4,907,947	$5,789,160
		National			
Direct Impact		$5,697,198	53.6	$3,989,113	$3,855,411
Secondary Impact		$10,216,392	48.9	$3,277,067	$5,602,683
Total Impact	$5,697,198	$15,913,590	102.5	$7,266,180	$9,458,094

Table L:6-4. Plan 5 RECONS Impacts to Specific Industries

IMPLAN Sectors	**Industries**	**Output**	**Jobs**	**Labor Income**	**Value Added**
	Direct Impacts				
29	Sand and gravel mining	$15,002	0.1	$2,935	$4,937
52	Construction of new power and communication structures	$59,178	0.4	$25,077	$30,748
54	Construction of new highways and streets	$59,174	0.3	$21,969	$26,807
55	Construction of new commercial structures, including farm structures	$59,118	0.4	$29,737	$31,868
56	Construction of other new nonresidential structures	$1,004,446	12.4	$883,404	$373,304
57	Construction of new single-family residential structures	$59,180	0.4	$27,881	$33,360
203	Cement manufacturing	$33,541	0.1	$2,953	$6,927
215	Iron and steel mills and ferroalloy manufacturing	$4,425	0.0	$358	$621
269	All other industrial machinery manufacturing	$242	0.0	$38	$54
331	Switchgear and switchboard apparatus manufacturing	$794	0.0	$183	$315

395	Wholesale - Machinery, equipment, and supplies	$4,055	0.0	$1,347	$2,488
400	Wholesale - Other nondurable goods merchant wholesalers	$58,023	0.2	$15,035	$33,437
401	Wholesale - Wholesale electronic markets and agents and brokers	$13,462	0.1	$19,730	$12,232
414	Air transportation	$268	0.0	$58	$196
415	Rail transportation	$12,881	0.0	$2,978	$6,422
416	Water transportation	$560	0.0	$77	$141
417	Truck transportation	$49,092	0.3	$19,866	$23,461
444	Insurance carriers, except direct life	$30,136	0.0	$4,008	$13,549
453	Commercial and industrial machinery and equipment rental and leasing	$133,671	0.4	$35,999	$82,967
457	Architectural, engineering, and related services	$458,219	2.4	$194,704	$236,007
463	Environmental and other technical consulting services	$20,819	0.2	$14,349	$12,077
470	Office administrative services	$395,844	6.8	$327,271	$99,747
515	Commercial and industrial machinery and equipment repair and maintenance	$354,088	2.2	$177,143	$220,932
544	* Employment and payroll of federal govt, non-military	$887,700	4.0	$548,570	$887,700
5001	Private Labor	$532,620	9.5	$532,620	$532,620
	Direct Impact	**$4,246,539**	**40.1**	**$2,888,290**	**$2,672,915**
	Secondary Impact	**$4,084,801**	**23.9**	**$1,385,014**	**$2,307,839**
	Total Impact	**$8,331,340**	**64.0**	**$4,273,304**	**$4,980,754**

The project first cost input into the RECONS model for Plan 6 (Extended Channel Enlargement + Lateral D Detention) was $17,817,000, which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified, 71.8 percent will be captured within the local study area. The remainder of the expenditures will be captured within the state or national level. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in Table L:6-5. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $17,817,000 support a total of 192.6 full-time equivalent jobs, $12,865,402 in labor income, $14,995,285 in the gross regional product, and $25,082,711 in economic output in the local impact area. More broadly, these expenditures support 308.4 full-time equivalent jobs, $21,875,893 in labor income, $28,474,967 in the gross regional product, and $47,910,178 in economic output in the nation.

Table L:6-5. Plan 6 RECONS Impacts to Local, State, and National Economy's

Area	**Local Capture**	**Output**	**Jobs**	**Labor Income**	**Value Added**
		Local			
Direct Impact		$12,784,824	120.8	$8,695,617	$8,047,201
Secondary Impact		$12,297,887	71.8	$4,169,785	$6,948,085
Total Impact	$12,784,824	$25,082,711	192.6	$12,865,402	$14,995,285
		State			
Direct Impact		$14,396,781	135.1	$10,059,882	$9,529,166
Secondary Impact		$14,148,825	81.8	$4,716,205	$7,899,944
Total Impact	$14,396,781	$28,545,606	216.8	$14,776,087	$17,429,109
		National			
Direct Impact		$17,152,243	161.3	$12,009,805	$11,607,275
Secondary Impact		$30,757,935	147.1	$9,866,088	$16,867,692
Total Impact	$17,152,243	$47,910,178	308.4	$21,875,893	$28,474,967

Table L:6-6. Plan 6 RECONS Impacts to Specific Industries

IMPLAN Sectors	**Industries**	**Output**	**Jobs**	**Labor Income**	**Value Added**
	Direct Impacts				
29	Sand and gravel mining	$45,165	0.3	$8,836	$14,864
52	Construction of new power and communication structures	$178,165	1.1	$75,498	$92,573
54	Construction of new highways and streets	$178,152	0.9	$66,141	$80,707
55	Construction of new commercial structures, including farm structures	$177,983	1.3	$89,528	$95,945
56	Construction of other new nonresidential structures	$3,024,031	37.3	$2,659,617	$1,123,885
57	Construction of new single-family residential structures	$178,170	1.2	$83,940	$100,434
203	Cement manufacturing	$100,980	0.2	$8,890	$20,853
215	Iron and steel mills and ferroalloy manufacturing	$13,323	0.0	$1,079	$1,869
269	All other industrial machinery manufacturing	$729	0.0	$115	$161
331	Switchgear and switchboard apparatus manufacturing	$2,391	0.0	$552	$947
395	Wholesale - Machinery, equipment, and supplies	$12,208	0.0	$4,056	$7,489

400	Wholesale - Other nondurable goods merchant wholesalers	$174,688	0.5	$45,266	$100,666
401	Wholesale - Wholesale electronic markets and agents and brokers	$40,529	0.4	$59,400	$36,827
414	Air transportation	$808	0.0	$173	$591
415	Rail transportation	$38,781	0.1	$8,965	$19,334
416	Water transportation	$1,687	0.0	$231	$424
417	Truck transportation	$147,798	0.8	$59,810	$70,632
444	Insurance carriers, except direct life	$90,730	0.1	$12,067	$40,790
453	Commercial and industrial machinery and equipment rental and leasing	$402,436	1.2	$108,379	$249,783
457	Architectural, engineering, and related services	$1,379,535	7.3	$586,184	$710,533
463	Environmental and other technical consulting services	$62,678	0.7	$43,200	$36,359
470	Office administrative services	$1,191,745	20.3	$985,296	$300,304
515	Commercial and industrial machinery and equipment repair and maintenance	$1,066,033	6.6	$533,316	$665,147
544	* Employment and payroll of federal govt, non-military	$2,672,550	12.0	$1,651,550	$2,672,550
5001	Private Labor	$1,603,530	28.5	$1,603,530	$1,603,530
	Direct Impact	**$12,784,824**	**120.8**	**$8,695,617**	**$8,047,201**
	Secondary Impact	**$12,297,887**	**71.8**	**$4,169,785**	**$6,948,085**
	Total Impact	**$25,082,711**	**192.6**	**$12,865,402**	**$14,995,285**

The project first cost input into the RECONS model for Plan 7 (Extended Channel Enlargement + 4 Detention Basins [2D]) was $49,427,000, which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified, 71.8 percent will be captured within the local study area. The remainder of the expenditures will be captured within the state or national level. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in Table L:6-7. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $49,427,000 support a total of 534.3 full-time equivalent jobs, $35,690,534 in labor income, $41,599,144 in the gross regional product, and $69,583,160 in economic output in the local impact area. More broadly, these expenditures support 855.6 full-time equivalent jobs, $60,686,970 in labor income, $78,993,780 in the gross regional product, and $132,909,938 in economic output in the nation.

Table L:6-7 Plan 7 RECONS Impacts to Local, State, and National Economy's

Area	**Local Capture**	**Output**	**Jobs**	**Labor Income**	**Value Added**
		Local			
Direct Impact		$35,466,999	335.1	$24,122,932	$22,324,128
Secondary Impact		$34,116,161	199.2	$11,567,602	$19,275,017
Total Impact	$35,466,999	$69,583,160	534.3	$35,690,534	$41,599,144
		State			
Direct Impact		$39,938,805	374.8	$27,907,605	$26,435,318
Secondary Impact		$39,250,939	226.8	$13,083,452	$21,915,615
Total Impact	$39,938,805	$79,189,744	601.6	$40,991,057	$48,350,934
		National			
Direct Impact		$47,582,866	447.5	$33,316,979	$32,200,302
Secondary Impact		$85,327,072	408.2	$27,369,991	$46,793,478
Total Impact	$47,582,866	$132,909,938	855.6	$60,686,970	$78,993,780

Table L:6-8. Plan 7 RECONS Impacts to Specific Industries

IMPLAN Sectors	**Industries**	**Output**	**Jobs**	**Labor Income**	**Value Added**
	Direct Impacts				
29	Sand and gravel mining	$125,294	0.9	$24,513	$41,236
52	Construction of new power and communication structures	$494,255	2.9	$209,443	$256,810
54	Construction of new highways and streets	$494,221	2.5	$183,484	$223,894
55	Construction of new commercial structures, including farm structures	$493,752	3.6	$248,365	$266,165
56	Construction of other new nonresidential structures	$8,389,110	103.3	$7,378,172	$3,117,824
57	Construction of new single-family residential structures	$494,270	3.3	$232,862	$278,619
203	Cement manufacturing	$280,134	0.5	$24,662	$57,851
215	Iron and steel mills and ferroalloy manufacturing	$36,961	0.0	$2,992	$5,184
269	All other industrial machinery manufacturing	$2,023	0.0	$318	$448
331	Switchgear and switchboard apparatus manufacturing	$6,633	0.0	$1,530	$2,627
395	Wholesale - Machinery, equipment, and supplies	$33,866	0.1	$11,251	$20,776

400	Wholesale - Other nondurable goods merchant wholesalers	$484,610	1.4	$125,575	$279,262
401	Wholesale - Wholesale electronic markets and agents and brokers	$112,433	1.2	$164,785	$102,164
414	Air transportation	$2,240	0.0	$481	$1,641
415	Rail transportation	$107,585	0.2	$24,869	$53,636
416	Water transportation	$4,680	0.0	$640	$1,175
417	Truck transportation	$410,012	2.2	$165,922	$195,944
444	Insurance carriers, except direct life	$251,699	0.3	$33,475	$113,158
453	Commercial and industrial machinery and equipment rental and leasing	$1,116,417	3.2	$300,659	$692,936
457	Architectural, engineering, and related services	$3,827,036	20.3	$1,626,160	$1,971,125
463	Environmental and other technical consulting services	$173,877	2.0	$119,843	$100,866
470	Office administrative services	$3,306,076	56.4	$2,733,359	$833,088
515	Commercial and industrial machinery and equipment repair and maintenance	$2,957,332	18.3	$1,479,497	$1,845,218
544	* Employment and payroll of federal govt, non-military	$7,414,050	33.3	$4,581,645	$7,414,050
5001	Private Labor	$4,448,430	79.1	$4,448,430	$4,448,430
	Direct Impact	**$35,466,999**	**335.1**	**$24,122,932**	**$22,324,128**
	Secondary Impact	**$34,116,161**	**199.2**	**$11,567,602**	**$19,275,017**
	Total Impact	**$69,583,160**	**534.3**	**$35,690,534**	**$41,599,144**

The project first cost input into the RECONS model for the Levee-Floodwall with Nonstructural Mitigation plan (Plan 8) was $18,887,000, which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified, 71.8 percent will be captured within the local study area. The remainder of the expenditures will be captured within the state or national level. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in Table L:6-9. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $18,887,000 support a total of 204.2 full-time equivalent jobs, $13,638,034 in labor income, $15,895,827 in the gross regional product, and $26,589,053 in economic output in the local impact area. More broadly, these expenditures support 327.0 full-time equivalent jobs, $23,189,649 in labor income, $30,185,031 in the gross regional product, and $50,787,424 in economic output in the nation.

Table L:6-9. Plan 8 RECONS Impacts to Local, State, and National Economy's

Area	Local Capture	Output	Jobs	Labor Income	Value Added
		Local			
Direct Impact		$13,552,617	128.1	$9,217,833	$8,530,475
Secondary Impact		$13,036,436	76.1	$4,420,201	$7,365,352
Total Impact	$13,552,617	$26,589,053	204.2	$13,638,034	$15,895,827
		State			
Direct Impact		$15,261,380	143.2	$10,664,028	$10,101,440
Secondary Impact		$14,998,533	86.7	$4,999,437	$8,374,375
Total Impact	$15,261,380	$30,259,912	229.9	$15,663,465	$18,475,814
		National			
Direct Impact		$18,182,321	171.0	$12,731,054	$12,304,350
Secondary Impact		$32,605,103	156.0	$10,458,596	$17,880,681
Total Impact	$18,182,321	$50,787,424	327.0	$23,189,649	$30,185,031

Table L:6-10 Plan 8 Mitigation RECONS Impacts to Specific Industries

IMPLAN Sectors	Industries	Output	Jobs	Labor Income	Value Added
	Direct Impacts				
29	Sand and gravel mining	$47,877	0.4	$9,367	$15,757
52	Construction of new power and communication structures	$188,864	1.1	$80,032	$98,132
54	Construction of new highways and streets	$188,851	1.0	$70,113	$85,554
55	Construction of new commercial structures, including farm structures	$188,672	1.4	$94,905	$101,707
56	Construction of other new nonresidential structures	$3,205,639	39.5	$2,819,341	$1,191,380
57	Construction of new single-family residential structures	$188,870	1.3	$88,981	$106,466
203	Cement manufacturing	$107,045	0.2	$9,424	$22,106
215	Iron and steel mills and ferroalloy manufacturing	$14,123	0.0	$1,143	$1,981
269	All other industrial machinery manufacturing	$773	0.0	$122	$171
331	Switchgear and switchboard apparatus manufacturing	$2,535	0.0	$585	$1,004
395	Wholesale - Machinery, equipment, and supplies	$12,941	0.0	$4,299	$7,939

400	Wholesale - Other nondurable goods merchant wholesalers	$185,179	0.5	$47,985	$106,712
401	Wholesale - Wholesale electronic markets and agents and brokers	$42,963	0.5	$62,968	$39,039
414	Air transportation	$856	0.0	$184	$627
415	Rail transportation	$41,110	0.1	$9,503	$20,495
416	Water transportation	$1,789	0.0	$244	$449
417	Truck transportation	$156,674	0.8	$63,402	$74,874
444	Insurance carriers, except direct life	$96,179	0.1	$12,791	$43,240
453	Commercial and industrial machinery and equipment rental and leasing	$426,604	1.2	$114,888	$264,784
457	Architectural, engineering, and related services	$1,462,383	7.8	$621,387	$753,204
463	Environmental and other technical consulting services	$66,442	0.8	$45,794	$38,543
470	Office administrative services	$1,263,315	21.5	$1,044,468	$318,339
515	Commercial and industrial machinery and equipment repair and maintenance	$1,130,053	7.0	$565,344	$705,093
544	* Employment and payroll of federal govt, non-military	$2,833,050	12.7	$1,750,734	$2,833,050
5001	Private Labor	$1,699,830	30.2	$1,699,830	$1,699,830
	Direct Impact	**$13,552,617**	**128.1**	**$9,217,833**	**$8,530,475**
	Secondary Impact	**$13,036,436**	**76.1**	**$4,420,201**	**$7,365,352**
	Total Impact	**$26,589,053**	**204.2**	**$13,638,034**	**$15,895,827**

7.0 RESULTS OF THE ENVIRONMENTAL ANALYSIS

7.1 INTRODUCTION

General

USACE guidance requires a cost effectiveness analysis and an incremental cost analysis for recommended environmental restoration and mitigation plans. A cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. An incremental cost analysis of the solutions is conducted to reveal changes in costs of increasing levels of environmental outputs. In the absence of a common measurement unit for comparing the nonmonetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analysis are valuable tools to assist in decision making. This appendix presents the results of the cost effectiveness and incremental cost analysis of North DeSoto County, Mississippi.

7.2 METHODOLOGY

The project was evaluated using guidance documents and software prepared by the USACE's Institute for Water Resources (IWR). IWR – Planning Suite Software (Version 2.0) was used to automate steps in the cost effectiveness and incremental cost analysis. Much of the text of this appendix was borrowed from the IWR Report (IWR 94-PS-2), Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps (Orth, 1994). The cost effectiveness and incremental cost analysis procedures are presented in nine steps, which are grouped into four tasks listed below.

A. Formulation of Combinations
   Step 1. Display outputs and costs
   Step 2. Identify combinable management features
   Step 3. Calculate outputs and costs of combinations

B. Cost Effectiveness Analysis
   Step 4. Eliminate economically inefficient solutions
   Step 5. Eliminate economically ineffective solutions

C. Development of Incremental Cost Curve
   Step 6. Calculate average costs
   Step 7. Recalculate average costs for additional outputs

D. Incremental Cost Analysis
   Step 8. Calculate incremental costs
   Step 9. Compare successive outputs and incremental costs

The results of these analyses are not fully displayed within the economic appendix, but the CE/ICA analysis is summarized as graphs and tables on the following pages of this section. They allow decision makers to progressively compare alternative levels of environmental outputs and ask if the next level is "worth it": that is, is the additional environmental output in the next level worth the additional monetary costs? It is important to note that these analyses will not usually lead, and are not intended to lead, to a single best solution as in economic cost-benefit analyses. They will improve the quality of decision making by ensuring that a rational, supportable, focused, and traceable approach is used for considering and selecting alternative methods to produce environmental outputs. The results though do not tell the entire story, as each of the creeks analyzed have environmentally technical significance that was not fully quantified by the environmental model.

The NER plan analyzed the existing condition biological conditions of more than 17 different streams within the county as shown in Figure L:7-1. Initial discussions with USACE team members in Vicksburg and partners at Engineer Research and Development Center (ERDC) indicated that the Coldwater River is a stable channel and as such do not require bank stabilization, which is the primary ER objective of this study. This allowed the PDT to screen this stream. Evaluations of Cow Pen Creek, Rocky Creek, Pigeon Roost and Byhalia identified that these streams were either stable or agraddational. Streams that were aggregational or stable were also screened because they were found to not meet the primary objective which is to restore and protect aquatic and riparian ecosystems by decreasing channel slopes and stabilizing bank lines which will improve transport of stream flows and sediment over a 50 period of analysis.

Ecosystem restoration management measures were developed for the remaining eleven streams through a brainstorming process led by team's environmental lead along with partners at ERDC. Alternative plans were identified using a channel stability assessment completed by ERDC. This method uses existing LIDAR data to assess the stream corridor conditions based on analysis of the longitudinal profile and cross-sections.

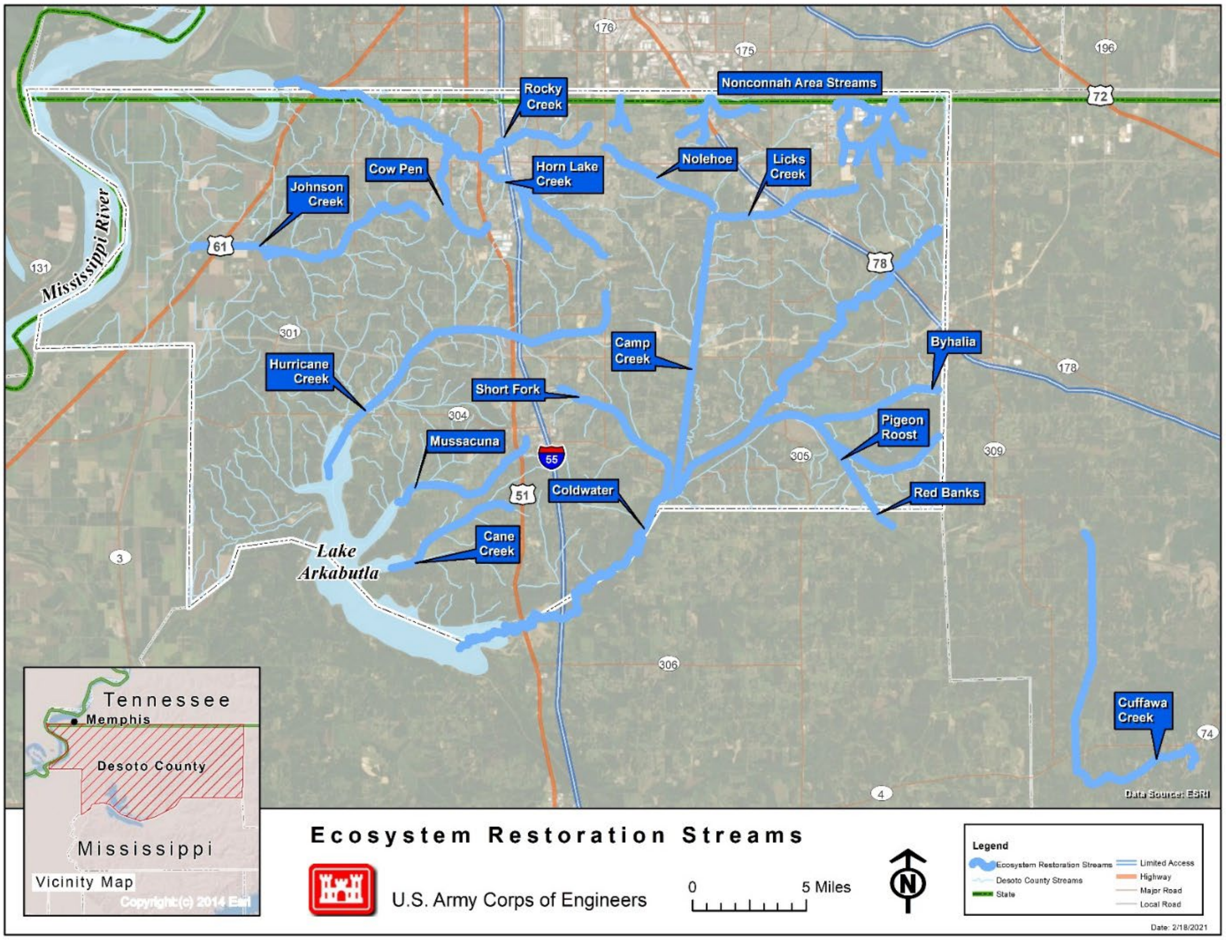

Figure L:7-1. DeSoto County Streams Evaluated for Ecosystem Restoration

This method allowed the PDT to undertake a rapid watershed assessment approach for planning based on geomorphic and engineering principles. An Initial Array of Ecosystem Restoration Alternatives is listed in Table 48.

The ER management measures were developed and correlated to the ecosystem restoration objectives. Included were measures that were thought to best address the stream stability, erosion, and ecosystem degradation concerns in the study area. The measures were then evaluated by a screening process based on the planning objectives, constraints, as well as the opportunities and problems of the study/project area. Ten measures (Table L:7-1) were evaluated including both terrestrial and in stream features.

Table L:7-1 Ecosystem Restoration Measures Evaluated

Type	**Measure ID**	**Description**	**Location**	**Screened (S) or Retained (R)**
Grade Control	ER-1	Low Drop Structures	All streams	R
	ER-2	High Drop Structures	All Streams	S
Bank Stabilization	ER-3	Riser pipes	All streams	R
	ER-4	Lateral stabilization with stone to protection	All streams	R
	ER-5	Rip Rap	All streams	R
Terrestrial Habitat Construction	ER-6	Riparian Buffer Strips	All streams	R
	ER-7	Constructed Habitat	All streams	S
In stream maintenance	ER-8	Clearing and Snagging	Hurricane, Johnson, Horn Lake Creek	S
In stream habitat Construction	ER-9	Streambank terracing	All streams	S
	ER-10	In-line detention	Horn Lake Basin	R

The ERDC team developed a hydrogeomorphic model that utilizes physical stream attributes to assess ecosystem restoration benefits gained from the stabilization of streams. This model is undergoing certification and will be certified by the final EIS. The Stream Condition Index or SCI model was formulated, tested, and refined to: determine existing conditions, identify problems in the watershed, prioritize of stream segments for restoration, recommend structural and non-structural restoration designs, and provide numerical assessment of alternatives for planning purposes. Using metrics to characterize the hydro-geomorphology, water quality, plant habitat and animal habitat of the stream reaches, the SCI model can show ecosystem restoration benefits gained from bank stabilization projects. An initial array of alternatives was identified utilizing bank stabilization systems identified by the ERDC geomorphology team along with riparian buffer strips of varying sizes and locations. Riparian acreages were determined using National Land Cover Data mapping within 100-m of a stream. Categories assumed to be reforestable include cultivated crops, barren land, hay/pasture, herbaceous, and shrub/scrub.

Each of the eleven streams evaluated for ecosystem restoration started with 5 alternatives identified those alternatives included:

1. Grade control alone
2. Riparian restoration alone, at the maximum quantity identified by NLCD data
3. Grade control+ maximum riparian acreage restored
4. Grade control + riparian immediately adjacent to grade control
5. Grade control + 25% of riparian acreage available adjacent to grade control

However, after discussing alternatives 1 and 2 as a team it was determined that alternative 2-riparian restoration alone and alternative 3-maximum riparian identified by national land cover data (NLCD) would both be screened across the county. While riparian restoration alone provides a significant number of AAHUs initially the PDT determined this would not be a complete plan because channel and bank stabilization are needed in these highly incised streams and degraded streams. Likewise, maximum riparian restoration along with grade control (alternative 3) was screened because while the land cover data illustrated this quantity land could be available for reforestation, the likelihood of acquiring this maximum amount was determined to be very low.

The remaining three alternatives (# 1, 4 and 5) were evaluated on each of eleven streams using the cost efficiency incremental cost analysis (CEICA) tool. With eleven streams and 3 alternatives per stream means that millions of combinations were analyzed. The tool identified only those cost-effective alternatives and those alternatives were then evaluated with the CEICA tool together, as well as grouped by basin.

Construction first costs (including contingency) were annualized at the FY22 federal discount rate of 2.25% over the 50 year period of analysis for the environmental restoration features. Interest during construction assumed a one-year construction duration using the same interest rate. Table L:7-2 shows the cost summary, average annual costs, and benefits for each of the alternatives input into the CEICA model.

Table L:7-2. Environmental Restoration Costs

Stream	Alt #	Alternative Description	AAHUs	Construction (w/Contingency)	Interest During Construction	Annualized OMRR&R	Annualized Interest During Construction	Total Average Annual Cost	AACost/AAHU
Camp Creek	CP-1	7 GCS	22	$2,307,114	$26,028	$16,000	$872	$94,203	$4,282
	CP-4	8 GCS + 47 riparian acres	53	$3,166,536	$35,724	$16,000	$1,197	$123,334	$2,327
	CP-5b	7 GCS + 39 riparian acres	48	$3,039,068	$34,286	$16,000	$1,149	$119,014	$2,479
Horn Lake Creek	HLC-1	14 GCS	41	$7,174,044	$80,935	$41,000	$2,713	$284,175	$6,931
	HLC-4	14 GCS+ 17 riparian acres	53	$6,982,973	$78,779	$41,000	$2,641	$277,698	$5,240
	HLC-5b	14 GCS+ 20 riparian acres	55	$7,345,901	$82,874	$41,000	$2,778	$290,000	$5,273
Johnson Creek	JC-1	11 GCS	18	$3,129,652	$35,308	$22,000	$1,183	$128,084	$7,116
	JC-4	11 GCS+ 43 riparian acres	48	$3,593,958	$40,546	$22,000	$1,359	$143,823	$2,996
	JC-5b	11 GCS+ 49 riparian acres	52	$4,033,823	$45,508	$22,000	$1,525	$158,732	$3,053
Cane Creek	CN-1	9 GCS	3	$1,960,540	$22,118	$15,000	$741	$81,455	$27,152
	CN-4	9 GCS + 20 riparian acres	17	$2,335,980	$26,354	$15,000	$883	$94,182	$5,540
	CN-5b	9 GCS+ 26 riparian acres	21	$2,461,923	$27,775	$15,000	$931	$98,451	$4,688
Hurricane Creek	HC-1	5 GCS	5	$2,907,073	$32,797	$19,000	$1,099	$117,540	$23,508
	HC-4	5 GCS +62 riparian acres	60	$4,034,795	$45,519	$19,000	$1,526	$155,765	$2,596
	HC-5b	5 GCS + 64 riparian acres	62	$4,084,715	$46,082	$19,000	$1,545	$157,458	$2,540
Lick Creek	LC-1	2 GCS	3	$728,611	$8,220	$10,000	$276	$34,697	$11,566
	LC-4	2 GCS +15 riparian acres	11	$1,024,144	$11,554	$10,000	$387	$44,715	$4,065
	LC-5b	2 GCS + 14 riparian acres	11	$1,014,851	$11,449	$10,000	$384	$44,400	$4,036
Mussacana Creek	MC-1	2 GCS	3	$1,080,931	$12,195	$11,000	$409	$47,640	$15,880
	MC-4	2 GCS + 9 riparian acres	9	$1,266,409	$14,287	$11,000	$479	$53,927	$5,992
	MC-5b	2 GCS + 23 riparian acres	16	$1,516,149	$17,105	$11,000	$573	$62,392	$3,900
Nonconnah Creek	NoN-1	6 GCS	1	$1,331,535	$15,022	$12,000	$504	$57,134	$57,134
	NoN-4	6 GCS + 5 riparian acres	5	$1,442,611	$16,275	$12,000	$546	$60,899	$12,180
	NoN-5b	6 GCS + 20 riparian acres	13	$1,502,193	$16,947	$12,000	$568	$62,919	$4,840
Nolehoe Creek	NL-1 (GCS only)	11 GCS	26	$2,911,795	$32,850	$20,000	$1,101	$118,700	$4,565
	NL-4 (GCS+Adj riparian)	11 GCS + 18 riparian acres	38	$3,251,283	$36,680	$20,000	$1,229	$130,207	$3,427
	NL-5b (GCS+10% riparian)	11 GCS +13 riparian acres	35	$3,169,464	$35,757	$20,000	$1,199	$127,434	$3,641
Short Fork	SF-1	9 GCS	5	$1,952,561	$22,028	$15,000	$738	$81,185	$16,237
	SF-4	9 GCS +12 riparian acres	14	$2,185,572	$24,657	$15,000	$826	$89,083	$6,363
	SF-5b	9 GCS + 92 riparian acres	34	$2,773,875	$31,294	$15,000	$1,049	$109,025	$3,207
Red Banks	RB-1	5 GCS	9	$2,201,811	$24,840	$16,000	$833	$90,634	$10,070
	RB-4	5 GCS + 24 riparian acres	25	$2,647,779	$29,871	$16,000	$1,001	$105,750	$4,230
	RB-5b	5 GCS + 19 riparian acres	21	$2,577,137	$29,074	$16,000	$975	$103,356	$4,922

7.3 RESULTS

As previously stated in this section, there are 33 different independent alternatives, where each one could be combined with each other, or a combination of each other creeks to form millions of potential alternatives. Within the CE/ICA model, the option was selected to only compute alternatives that the model has determined as being cost effective in order to save computation time.

The CE/ICA model was set up and ran in the following formats:

1) Each creek is an individual alternative
2) Each basin is an individual alternative
3) The county is an individual alternative

The PDT decided that the most detailed and informative model set up was running as a county, meaning every creek had an opportunity to join with other creeks to form the most cost-effective plan. During this set up, a constraint was added so that the combined cost-effective plan could not have multiple alternatives within the same creek. In this set up, if there were any creeks that did not have any individual cost-effective runs, they would not show up in the cost effective or best buy results since it was not a requirement that any creek be included in the final plan.

The resulting CE/ICA model simulation found 13 best buy plans and 179 cost effective plans. Once the plans are identified, the model uses incremental costing. Incremental cost is the additional cost incurred by selecting one alternative over another and is computed by subtracting the cost of one alternative from another. The "best buy" plans are the plans that provide the greatest increase in output for the least increases in cost. Figure L:7-2 shows the CEICA cartesian plot that shows the incremental increase in costs and benefits as additional creeks are added to the plan.

Federal planning for water resources development is conducted in accordance with the requirements of the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). The P&G provides a decision rule for selecting a tentatively selected plan where both outputs and costs are featured in dollars. This rule states: "The alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (National Economic Development Plan, NED Plan) is to be selected… (Paragraph 1.10.2)". There is no similar rule for plan selection where the outputs are not featured in dollars, as is the case in planning for ecosystem restoration. In the absences of such a decision-making rule, cost-effectiveness and incremental cost analysis helps to better understand the consequences of the preferred plan in relation to other choices.

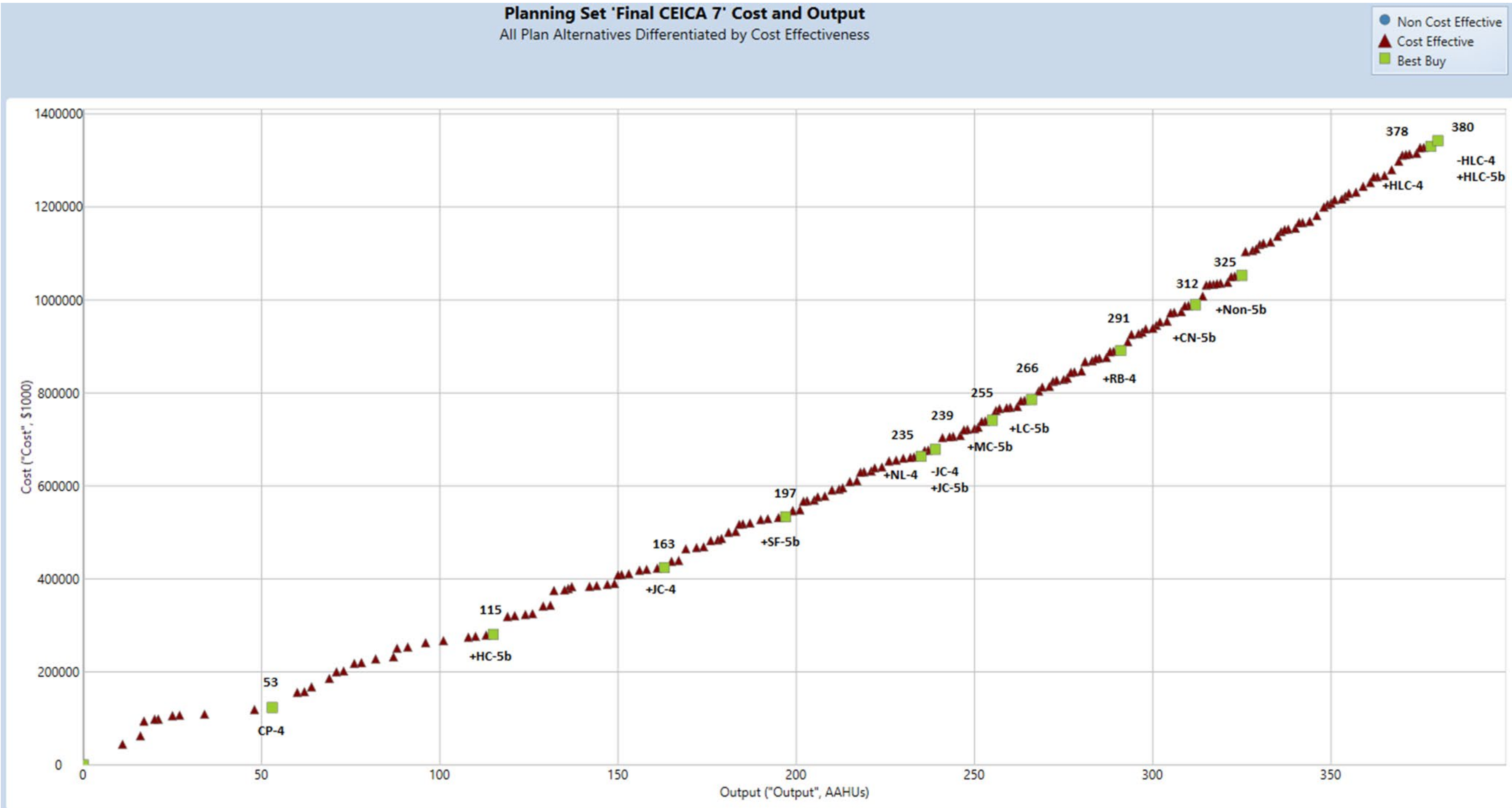

Figure L:7-2 North DeSoto CEICA Cartesian Plot

7.4 INCREMENTAL COST ANALYSIS CONCLUSIONS & TSP

The Best Buy alternatives presented provide the information necessary to make well-informed decisions regarding desired project scale. Progressing through the increasing levels of output for the alternatives in Table L:7-3 and Figure L:7-3 helps determine whether the increase in Net AAHUs is worth the additional cost. As long as decision makers consider a level of output to be "worth it", subsequent levels of output are considered. When a level of output is determined to be "not worth it", subsequent levels of will likely be "not worth it", and the final decision regarding desired project scale for environmental restoration planning will have been reached. The PDT recommends proceeding with alternative 5 for each of the 11 creeks to form the NER Plan, which carries a total cost of $35,165,479.

Table L:7-3. North DeSoto CEICA Summary of Best Buy Plans (Sorted by Cost Effectiveness)

Stream	**Alt #**	**Alternative Description**	**AAHUs**	**Average Annual Cost**	**AACost/AAHU**
Camp Creek	CP-4	8 GCS + 47 riparian acres	53	$123,334	$2,327
Hurricane Creek	HC-5	5 GCS + 64 riparian acres	62	$157,458	$2,540
Cane Creek	CN-5	9 GCS+ 26 riparian acres	21	$98,451	$4,688
Johnson Creek	JC-5	11 GCS+ 49 riparian acres	52	$158,732	$3,053
Nonconnah Creek	NoN-5	6 GCS + 20 riparian acres	13	$62,919	$4,840
Mussacuna Creek	MC-5	2 GCS + 23 riparian acres	16	$62,392	$3,900
Red Banks	RB-4	5 GCS + 24 riparian acres	25	$105,750	$4,230
Short Fork	SF-5	9 GCS + 92 riparian acres	34	$109,025	$3,207
Lick Creek	LC-5	2 GCS + 14 riparian acres	11	$44,400	$4,036
Nolehoe Creek	NL-4	11 GCS + 18 riparian acres	38	$130,207	$3,427
Horn Lake Creek	HLC-5	14 GCS+ 20 riparian acres	55	$290,000	$5,273
		TOTAL NER PLAN	**380**	**$1,343,000**	**$3,533**

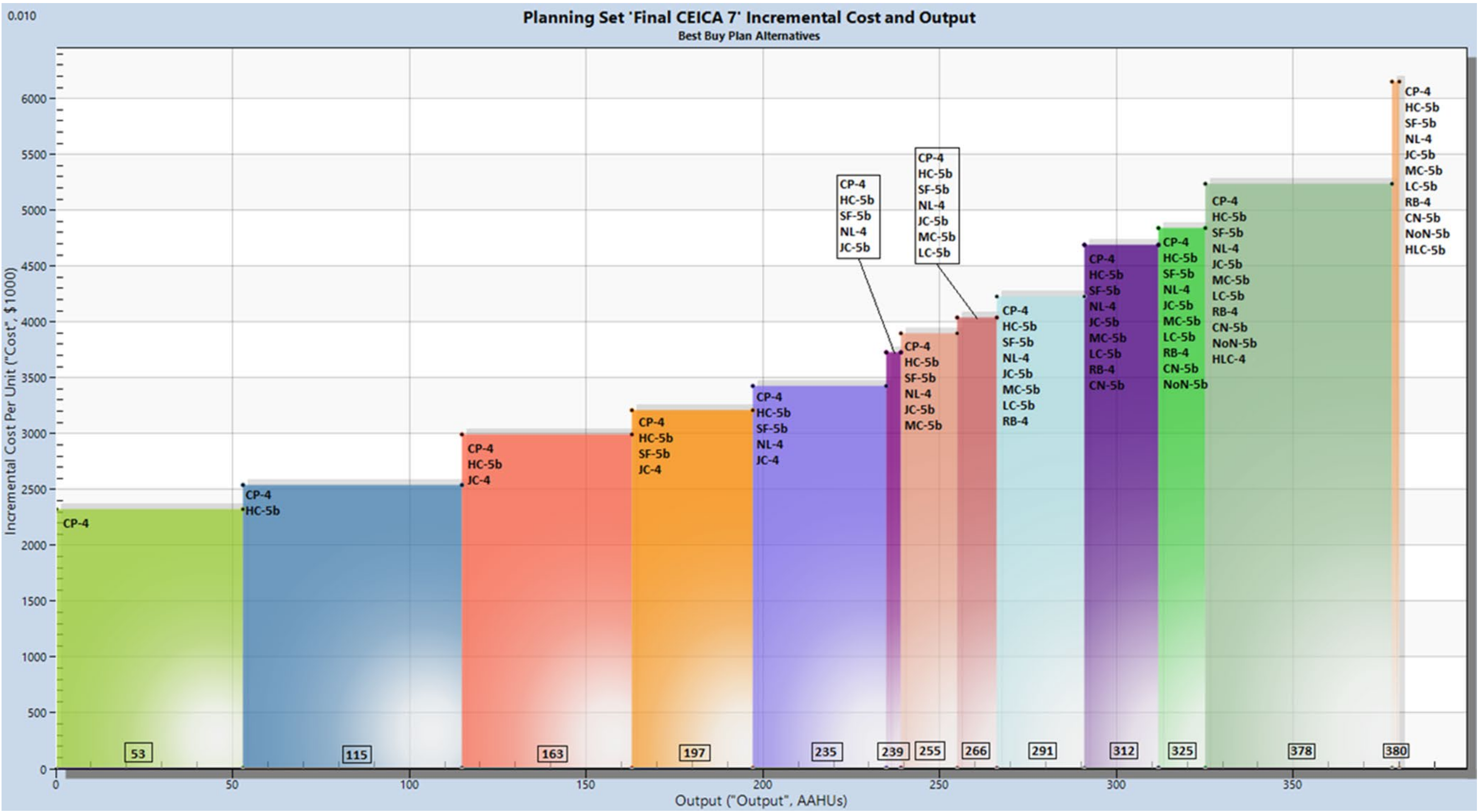

Figure 7-3. North DeSoto CEICA Box Plot