Mississippi Valley Division,
Regional Planning and Environment Division South

# Memphis Metropolitan Stormwater – North DeSoto County Feasibility Study, DeSoto County Mississippi


## Appendix L – Economics

## May 2021

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# Section 1
# Background Information

## 1.1 INTRODUCTION

### 1.1.1 General

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 determine National Economic Development (NED) damages and benefits under existing conditions and the projects costs. The damages and costs were calculated using FY 2021 price levels. Costs were annualized using the FY 2021 Federal discount rate of 2.5 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.

### 1.1.2 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.

#### 1.1.2.1 Physical Flood Damage Reduction

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

#### 1.1.2.2 Emergency Cost Reduction Benefits

Emergency costs are those costs incurred by a community during and immediately following a major storm. Emergency costs for this study include travel, meal, cleanup supplies, unpaid labor, and vandalism costs. These costs were applied to residential structures.

#### 1.1.2.3 Traffic Detour Transit Delay Reduction

A reduction in detour time as a result of having to close high traffic road segments for both residential (car) and commercial (semi-truck) traffic due to flooded roadways.

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

#### 1.1.2.4 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. The Economic Consequences Model (ECAM) is another RED model that is utilized by this study to measure the effects of unmitigated floodwaters on regional production and employment.

#### 1.1.2.5 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 HEC-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

### 1.2.1 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 parishes.

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 amount 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

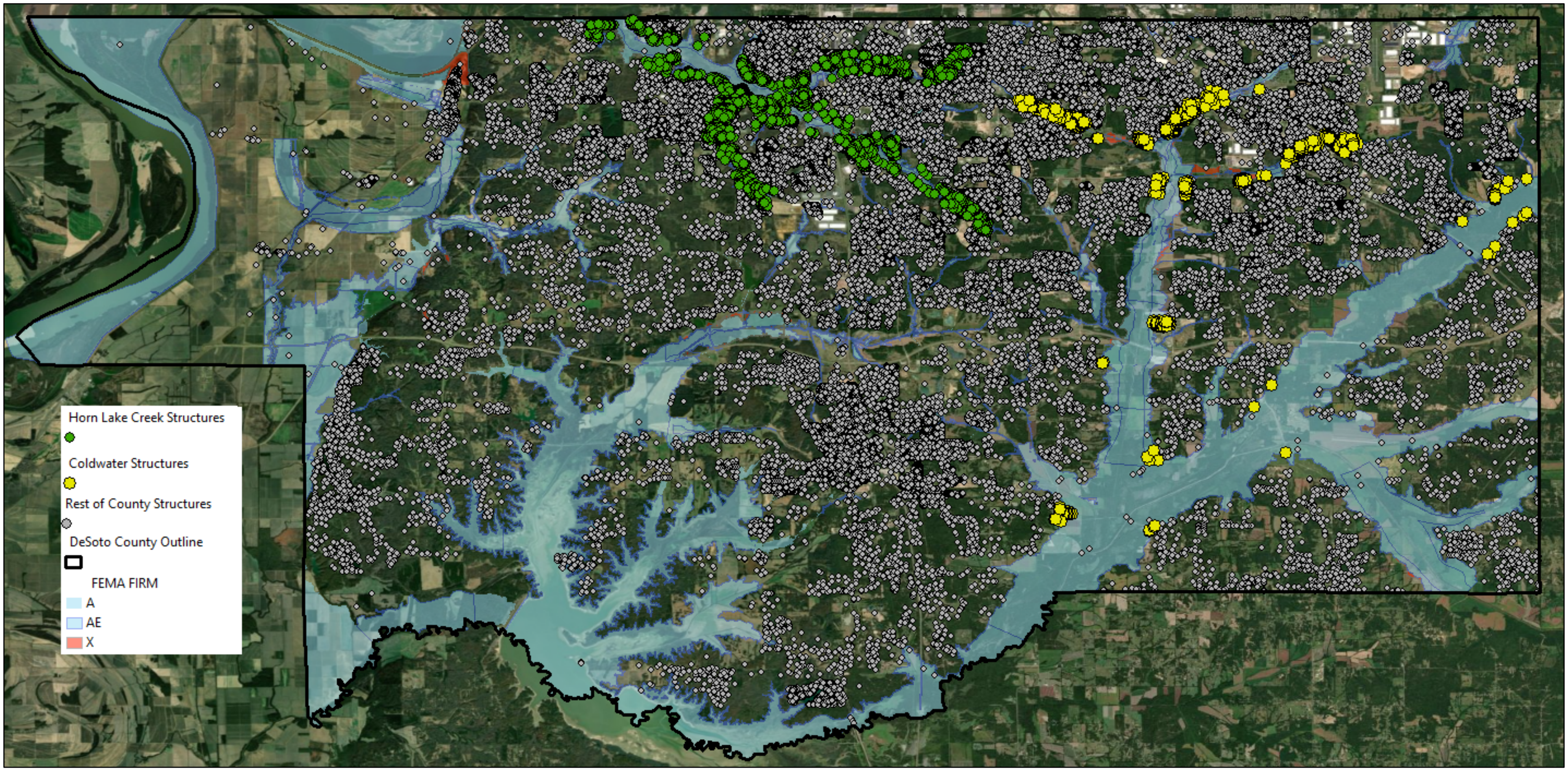


*Figure L: 1-1. North DeSoto County Boundary and Structure Inventory*

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 L: 1-3 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 4,013 structures in Horn Lake Basin and 973 structures in Coldwater Basin located across the combined 28 study area reaches.

*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 | 190 | 15 | 205 |
| *Horn Lake 2* | 15.30 | 18.20 | 367 | 4 | 371 |
| *Horn Lake 3* | 18.20 | 18.94 | 230 | 38 | 268 |
| *Horn Lake 4* | 18.94 | 19.73 | 21 | 106 | 127 |
| *Horn Lake 5* | 19.73 | 21.50 | 39 | 62 | 101 |
| *Horn Lake 6* | 21.50 | 22.31 | 191 | 5 | 196 |
| *Horn Lake 7* | 22.31 | 23.81 | 141 | 8 | 149 |
| *Horn Lake 8* | 23.81 | 25.98 | 206 | 2 | 208 |
| *Rocky Creek 1* | 0.08 | 1.32 | 109 | 2 | 111 |
| *Rocky Creek 2* | 1.32 | 3.41 | 567 | 57 | 624 |
| *Rocky Creek 3* | 3.41 | 5.42 | 313 | 4 | 317 |
| *Cow Pen Creek 1* | 0.51 | 2.48 | 761 | 67 | 828 |
| *Cow Pen Creek 2* | 2.48 | 4.47 | 359 | 3 | 362 |
| *Lateral D 1* | 0.20 | 1.06 | 144 | 2 | 146 |
| *Lateral D 2* | 1.06 | 2.57 | 0 | 0 | 0 |
| *Total* | | | 3,638 | 375 | 4,013 |

*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 |

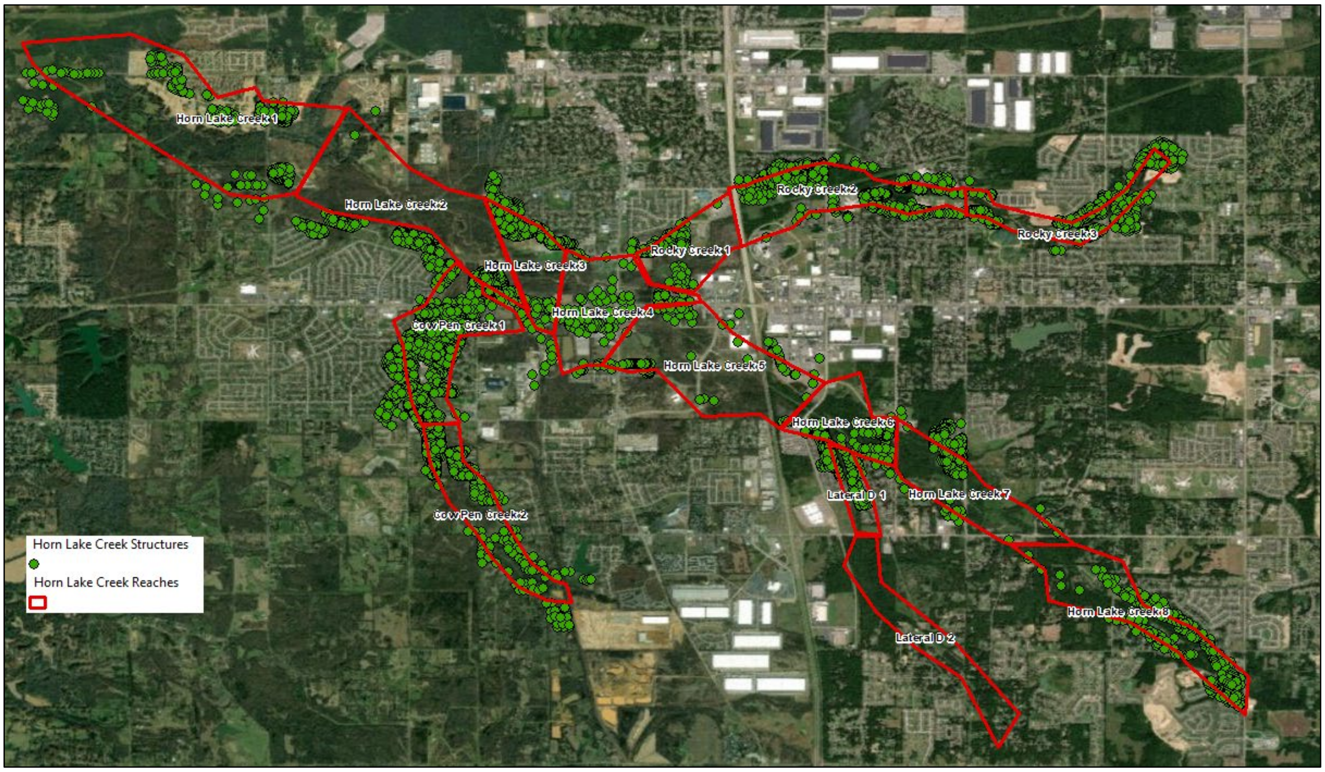


*Figure L: 1-2. Horn Lake Creek Reaches*

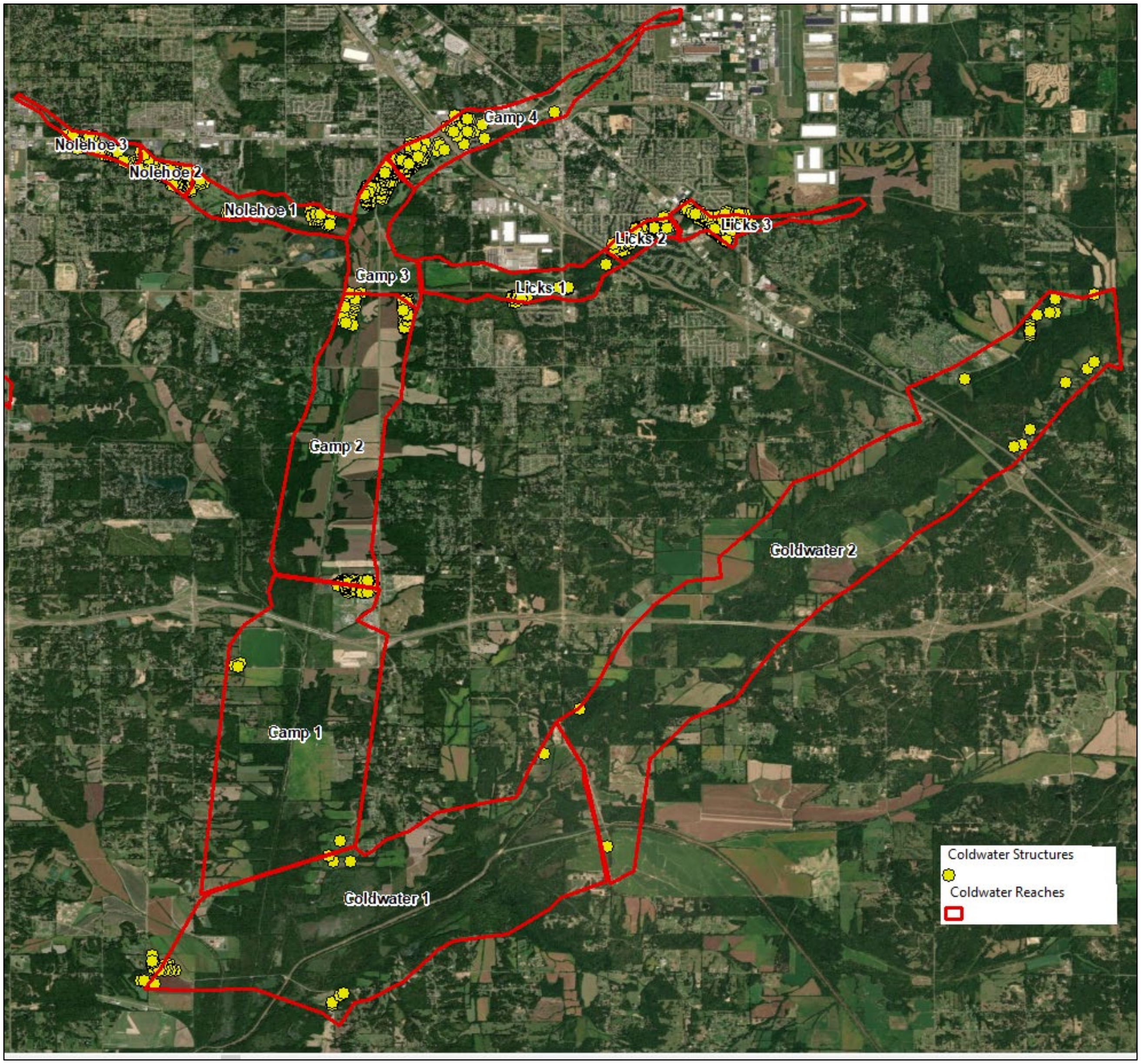


*Figure L: 1-3. Coldwater Basin Reaches*

### 1.2.2 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

### 1.3.1 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 (Table L: 1-5). 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<br>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*<br>*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 |

### 1.3.2 Income

Table L: 1-9 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 |

### 1.3.3 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.

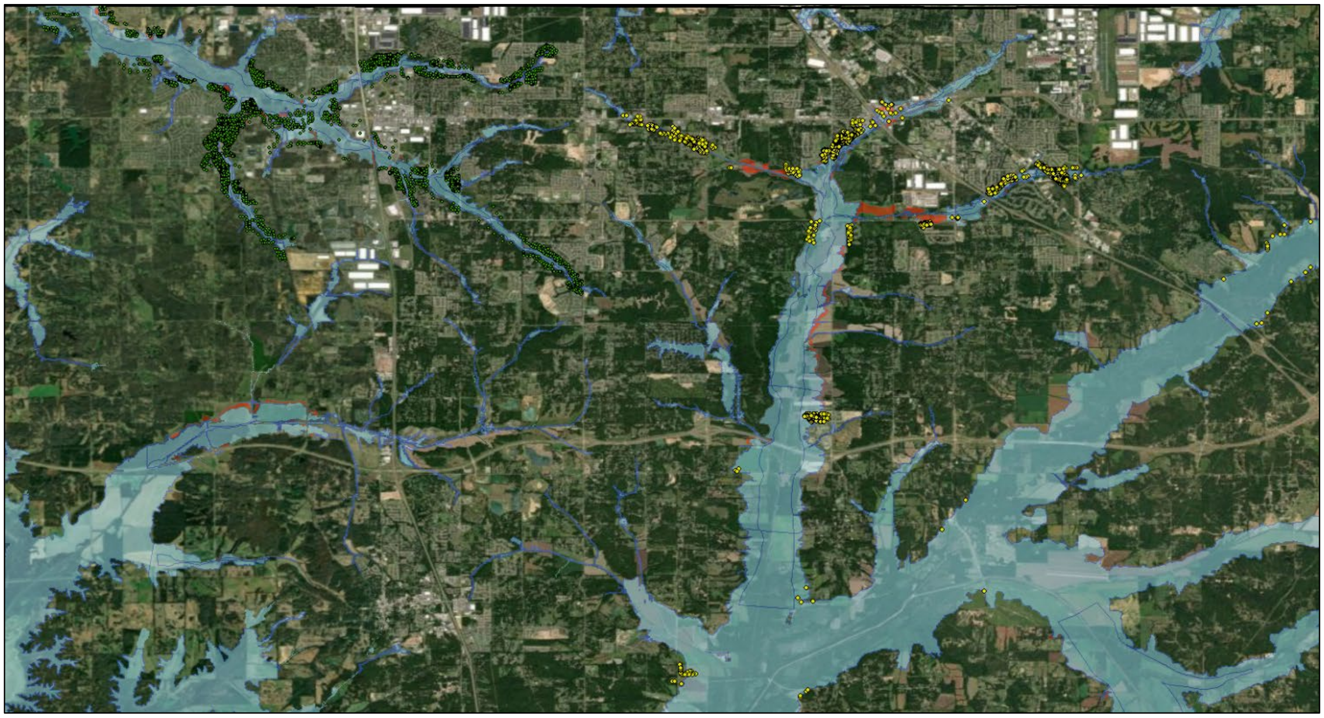

*Figure L: 1-4. DeSoto County FEMA FIRM*

## 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.

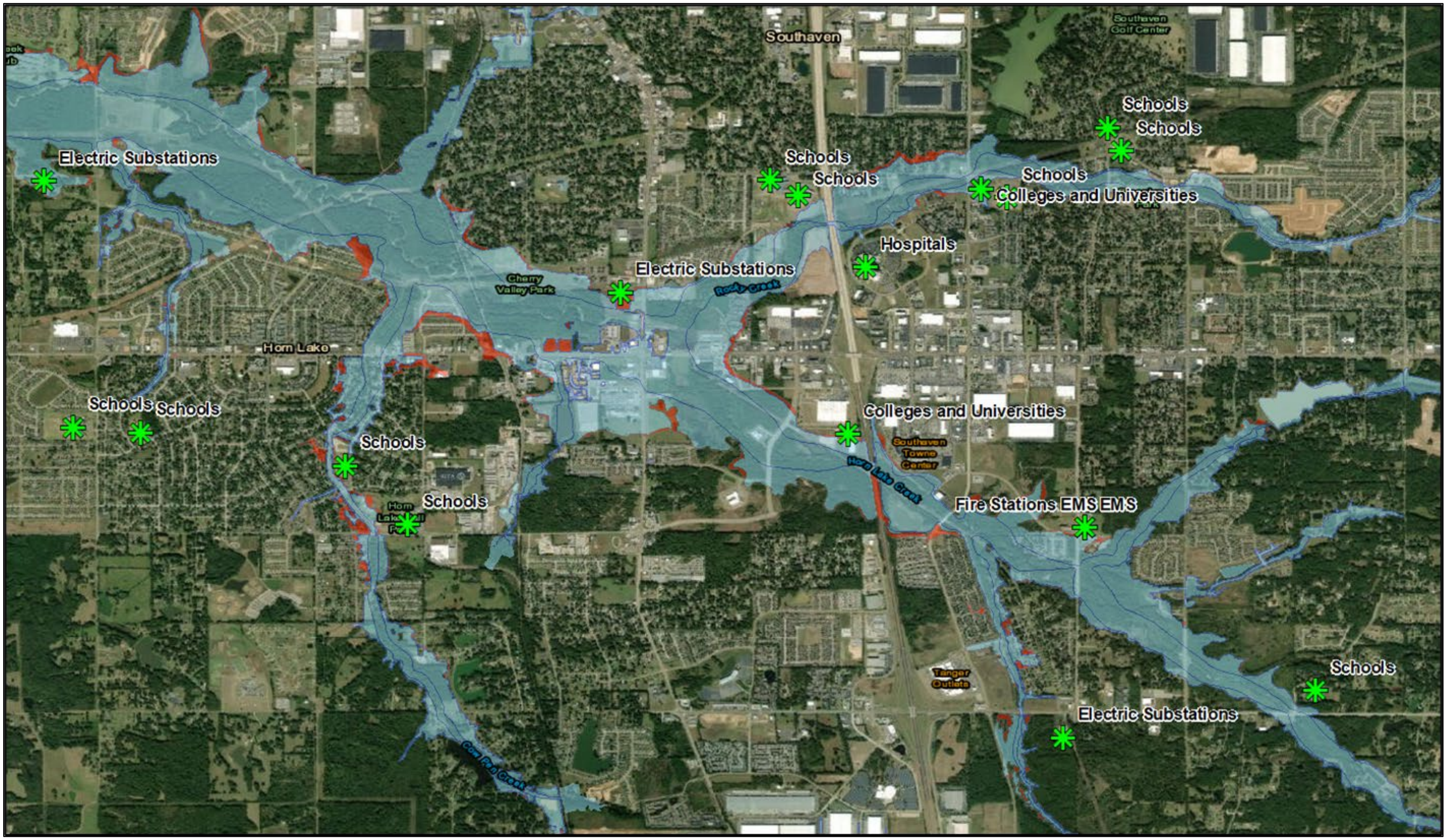


*Figure L: 1-5. Horn Lake Basin Critical Infrastructure*

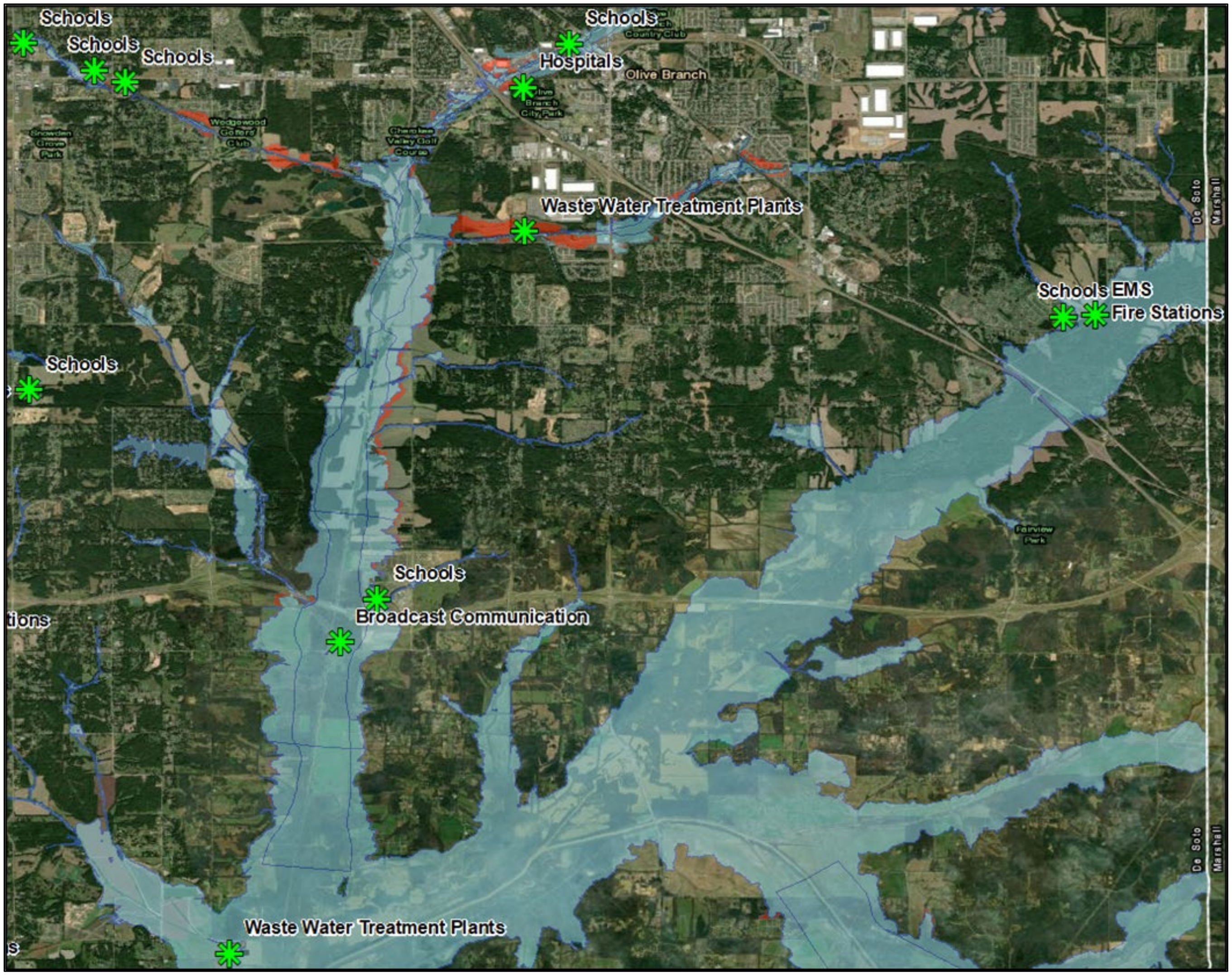


*Figure L: 1-6. Coldwater Basin Critical Infrastructure*

## 1.6 SCOPE OF THE STUDY

### 1.6.1 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 are listed in Table L: 1-10 and Table L:1-11.

*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, 6 were carried forward to the final array (Table L: 1-12. 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 |
| *25YR Nonstructural Aggregation* | Final 4A |
| *Extended Channel Enlargement* | Final 5A |
| *Extended Channel Enlargement and 25YR Nonstructural* | Final 5B |
| *Extended Channel Enlargement and Lateral D Detention* | Final 6A |
| *Extended Channel Enlargement, Lateral D Detention, and 25YR Nonstructural* | Final 6B |
| *Extended Channel Enlargement, Lateral D, Rocky Creek, Cow Pen Detention, and 25YR Nonstructural* | Final 7A |

#### 1.6.1.1 Nonstructural

Two nonstructural measures have been carried forward to the final array and include elevating residential structures up to the future year 1% AEP stage, not to exceed 13 feet and floodproofing non-residential structures up to 3 feet. For both nonstructural measures, 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. The final array includes the 4% AEP floodplain, which was optimized by comparing net benefits of each of the three floodplains analyzed. Since the 4% AEP floodplain individually reasonably maximized net benefits, it was the only nonstructural aggregation combined with other structural measures.

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.

# Section 2

# Economic and Engineering Inputs to the HEC-FDA Model

## 2.1 HEC-FDA MODEL

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.4.2 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:

- **Structure Inventory** – discusses methodology, structural value estimation, content-to-structure value ratios, vehicle value estimation, and flood related damages and costs
- **Elevation Data & Sampling** – discusses ground surface elevation, foundation heights, first floor elevations, and sampling structural attributes
- **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
- **Depth Damage Relationships** – discusses the depth damage relationships, uncertainty and how the distributions were generated

## 2.2 ECONOMIC INPUTS TO THE HEC-FDA MODEL

### 2.2.1 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.

#### 2.2.1.1 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. RS Means Structure Inventory Statistics*

| 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 | Pub2 |
| Office, 1 Story | GOV1 | Pub2 |
| Police Station | GOV2 | Pub2 |
| Factory, 1 Story | IND1 | StorageInd |
| Factory, 1 Story | IND2 | StorageInd |
| Factory, 1 Story | IND3 | StorageInd |
| Factory, 1 Story | IND4 | StorageInd |
| Office, 1 Story | IND6 | OfficeInd |
| Church | REL1 | Pub1 |
| 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 |
| Nursing Home | RES6 | Pub1 |

#### 2.2.1.2 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.

#### 2.2.1.3 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.

#### 2.2.1.4 Application of RS Means – Non-residential Structures

The 2020 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.

#### 2.2.1.5 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 L: 2-2 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 |

#### 2.2.1.6 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 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 |

#### 2.2.1.7 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 2011 Fargo-Moorhead Feasibility Study, which conducted 33 field interviews with commercial, industrial, and public properties. The interviews were used to develop unique CSVR's for non-residential structures.

Since only a limited number of property owners participated in the field surveys and the participants were not randomly selected, statistical bootstrapping was performed to address the potential sampling error in estimating the mean and standard deviation of the CSVR values. Statistical bootstrapping uses re-sampling with replacement to improve the estimate of a population statistic when the sample size is insufficient for straightforward statistical inference. The bootstrapping method has the effect of increasing the sample size and accounts for distortions caused by a specific sample that may not be fully representative of the population.

#### 2.2.1.8 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 33 field interviews performed as part of the 2011 Fargo-Moorhead Feasibility 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* | 100% | 24% |
| *OfficeCom* | 100% | 10% |
| *StorageCom* | 100% | 10% |
| *Retail* | 100% | 10% |
| *Restaurant* | 100% | 10% |
| *Barn* | 200% | 5% |
| *Pub1* | 100% | 10% |
| *Pub2* | 100% | 10% |
| *OfficeInd* | 100% | 10% |
| *StorageInd* | 100% | 10% |
| *School* | 100% | 10% |
| *Apt1* | 100% | 10% |

#### 2.2.1.9 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 $10,400 value has been indexed to FY20 price levels since the original source, Edmonds, has not republished the average value of a used car since 2018.

If an individual structure contained more than one housing unit, then the adjusted vehicle value was assigned to each housing unit in a residential or multi-family structure category. Only vehicles associated with residential structures were included in the analysis. Vehicles associated with non-residential properties were not included in the evaluation.

#### 2.2.1.10 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.

#### 2.2.1.11 Other Flood Related Damage Costs

Miscellaneous flood related costs and damages are typically discussed in the Other Benefit Categories section of the Economic Appendix. However, these costs were included as part of the HEC-FDA structure records for the individual residential and non-residential structures in the North DeSoto County study area, and therefore these costs are being treated as an economic input. The HEC-FDA model does not report these damages separately from the total expected annual without-project and with-project damages.

Following the April 1997 flood in Grand Forks and East Grand Forks, North Dakota, a post-flood survey was conducted to record data about costs that flood victims incurred besides damage to their property and its contents. These post-flood surveys included expenditures for travel, lodging and meals while evacuated from their homes; flood-related medical costs; costs related to vandalism, looting and theft; cleanup costs including unpaid labor; and any other costs caused by flooding and not included as typical structural, content, or vehicle damage.

The 2011 Fargo-Moorhead Feasibility Study utilized the post-flood survey data and applied a regression-based statistical analysis to determine the expected damage a landowner would experience based on a depth of flooding. This custom depth-damage function relied on the “other value” within the HEC-FDA model being set at $100,000, and the depth damage function assigned damages ranging from $900 to $17,300 based on the depth of flooding.

The North DeSoto County study is relying on the data provided by the 1997 Grand Forks post-flood survey and 2011 Fargo-Moorhead Feasibility Study as a proxy for other flood related damages and costs. The two study areas share similar population, development, and riverine flooding characteristics, and this study assumes it to be an accurate representation of costs landowners would experience given a flood event. The other flood related damage costs have been indexed to FY20 Memphis area costs using the 2019 RS Means Square Foot Costs Data catalog to reflect local characteristics and current prices.

#### 2.2.1.12 Other Flood Related Damage Uncertainty

The uncertainty surrounding other flood related damages sourced from the 1997 Grand Forks post-flood survey and 2011 Fargo-Moorhead Feasibility Study assume a normal distribution with a standard deviation of 10%.

### 2.2.2 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 L: 2-1 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 L: 2-1 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 L: 2-1).

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. See Figure L: 2-1 for the statistically significant sample size formula utilized for this study. A third sample will be completed of the 2% AEP floodplain post-TSP to better refine structural attributes prior to the final report.

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

$n$ = 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 amount 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

#### 2.2.2.1 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.

#### 2.2.2.2 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.

#### 2.2.2.3 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 L: 2-4 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.

### 2.2.3 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 draft report Solicitation of Expert Opinion Depth-Damage Function Calculations for the Benefit-Cost Analysis Tool (URS Group, 2008). Twenty-one core non-residential structures were evaluated by a panel of experts recruited from across the United States. The resulting data from the panel included nationally relevant depth-damage relationships for use in estimating the value of damages expected to occur from a flood event. Each DDF is applicable to businesses across the Nation. These FEMA/USACE expert engineered depth-damage relationships were used for non-residential structures in the study area.

The mobile home depth-damage relationships were based on the relationships developed by a panel of insurance experts as part of the 2006 Morganza to the Gulf Feasibility Study, conducted by the USACE New Orleans District.

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. The generic vehicle curves for sedans were used for vehicles associated with residential structures.

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.

#### 2.2.3.1 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 mobile homes, a triangular probability density function was used to determine the uncertainty surrounding the damage percentage associated with each depth of flooding. A minimum, maximum, and most-likely damage estimate was provided by the panel of experts involved in the 2006 Morganza to the Gulf Feasibility Study for each depth of flooding.

For non-residential structures, the Solicitation of Expert Opinion Depth-Damage Function Calculations for the Benefit-Cost Analysis Tool (URS Group, 2008) reference was utilized to source a normal distribution for non-residential structures.

There was not enough information regarding vehicle damages to develop an uncertainty distribution surrounding the depth-damage relationship.

Section 8 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.

#### 2.2.3.2 Summary of the HEC-FDA Model Uncertainty

Table L 2-6 contains the damage percentages at each depth of flooding along with the uncertainty surrounding the damage percentages.

*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** | | | **Content Value** | **Vehicle Value** | | | **Other Value** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Triangular | | | | Triangular | | | |
| | Normal | Normal | Normal | Min | Most Likely | Max | Normal | Min | Most Likely | Max | Normal |
| *Oreswoutbsmt* | 18% | 30% | 35% | 69% | 100% | 116% | 0% | 16% | 100% | 180% | 10% |
| *Treswoutbsmt* | 18% | 30% | 35% | 69% | 100% | 116% | 0% | 16% | 100% | 180% | 10% |
| *Apt1* | 20% | 30% | 36% | 80% | 100% | 123% | 10% | 16% | 100% | 180% | 10% |
| *MobHome* | 18% | 30% | 35% | 48% | 100% | 147% | 24% | 16% | 100% | 180% | 10% |
| *Restaurant* | 20% | 30% | 36% | 80% | 100% | 123% | 10% | N/A | | | 10% |
| *StorageCom* | 20% | 30% | 36% | 80% | 100% | 123% | 10% | | | | 10% |
| *StorageInd* | 34% | 30% | 58% | 80% | 100% | 123% | 10% | | | | 10% |
| *OfficeCom* | 20% | 30% | 36% | 80% | 100% | 123% | 10% | | | | 10% |
| *OfficeInd* | 34% | 30% | 58% | 80% | 100% | 123% | 10% | | | | 10% |
| *School* | 48% | 30% | 48% | 80% | 100% | 123% | 10% | | | | 10% |
| *Pub1* | 48% | 30% | 48% | 80% | 100% | 123% | 10% | | | | 10% |
| *Pub2* | 48% | 30% | 48% | 80% | 100% | 123% | 10% | | | | 10% |
| *Barn* | 20% | 30% | 36% | 80% | 100% | 123% | 5% | | | | 10% |
| *Retail* | 20% | 30% | 36% | 80% | 100% | 123% | 10% | | | | 10% |

## 2.3 ENGINEERING INPUTS TO THE HEC-FDA MODEL

### 2.3.1 Stage-Probability Relationships

Stage-probability relationships were provided for the existing without-project condition (2025) and future without-project condition (2075). Future condition hydraulics were initially not analyzed for the with project conditions due to limited increases in stages. Post-TSP milestone, a 2D hydraulic model is being refined, and future condition hydraulics will be analyzed prior to the final report.

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 H&H and GIS branches interpolated the results to provide water surface profiles for eight AEP events: 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). The without-project water surface profiles were based on riverine flood events. The future without-project condition (2075) is based on increases in runoff from continued development within the watershed. Hydraulic data was provided in conventional cross sectional 1D format.

### 2.3.2 Uncertainty Surrounding the Stage Probability Relationships

A 25-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. An uncertainty distribution surrounding the rating curve has not been developed at this stage of the study but will be defined post-TSP milestone once the 2D hydraulic model is completed.

# Section 3

# 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. 25 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: 3-8 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. The tables are split by basin and creek.

*Table L: 3-1. 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)* | | | |
| *0.50 (2 yr.)* | 0 | 0 | 0 |
| *0.20 (5 yr.)* | 220 | 94 | 314 |
| *0.10 (10 yr.)* | 821 | 381 | 1,202 |
| *0.04 (25 yr.)* | 1,680 | 785 | 2,465 |
| *0.02 (50 yr.)* | 2,437 | 1,144 | 3,581 |
| *0.01 (100 yr.)* | 4,417 | 2,020 | 6,438 |
| *0.005 (200 yr.)* | 5,423 | 2,477 | 7,900 |
| *0.002 (500 yr.)* | 20,361 | 8,736 | 29,096 |

*Table L: 3-2. 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)* | | | |
| *0.50 (2 yr.)* | 0 | 0 | 0 |
| *0.20 (5 yr.)* | 460 | 5,795 | 6,255 |
| *0.10 (10 yr.)* | 1,557 | 10,467 | 12,024 |
| *0.04 (25 yr.)* | 2,736 | 15,116 | 17,852 |
| *0.02 (50 yr.)* | 4,611 | 19,515 | 24,126 |
| *0.01 (100 yr.)* | 7,034 | 25,719 | 32,752 |
| *0.005 (200 yr.)* | 8,763 | 29,815 | 38,578 |
| *0.002 (500 yr.)* | 31,863 | 75,267 | 107,130 |

*Table L: 3-3. 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)* | | | |
| *0.50 (2 yr.)* | 0 | 0 | 0 |
| *0.20 (5 yr.)* | 2,461 | 188 | 2,649 |
| *0.10 (10 yr.)* | 3,551 | 614 | 4,164 |
| *0.04 (25 yr.)* | 4,996 | 1,578 | 6,574 |
| *0.02 (50 yr.)* | 6,149 | 2,421 | 8,569 |
| *0.01 (100 yr.)* | 8,388 | 4,292 | 12,680 |
| *0.005 (200 yr.)* | 10,451 | 6,011 | 16,462 |
| *0.002 (500 yr.)* | 14,361 | 9,073 | 23,434 |

*Table L: 3-4. 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)* | | | |
| *0.50 (2 yr.)* | 0 | 0 | 0 |
| *0.20 (5 yr.)* | 493 | 34 | 527 |
| *0.10 (10 yr.)* | 1,604 | 111 | 1,715 |
| *0.04 (25 yr.)* | 2,613 | 182 | 2,795 |
| *0.02 (50 yr.)* | 3,282 | 228 | 3,510 |
| *0.01 (100 yr.)* | 3,721 | 259 | 3,980 |
| *0.005 (200 yr.)* | 3,917 | 272 | 4,189 |
| *0.002 (500 yr.)* | 4,298 | 299 | 4,597 |

*Table L: 3-5. 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: 3-6. 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: 3-7. 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: 3-8. 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 0.50 (2-year) and 0.20 (5-year) AEP events were modified to have the 2-year and 5-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: 3-9 through Table L: 3-10 show the damages reduced and residual damages for each plan. The nonstructural alternatives did not reduce any damages to vehicles (Auto).

Table L: 3-11 and Table L: 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 L: 3-14 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 both detention, channel enlargement, and nonstructural measures are all effective at reducing expected annual damages. The levee features are less effective than the other measures at reducing expected annual damage. Figures L: 3-1, L: 3-2, and L: 3-3 show the existing condition damages for the 4%, 2%, and 1% AEP flood frequencies within the Horn Lake Creek Basin.

*Table L: 3-9. 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: 3-10. 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 | 308 | 2,746 | 202 | 17 | 1,717 | 4,990 | - |
| *Final 4A* | 25YR Nonstructural Aggregation | 308 | 967 | 17 | 0 | 666 | 1,958 | 3,032 |
| *Final 5A* | Extended Channel Enlargement | 290 | 964 | 101 | 16 | 1,574 | 2,945 | 2,046 |
| *Final 5B* | Extended Channel Enlargement and 25YR Nonstructural | 290 | 318 | 74 | 16 | 839 | 1,537 | 3,453 |
| *Final 6A* | Extended Channel Enlargement and Lateral D Detention | 241 | 772 | 67 | 16 | 1,366 | 2,463 | 2,528 |
| *Final 6B* | Extended Channel Enlargement, Lateral D Detention, and 25YR Nonstructural | 241 | 152 | 20 | 16 | 611 | 1,041 | 3,950 |
| *Final 7A* | Extended Channel Enlargement with Lateral D, Rocky Creek, Cow Pen Detention, and 25YR Nonstructural | 143 | 4 | 5 | 5 | 456 | 614 | 4,377 |

*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 | Damage Reduced | 0.75 | 0.5 | 0.25 |
| *Without* | Without Project Condition | 4,990 | 4,990 | (0) | - | - | - |
| *Final 4A* | 25YR Nonstructural Aggregation | 4,990 | 1,958 | 3,032 | 2,218 | 2,913 | 3,787 |
| *Final 5A* | Extended Channel Enlargement | 4,990 | 2,945 | 2,045 | 1,398 | 1,804 | 2,500 |
| *Final 5B* | Extended Channel Enlargement and 25YR Nonstructural | 4,990 | 1,537 | 3,453 | 2,674 | 3,818 | 5,385 |
| *Final 6A* | Extended Channel Enlargement and Lateral D Detention | 4,990 | 2,463 | 2,527 | 1,745 | 2,307 | 3,124 |
| *Final 6B* | Extended Channel Enlargement, Lateral D Detention, and 25YR Nonstructural | 4,990 | 1,041 | 3,949 | 2,838 | 4,040 | 5,580 |
| *Final 7A* | Extended Channel Enlargement with Lateral D, Rocky Creek, Cow Pen Detention, and 25YR Nonstructural | 4,990 | 614 | 4,376 | 2,869 | 4,128 | 5,815 |

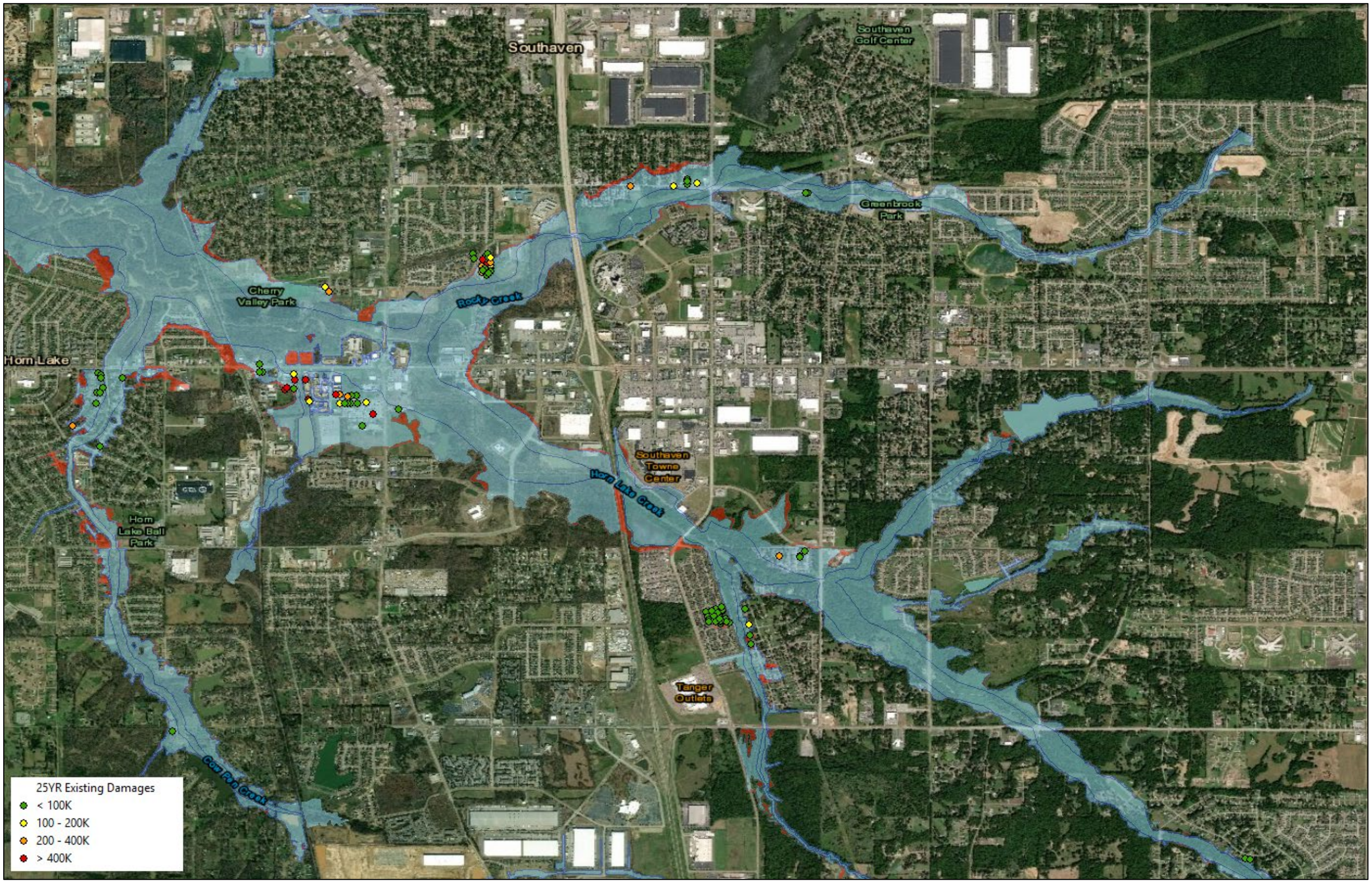


*Figure L: 3-1. Existing Condition 4% AEP Damages*

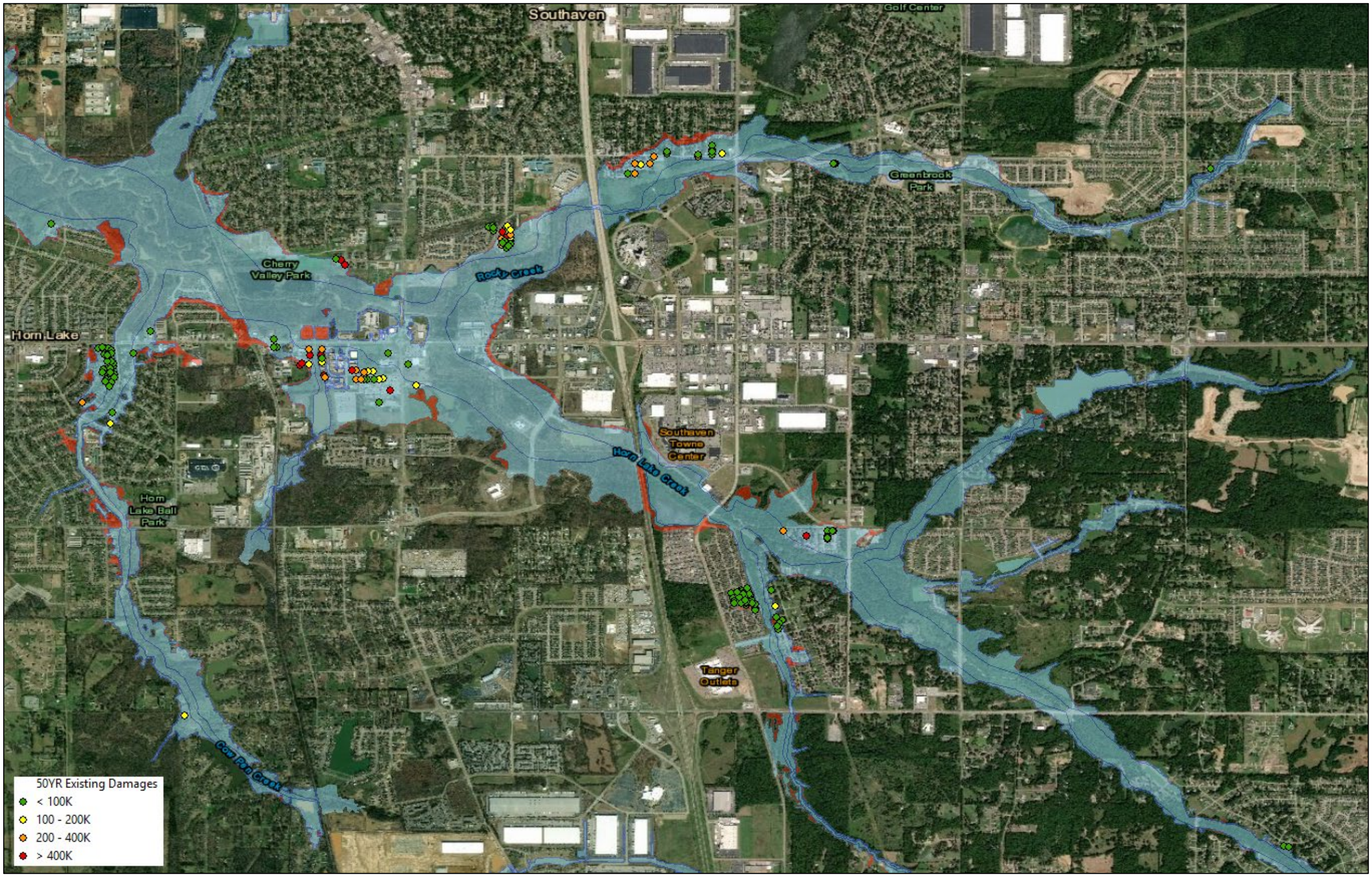


*Figure L: 3-2. Existing Condition 2% AEP Damages*

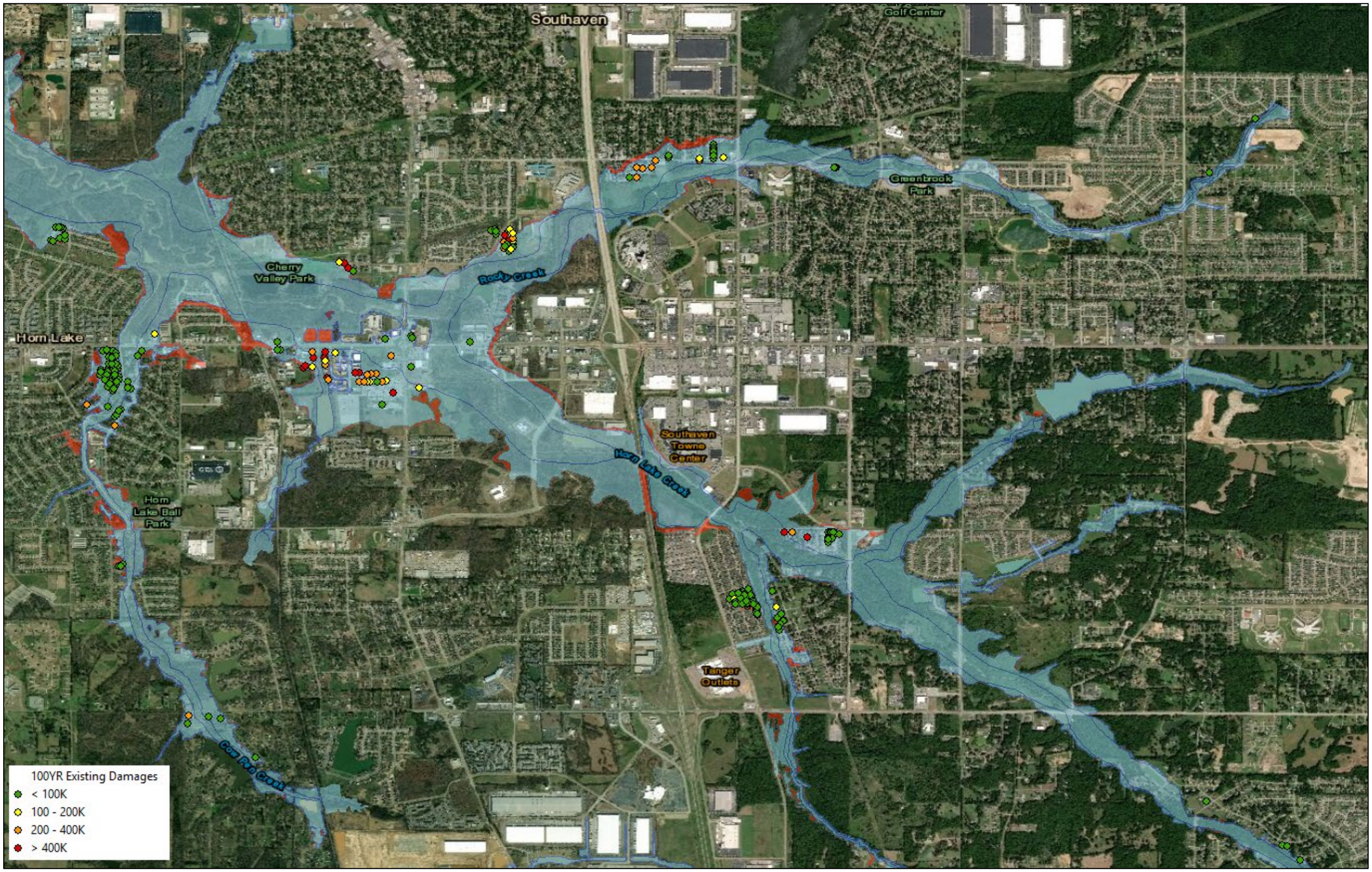


*Figure L: 3-3. Existing Condition 1% AEP Damages*

# Section 4
# Project Costs

## 4.1 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.

## 4.2 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 lasted one year. Interest during construction was calculated using an end of year payment schedule and 2.5% discount rate.

## 4.3 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 2.5% 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.

### 4.3.1 Residential Structures

The estimate of the cost to elevate residential structures was computed once model execution was completed. Elevation costs were based on the difference in the number of feet between the original first floor elevation and the target elevation (the future condition 1% AEP stage) for each structure in the HEC-FDA module. The number of feet that each structure was raised was rounded to the next highest one-foot increment. Elevation costs by structure were summed to yield an estimate of total structure elevation costs.

The cost per square foot for raising a structure was based on data obtained during interviews in 2008 with representatives of three major metropolitan New Orleans area firms that specialize in the structure elevation. Composite costs were derived for residential structures by type: slab and pier foundation, one story and two-story configurations, and for mobile homes. These composite unit costs also vary by the number of feet that structures may be elevated. Table L: 4-1 displays the costs for each of the five residential categories analyzed and by the number of feet elevated.

The cost per square foot to raise an individual structure to the target height was multiplied by the footprint square footage of each structure to compute the costs to elevate the structure. The footprint square footage for each structure was determined by applying the average square footage estimated for each residential structure. The total costs for all elevated structures were annualized over the 50-year period of analysis of the project using the Fiscal Year 2021 Federal discount rate of 2.5 percent. The square foot costs for elevation was price indexed to FY21 price levels using RS Means cost catalog

### 4.3.2 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: 4-2 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 are expressed in FY 2021 prices.

*Table L: 4-1. Nonstructural Elevation Costs for Residential Structures ($/Sq ft.)*

| ***Height*** | **Oreswoutbsmt** | **Treswoutbsmt** | **MobHome** |
|---|---|---|---|
| *[ft.]* | [$] | [$] | [$] |
| *N/A* | 0 | 0 | 0 |
| *1* | 118 | 130 | 58 |
| *2* | 118 | 130 | 58 |
| *3* | 121 | 133 | 58 |
| *4* | 125 | 143 | 71 |
| *5* | 125 | 143 | 71 |
| *6* | 128 | 144 | 71 |
| *7* | 128 | 144 | 71 |
| *8* | 132 | 149 | 71 |
| *9* | 132 | 149 | 71 |
| *10* | 132 | 149 | 71 |
| *11* | 132 | 149 | 71 |
| *12* | 132 | 149 | 71 |
| *13* | 136 | 157 | 71 |
| *14* | 136 | 157 | 71 |
| *15* | 136 | 157 | 71 |
| *16* | 136 | 157 | 71 |

Note: The occupancy types displayed in in this table were converted to the depth damage-functions utilized for this study and include 1-Story Res, 2-Story Res, and Mobile Home.

*Table L: 4-2. 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 |

## 4.4 ANNUAL PROJECT COSTS

Life cycle cost estimates were provided for the nonstructural measures in FY21 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 2021 Federal interest rate of 2.5 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis.

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. Residential structures are recommended to be elevated to the future year (2075) 1% AEP stage, and therefore it is assumed that future increases in water surface elevation will not require future elevations.

Table L: 4-3 through Table L: 4-7 summarize the construction, environmental, real estate, cultural, IDC, and O&MRRR costs for each of the alternatives and basins.

*Table L: 4-3. 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: 4-4. Summary of Costs for Horn Lake Basin Focused Array (3 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: 4-5. Summary of Costs for Horn Lake Basin Focused Array (2 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 |

*Table L: 4-6. 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: 4-7. Summary of Costs for Horn Lake Basin Final Array*

| ***Final Array*** | **Final 4A** | **Final 5A** | **Final 5B** | **Final 6A** | **Final 6B** | **Final 7A** |
|---|---|---|---|---|---|---|
| *Construction First Cost* | 63,944,321 | 6,546,189 | 53,400,137 | 17,875,739 | 49,122,188 | 61,839,471 |
| *Environmental Mitigation Cost* | - | 7,410,696 | 7,410,696 | 7,820,696 | 7,820,696 | 8,200,696 |
| *Real Estate Cost* | - | - | 5,576,875 | - | 4,186,250 | 3,609,375 |
| *Cultural Cost* | - | - | - | - | | |
| *Interest During Construction* | 197,674 | 82,000 | 255,759 | 223,000 | 317,407 | 655,392 |
| *Total Cost* | 64,141,995 | 14,038,885 | 66,643,467 | 25,919,435 | 61,446,541 | 74,304,934 |
| *Annualized O&MRRR* | - | 337,000 | 337,000 | 632,000 | 632,000 | 1,202,000 |
| | | | | | | |
| *Total Average Annual Cost* | 2,262,000 | 832,000 | 2,687,000 | 1,546,000 | 2,798,000 | 3,822,000 |

Reference:

Final Array 4A – 4% AEP (25YR) Nonstructural Aggregation

Final Array 5A – Extended Channel Enlargement (18.60 – 19.41)

Final Array 5B – Extended Channel Enlargement and 4% AEP (25YR) Nonstructural Aggregation

Final Array 6A – Extended Channel Enlargement and Lateral D Detention

Final Array 6B – Extended Channel Enlargement, Lateral D Detention, and 4% AEP (25YR) Nonstructural Aggregation

Final Array 7A – Extended Channel Enlargement, Cow Pen, Lateral D, Rocky Creek Detention and 4% AEP (25YR) Nonstructural Aggregation

# Section 5
# Results of the Economic Analysis

## 5.1 NET BENEFITS

### 5.1.1 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 has been approved and the 2D hydraulic model reviewed, future with project hydraulics will be ran through HEC-FDA and the amount of damage increased over the 50-year period of analysis can be realized. The total average annual benefits were computed in HEC-FDA and include structural, content, vehicle, and other emergency cost damages reduced. A 1% AEP survey of HEC-FDA structure detail out files shows that structural alternative damages reduced from these categories is approximately the following: structure (40%), contents (51%), vehicle (5%), and other emergency related costs (4%). Nonstructural damages reduced are similar, but shows no damages reduced for vehicles. Table L: 5-1 shows the net benefits for the Horn Lake Basin focused array, Table L: 5-2 shows the net benefits for the Coldwater Basin focused array, and Table L: 5-3 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 4A* | 2,262,000 | 3,032,000 | 770,000 | 1.34 |
| *Final 5A* | 832,000 | 1,957,000 | 1,125,000 | 2.35 |
| *Final 5B* | 2,687,000 | 3,453,000 | 766,000 | 1.29 |
| *Final 6A* | 1,546,000 | 2,528,000 | 982,000 | 1.64 |
| *Final 6B* | 2,798,000 | 3,950,000 | 1,152,000 | 1.41 |
| *Final 7A* | 3,822,000 | 4,277,000 | 455,000 | 1.12 |

The plan that reasonably maximizes net benefits is currently Final 6B, which is defined as Extended Channel Enlargement, Lateral D Detention, and 4% AEP (25YR) Nonstructural Aggregation. Final 6B is estimated to induce less than a few inches of floodwaters starting at the 10% AEP event for 27 total structures along four different Horn Lake Creek reaches. The study conservatively estimated that all 27 structures would be elevated, which is reflected in the environmental mitigation costs throughout the economic appendix. Final 3B will hereto be referenced as the NED plan.

During the TSP Milestone meeting, the sponsor and USACE decided to select a Locally Preferred Plan (LPP) that had the highest expected annual damages reduced, which is Final 7A. Final 7A is defined as Extended Channel Enlargement, Cow Pen, Lateral D, Rocky Creek Detention and 4% AEP (25YR) Nonstructural Aggregation. Final 7a will hereto be referenced as the LPP plan.

Table L: 5-4 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.

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

| Item | NED Plan (Final 6B) | LPP Plan (Final 7A) |
|---|---|---|
| ***Structure, Contents, Vehicles, and Other*** | **$3,950,000** | **$4,277,000** |
| *Total Annual Benefits* | $3,950,000 | $4,277,000 |
| | | |
| *First Costs* | $49,122,188 | $61,839,471 |
| *Interest During Construction* | $317,407 | $655,392 |
| *Environmental Mitigation Costs* | $7,820,696 | $8,200,696 |
| *Annual Operation & Maintenance Costs* | $632,000 | $1,202,000 |
| *Total Annual Costs* | $2,798,000 | $3,822,000 |
| | | |
| *B/C Ratio* | 1.41 | 1.12 |
| *Expected Annual Net Benefits* | $1,152,000 | $455,000 |

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

| ***Nonstructural Measure*** | NED Plan (Final 6B) | LPP Plan (Final 7A) |
|---|---|---|
| *Dry Floodproofing (Commercial)* | 15 | 6 |
| *Dry Floodproofing (Industrial)* | 1 | 0 |
| *Dry Floodproofing (Apartment)* | 8 | 8 |
| *Elevation (1-2 Story Residential)* | 42 | 23 |
| *Total* | 66 | 37 |

## 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 $2.8 million, and therefore a 75% that the BCR will exceed 1.01.

*Table L: 5-6. Probability Benefits Exceed Costs*

| ***NED Plan (Final 6B)*** | **75%** | **50%** | **Median** | **25%** |
|---|---|---|---|---|
| *Total Average Annual Cost* | 2,798,000 | 2,798,000 | 2,798,000 | 2,798,000 |
| *Total Average Annual Benefits* | 2,837,760 | 4,039,560 | 3,950,000 | 5,579,770 |
| *Net Benefits* | 39,760 | 1,241,560 | 1,152,000 | 2,781,770 |
| *BCR* | 1.01 | 1.44 | 1.41 | 1.99 |
| | | | | |
| ***LPP Plan (Final 7A)*** | **75%** | **50%** | **Median** | **25%** |
| *Total Average Annual Cost* | 3,822,000 | 3,822,000 | 3,822,000 | 3,822,000 |
| *Total Average Annual Benefits* | 2,868,750 | 4,127,930 | 4,277,000 | 5,814,680 |
| *Net Benefits* | (953,250) | 305,930 | 455,000 | 1,992,680 |
| *BCR* | 0.75 | 1.08 | 1.12 | 1.52 |

While the inputs to the economic model are likely not to change significantly going forward, there are various assumptions that inform the HEC-FDA model that are subject to continued uncertainty and have a chance to impact the estimated net benefits. The primary changing variable are the hydraulic inputs. The H&H engineering branch is currently remodeling the study area within the context of a 2D model instead of a 1D model, which was utilized up to this point. Once the 2D model is complete, revised hydraulics will be run through HEC-FDA, including future with project (2075) condition runs.

The cost estimate for each plan have not been certified by the cost center of expertise and therefore the cost data utilized in this study is also subject to change. Finally, the NED and LPP plans are currently modeled in a 1D environment and found to cause minor inducements downstream in the Horn Lake Creek area. These inducements will be further investigated and will therefore impact the cost and benefits of the TSP going forward.

## 5.4 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.

## 5.5 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 Figure L: 5-1 and Figure L: 5-2, which shows the residual damages (gray area of the bar) by each creek within Horn lake Basin for the NED and LPP plans. While the NED plan reasonably maximized net benefits, it does not provide the most damages reduced (minimizing residual damages). The plan that reduces the most amount of damages is the LPP plan. The residual damages for the NED plan are concentrated in the Rocky Creek and Cow Pen Creek reaches and moving to the LPP reduces these damages so that there are no concentrations left within the study area where residual damages of over 16% exist.

The residual damages that do exist in the LPP plan are structures with flood depths that cannot be mitigated, even by combinations of detention, channel enlargement, and nonstructural. Residual damages during the LPP plan are occurring in situations where the channel enlargement and detention measures do not fully reduce stages on the structure in tandem with the structures being located outside the 4% AEP (25-YR) floodplain. In this situation, they the structures receive reduced stages, but since they are not in the 4% AEP floodplain aggregation, the structures are not eligible for nonstructural measures. The only feasible way to reduce the remaining residual damages would be to increase the size of the floodplain aggregation to the 2% or 1% AEP floodplain.

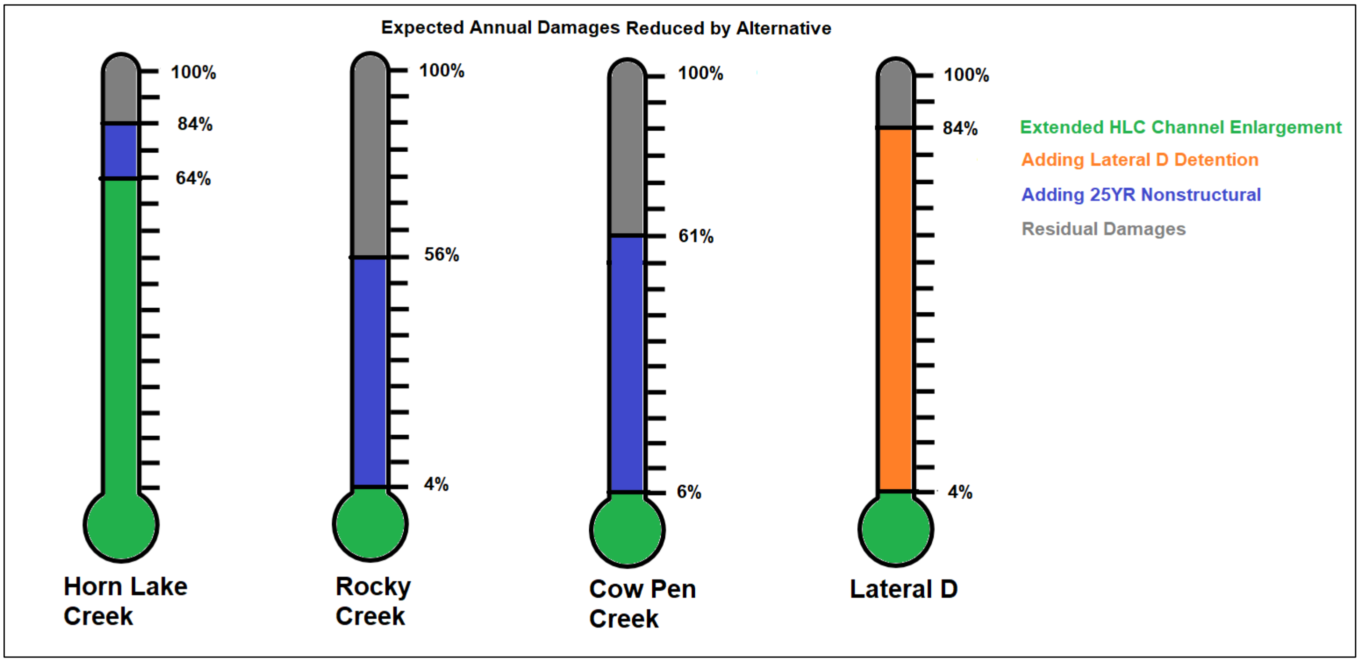


*Figure L: 5-1. NED Plan Damages Reduced (Residual Risk) by Stream (2025 Condition)*

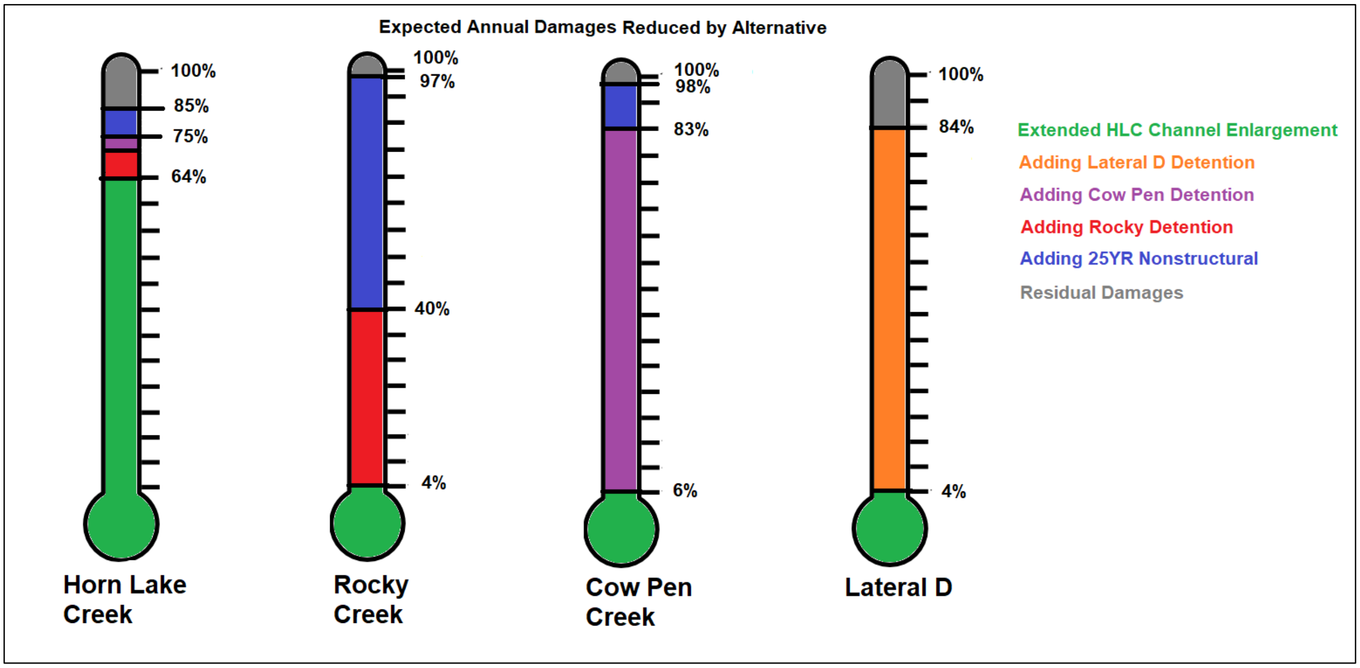


*Figure L: 5-2. LPP Plan Damages Reduced (Residual Risk) by Stream (2025 Condition)*

## 5.6 LIFE SAFETY

Hydraulic modeling for North DeSoto County currently does not support the depths or velocities on any given structure for life safety to be a risk. This conclusion assumes that the occupant is able to reach the highest floor of his or her structure, including above floor spaces such as the attic or roof. With this said, a preliminary economic analysis was performed on flood prone roadways to determine if there was a life safety risk to vehicles on the roadway. The analysis, performed in conjunction with the H&H branch, found there to be three flood prone roads in Horn Lake Creek (Stateline, Goodman, and Highway 51), one in Rocky Creek (Greenbrook), and one in Cow Pen Creek (Meadowbrook). Of these flood prone roads, only two (Goodman and Highway 51) were determined to pose a life safety risk for vehicles attempting to traverse them during a flood event.

A life safety risk was computed using the Corps' HEC-LifeSim computer model, which has a depth x velocity relationship to show when vehicles will begin to lose traction and potentially be swept off the road. In the case of Goodman and Highway 51, this phenomenon begins at the 20% AEP (5-year) event, when flood waters exceed 0.8 feet of depth and 3 feet per second of velocity concurrently. Figure L: 5-3 shows the depth x velocity relationship with uncertainty bands.

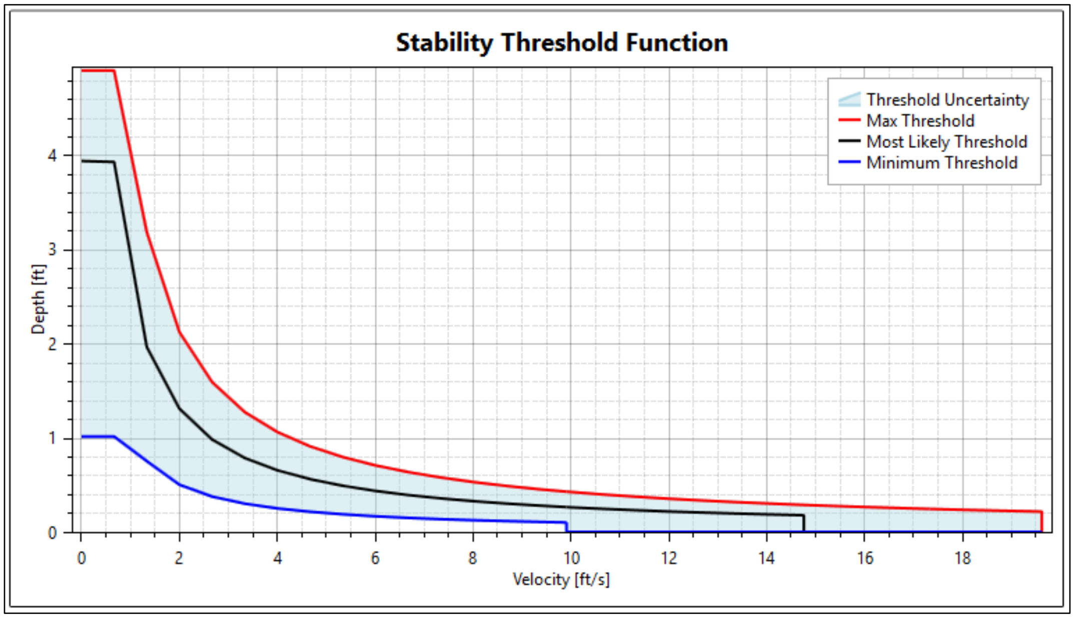


*Figure L: 5-3. HEC-LifeSim Vehicular Stability Function*

The Horn Lake Creek channel enlargement feature of the NED and LPP alternatives helps reduce stages along portions of the channel that pose a life safety risk for vehicles passing during a flood event. The channel enlargement measure within both the NED and LPP alternatives reduces flood stages during a 20% AEP (5-year) event by at least 0.3 feet, and flood stages during a 10% AEP (10-year) event by 0.4 feet. These reductions in stage reduce the depth x velocity forces acting on vehicles to the point that the risk of a vehicle being swept off the road diminishes. With this said, during less frequent events starting at the 4% AEP (25-year) event, the required threshold for sweeping vehicles off the road begins again, even with the channel enlargement measure in place. The inclusion of the detention basins relative to the life safety analysis has not been completed for this draft report but will be finished by the final report.

## 5.7 TRAFFIC DISRUPTION ANALYSIS

As indicated in the Life Safety section, there are a few low spots along the transportation network within the Horn Lake Basin that become flood prone, starting as early as the 50% AEP flood event. The economic cost of detouring residential (cars) and commercial traffic (semi-trucks) as a result of a flooded road closure is qualifiable as NED benefit. Texas A&M releases an annual study titled the Urban Mobility Report and was last published in 2019. The mobility report estimates the value of the delay time based on the extra fuel consumed during congestion and the value of the personal time that a motorist loses because they are delayed. The research concluded a value of $18.12/hour for a personal traveler and $52.14/hour for a commercial traveler. Following report guidance, these values were indexed to FY21 using the Bureau of Labor Statistics Consumer Price Index (CPI).

The traffic disruption analysis uses these hourly rates with the number of hours that a road is expected to be closed from floodwaters for each of the eight flood frequencies used in the HEC-FDA model to determine the average annual cost of traffic disruption. This value is based on the length of the detour that motorists would have to take to avoid the flooded road. For the Horn Lake Basin area, this analysis was completed for Goodman Road, which according to the Mississippi Department of Transportation, experiences more than 36,000 vehicles on a daily basis. Normal length of this road segment through the study area is approximately four miles, which is expected using professional judgement to be extended to more than 15 miles once the flooded segment of the road occurs. The detour of 15 miles is based on what potential roads could handle the volume of both residential, but also semi-truck traffic. The daily road closure cost is a function of the value of lost time and fuel by traveling the extra distance and how frequency it's expected this detour to occur.

Table L: 5-4 shows the expected average annual cost of traffic disruption between the existing (without project) condition and the with project condition, which assumes extended channel enlargement and detention basin. This analysis assumes the roads will be closed preemptively, meaning prior to depth x velocity forces becoming life threatening, and therefore the flood frequencies will be inconsistent with the life safety analysis.

Table L: 5-7 shows an average annual traffic disruption impact reduced of $80,700. Given that this figure would represent 2% of the total benefits when combined with structure, content, and vehicle damages prevented, it has not been included within the total NED and LPP analysis. As a result, the spreadsheet model utilized to estimate these traffic disruption damages was not submitted to the Flood Risk Management Planning Center of Expertise (FRM-PCX) to receive one-time approval for use.

The final report will revisit this analysis and determine the traffic disruption impact for other flood prone roads, such as Highway 51. Given the dense urban environment with ample detour routes available, combined with short and flashy flood durations, it is not expected that the final report will include traffic disruption benefits within the final NED analysis.

*Table L: 5-7. Traffic Disruption Damages Prevented for Goodman Road*

| Without Project (Existing Condition) | | | | | |
|---|---|---|---|---|---|
| **Flow** | Flood Frequency | Length of Closure (days) | Daily Road Closure Cost | Cost Per Event | Expected Annual Cost |
| **2652** | 1.000 | 0.0 | 382,700 | $0 | $0 |
| **4886** | 0.500 | 0.23 | 382,700 | $89,300 | $22,300 |
| **6150** | 0.200 | 0.33 | 382,700 | $124,400 | $32,100 |
| **7157** | 0.100 | 0.36 | 382,700 | $137,100 | $13,100 |
| **8437** | 0.040 | 0.41 | 382,700 | $156,300 | $8,800 |
| **9455** | 0.020 | 0.44 | 382,700 | $169,000 | $3,300 |
| **10413** | 0.010 | 0.46 | 382,700 | $177,000 | $1,700 |
| **12696** | 0.002 | 0.48 | 382,700 | $185,000 | $1,400 |
| | | | | | **$400** |
| | **Average Annual Damage** | | | | **$83,100** |
| **With Project (Channel Enlargement)** | | | | | |
| **Stage** | Flood Frequency | Length of Closure (days) | Daily Road Closure Cost | Cost Per Event | Expected Annual Cost |
| **2652** | 1.000 | 0.00 | 382,700 | $0 | $0 |
| **4886** | 0.500 | 0.00 | 382,700 | $0 | $0 |
| **6150** | 0.200 | 0.00 | 382,700 | $0 | $0 |
| **7157** | 0.100 | 0.00 | 382,700 | $0 | $0 |
| **8437** | 0.040 | 0.00 | 382,700 | $0 | $0 |
| **9455** | 0.020 | 0.00 | 382,700 | $0 | $0 |
| **10413** | 0.010 | 0.42 | 382,700 | $161,100 | $800 |
| **12696** | 0.002 | 0.44 | 382,700 | $169,000 | $1,300 |
| | | | | | **$300** |
| | **Average Annual Damage** | | | | **$2,400** |
| | **Average Annual Benefit** | | | | **$80,700** |

## 5.8 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 flood prone 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 |

# Section 6
# 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 these disbursements 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 total cost input into the RECONS model for the recommended NED plan was $49,122,188, which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified, 46 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: 6-1. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $49,122,188 support a total of 633.9 full-time equivalent jobs, $34,410,552 in labor income, $40,816,439 in the gross regional product, and $63,522,586 in economic output in the local impact area. More broadly, these expenditures support 1,018.8 full-time equivalent jobs, $62,295,355 in labor income, $81,442,248 in the gross regional product, and $138,132,288 in economic output in the nation.

*Table L: 6-1. NED RECONS Impacts to Local, State, and National Economy's ($1,000)*

| ***Area*** | **Local Capture ($000)** | **Output ($000)** | **Jobs** | **Labor Income ($000)** | **Value Added ($000)** |
|---|---|---|---|---|---|
| | | | ***Local*** | | |
| *Direct Impact* | | $38,195,536 | 469.0 | $26,739,328 | $26,649,768 |
| *Secondary Impact* | | $25,327,050 | 165.0 | $7,671,223 | $14,166,671 |
| *Total Impact* | $38,195,536 | $63,522,586 | 633.9 | $34,410,552 | $40,816,439 |
| | | | ***State*** | | |
| *Direct Impact* | | $28,379,415 | 286.3 | $15,709,280 | $15,557,432 |
| *Secondary Impact* | | $22,519,369 | 140.1 | $6,174,729 | $11,504,090 |
| *Total Impact* | $41,642,406 | $50,898,784 | 426.3 | $21,884,009 | $27,061,522 |
| | | | ***National*** | | |
| *Direct Impact* | | $48,293,963 | 583.2 | $33,998,939 | $32,540,356 |
| *Secondary Impact* | | $89,838,325 | 435.6 | $28,296,416 | $48,901,892 |
| *Total Impact* | $48,293,963 | $138,132,288 | 1,018.8 | $62,295,355 | $81,442,248 |

The direct impacts by industry are summarized in Table L: 6-2

*Table L: 6-2. NED RECONS Impacts to Specific Industries ($1,000)*

| ***IMPLAN Sectors*** | **Industries** | **Output** | **Jobs** | **Labor Income** | **Value Added** |
|---|---|---|---|---|---|
| | **Direct Impacts** | | | | |
| *29* | Sand and gravel mining | $39,576 | 0.3 | $7,379 | $13,966 |
| *56* | Construction of other new nonresidential structures | $14,736,656 | 157 | $9,278,716 | $6,848,928 |
| *203* | Cement manufacturing | $0 | 0.0 | $0 | $0 |
| *400* | Wholesale - Other nondurable goods merchant wholesalers | $500,157 | 1.8 | $97,155 | $237,484 |
| *414* | Air transportation | $1,372 | 0.0 | $448 | $999 |
| *415* | Rail transportation | $179,592 | 0.3 | $44,353 | $98,836 |
| *416* | Water transportation | $1,108 | 0.0 | $484 | $499 |
| *417* | Truck transportation | $1,056,062 | 6.2 | $347,805 | $448,221 |
| *444* | Insurance carriers, except direct life | $11,869 | 0.0 | $1,198 | $4,966 |
| *453* | Commercial and industrial machinery and equipment rental and leasing | $2,908,451 | 8.1 | $775,256 | $1,876,180 |
| *457* | Architectural, engineering, and related services | $160,277 | 1.1 | $55,150 | $62,003 |
| *463* | Environmental and other technical consulting services | $179,594 | 2.2 | $112,356 | $100,939 |
| *470* | Office administrative services | $1,842,082 | 34 | $500,905 | $378,008 |
| *544* | * Employment and payroll of federal govt, non-military | $3,315,748 | 17 | $2,255,133 | $3,315,748 |
| *5001* | Private Labor | $13,262,991 | 240 | $13,262,991 | $13,262,991 |
| | **Direct Impact** | **$38,195,536** | **469** | **$26,739,328** | **$26,649,768** |
| | **Secondary Impact** | **$25,327,050** | **165** | **$7,671,223** | **$14,166,671** |
| | **Total Impact** | **$63,522,586** | **634** | **$34,410,552** | **$40,816,439** |

The total cost input into the RECONS model for the recommended LPP plan was $61,839,471 which excludes environmental costs, real estate costs, cultural costs, and IDC. Of this the total expenditures identified; 46 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 $61,839,471 support a total of 798.0 full-time equivalent jobs, $43,319,127 in labor income, $51,383,440 in the gross regional product, and $79,967,999 in economic output in the local impact area. More broadly, these expenditures support 1,282.5 full-time equivalent jobs, $78,423,050 in labor income, $102,526,897 in the gross regional product, and $173,893,468 in economic output in the nation.

*Table L: 6-3. NED RECONS Impacts to Local, State, and National Economy's ($1,000)*

| Area | Local Capture ($000) | Output ($000) | Jobs | Labor Income ($000) | Value Added ($000) |
|---|---|---|---|---|---|
| **Local** | | | | | |
| *Direct Impact* | | $48,084,009 | 590.4 | $33,661,895 | $33,549,147 |
| *Secondary Impact* | | $31,883,991 | 207.7 | $9,657,233 | $17,834,292 |
| *Total Impact* | $48,084,009 | $79,967,999 | 798.0 | $43,319,127 | $51,383,440 |
| **State** | | | | | |
| *Direct Impact* | | $35,726,585 | 360.4 | $19,776,268 | $19,585,108 |
| *Secondary Impact* | | $28,349,427 | 176.3 | $7,773,310 | $14,482,393 |
| *Total Impact* | $52,423,242 | $64,076,011 | 536.7 | $27,549,578 | $34,067,501 |
| **National** | | | | | |
| *Direct Impact* | | $60,796,826 | 734.1 | $42,800,951 | $40,964,754 |
| *Secondary Impact* | | $113,096,642 | 548.4 | $35,622,098 | $61,562,143 |
| *Total Impact* | $60,796,826 | $173,893,468 | 1,282.5 | $78,423,050 | $102,526,897 |

The direct impacts, or value added, to specific industries are summarized in Table L: 6-4

*Table L: 6-4. NED RECONS Impacts to Specific Industries ($1,000)*

| ***IMPLAN Sectors*** | **Industries** | **Output** | **Jobs** | **Labor Income** | **Value Added** |
|---|---|---|---|---|---|
| | **Direct Impacts** | | | | |
| *29* | Sand and gravel mining | $49,822 | 0.4 | $9,290 | $17,581 |
| *56* | Construction of other new nonresidential structures | $18,551,841 | 198 | $11,680,891 | $8,622,053 |
| *203* | Cement manufacturing | $0 | 0.0 | $0 | $0 |
| *400* | Wholesale - Other nondurable goods merchant wholesalers | $629,643 | 2.3 | $122,308 | $298,966 |
| *414* | Air transportation | $1,727 | 0.0 | $564 | $1,258 |
| *415* | Rail transportation | $226,087 | 0.4 | $55,835 | $124,424 |
| *416* | Water transportation | $1,395 | 0.0 | $609 | $628 |
| *417* | Truck transportation | $1,329,467 | 7.8 | $437,849 | $564,262 |
| *444* | Insurance carriers, except direct life | $14,941 | 0.0 | $1,508 | $6,252 |
| *453* | Commercial and industrial machinery and equipment rental and leasing | $3,661,422 | 10 | $975,962 | $2,361,905 |
| *457* | Architectural, engineering, and related services | $201,771 | 1.4 | $69,428 | $78,055 |
| *463* | Environmental and other technical consulting services | $226,089 | 2.7 | $141,443 | $127,071 |
| *470* | Office administrative services | $2,318,980 | 43 | $630,585 | $475,871 |
| *544* | * Employment and payroll of federal govt, non-military | $4,174,164 | 21 | $2,838,966 | $4,174,164 |
| *5001* | Private Labor | $16,696,657 | 303 | $16,696,657 | $16,696,657 |
| | **Direct Impact** | **$48,084,009** | **590** | **$33,661,895** | **$33,549,147** |
| | **Secondary Impact** | **$31,883,991** | **208** | **$9,657,233** | **$17,834,292** |
| | **Total Impact** | **$79,967,999** | **798** | **$43,319,127** | **$51,383,440** |

# Section 7
# Results of the Environmental Analysis

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.

## 7.1 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 aggradational. 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.

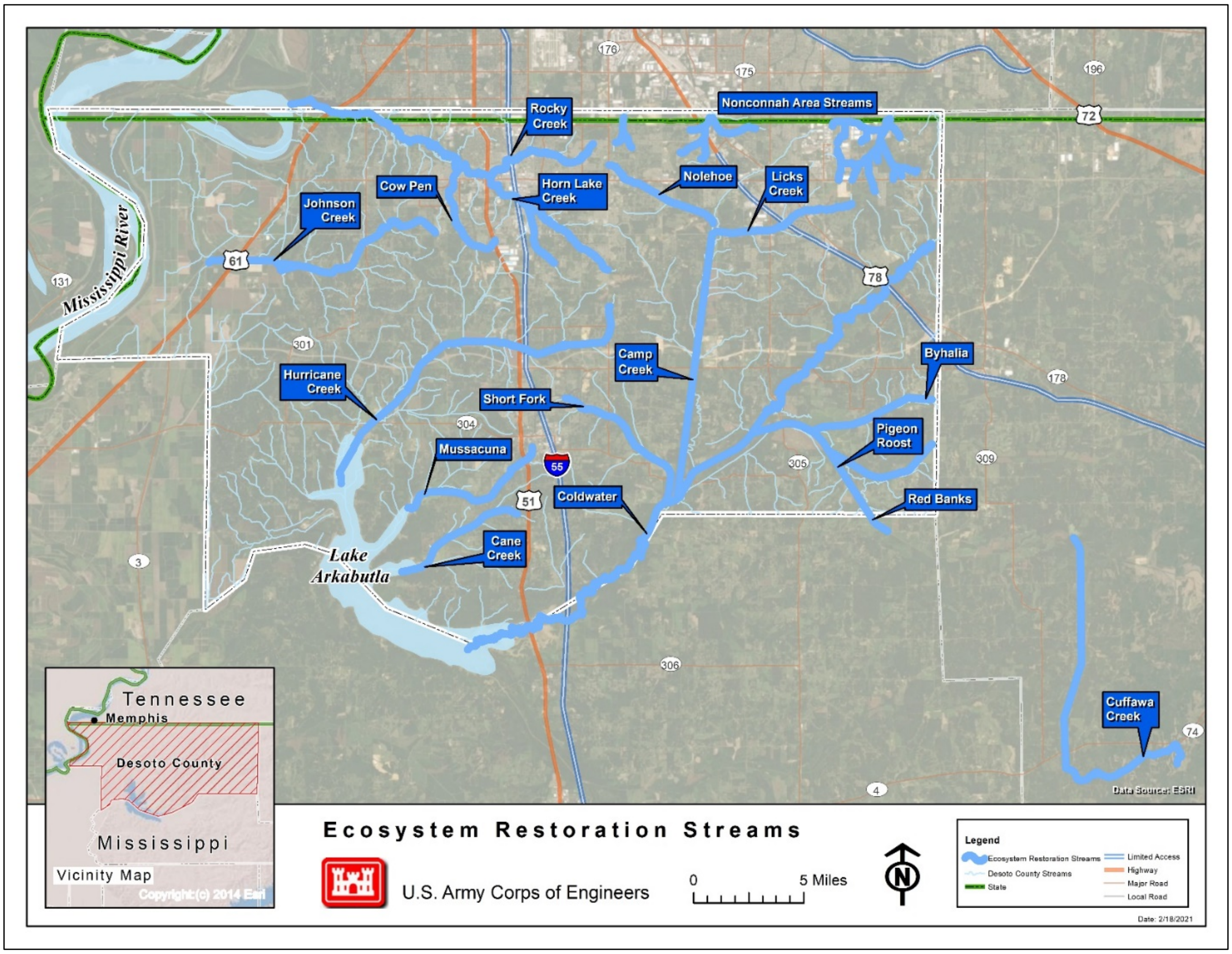


*Figure L: 7-1. DeSoto County Streams Evaluated for Ecosystem Restoration*

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 L: 7-1.

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 FY21 federal discount rate of 2.5% 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 for each of the alternatives input into the CEICA model. Table L: 7-3 shows the average annual costs and benefits for each of the alternatives input into the CEICA model. Table L: 7-3 helps illustrate that alternative #5, which includes grade control + 25% of riparian acreage available adjacent to grade control is always the alternative for each creek that optimizes costs and benefits and is most efficient relative to the other two alternatives within the same creek.

*Table L: 7-2. Environmental Restoration Costs*

| Stream | Alt # | Alternative Description | Construction (w/Contingency) | Annualized OMRR&R | Annualized Interest During Construction | Total Average Annual Cost |
|---|---|---|---|---|---|---|
| Camp Creek | CP-1 | 7 GCS | $1,998,174 | $15,000 | $776 | $86,227 |
| | CP-4 | 7 GCS + 47 acres riparian | $2,516,126 | $15,000 | $1,022 | $104,736 |
| | CP-5 | 7 GCS + 98 acres riparian | $3,049,241 | $15,000 | $1,234 | $123,744 |
| Cane Creek | CN-1 | 9 GCS | $1,703,834 | $11,000 | $529 | $71,603 |
| | CN-4 | 9 GCS + 6 acres riparian | $1,794,096 | $11,000 | $564 | $74,820 |
| | CN-5 | 9 GCS + 66 acres riparian | $2,415,783 | $11,000 | $846 | $97,022 |
| Horn Lake Creek | HLC-1 | 14 GCS | $7,068,344 | $12,000 | $3,208 | $264,425 |
| | HLC-4 | 14 GCS+ 17 acres riparian | $7,270,800 | $12,000 | $3,350 | $271,704 |
| | HLC-5 | 14 GCS+ 64 acres riparian | $7,757,669 | $12,000 | $3,526 | $289,046 |
| Hurricane Creek | HC-1 | 9 GCS | $2,580,414 | $13,000 | $1,128 | $105,109 |
| | HC-4 | 9 GCS+ 22 acres riparian | $2,838,181 | $13,000 | $1,269 | $114,338 |
| | HC-5 | 9 GCS+ 160 acres riparian | $4,271,767 | $13,000 | $1,904 | $165,518 |
| Johnson Creek | JC-1 | 11 GCS | $2,904,126 | $21,000 | $1,269 | $124,663 |
| | JC-4 | 11 GCS+ 43 acres riparian | $3,377,804 | $21,000 | $1,481 | $141,576 |
| | JC-5 | 11 GCS+ 122 acres riparian | $4,201,235 | $21,000 | $1,869 | $170,996 |
| Lick Creek | LC-1 | 3 GCS | $697,945 | $9,000 | $317 | $33,926 |
| | LC-4 | 3 GCS+ 11 acres riparian | $841,244 | $9,000 | $388 | $39,048 |
| | LC-5 | 3 GCS+ 36 acres riparian | $1,095,904 | $9,000 | $494 | $48,133 |
| Mussacuna Creek | MC-1 | 3 GCS | $936,140 | $9,000 | $423 | $42,430 |
| | MC-4 | 3 GCS+ 9 acres riparian | $1,123,567 | $9,000 | $458 | $49,073 |
| | MC-5 | 3 GCS+ 57 acres riparian | $1,620,221 | $9,000 | $670 | $66,796 |
| Nolehoe Creek | NL-1 | 11 GCS | $2,739,845 | $20,000 | $1,199 | $117,800 |

| Stream | Alt # | Alternative Description | Construction (w/Contingency) | Annualized OMRR&R | Annualized Interest During Construction | Total Average Annual Cost |
|---|---|---|---|---|---|---|
| Nonconnah Creek | NL-4 | 11 GCS+17acres riparian | $2,947,378 | $20,000 | $1,305 | $125,223 |
| | NL-5 | 11 GCS +32 acres riparian | $3,107,012 | $20,000 | $1,375 | $130,922 |
| | NoN-1 | 7 GCS | $1,188,602 | $12,000 | $564 | $54,472 |
| | NoN-4 | 7 GCS+ 5 acres riparian | $1,269,169 | $12,000 | $599 | $57,348 |
| | NoN-5 | 7 GCS+107 acres riparian | $2,328,415 | $12,000 | $1,093 | $95,188 |
| Red Banks | RB-1 | 5 GCS | $1,903,115 | $13,000 | $670 | $80,770 |
| | RB-4 | 5 GCS+24 acres riparian | $2,182,915 | $13,000 | $811 | $90,776 |
| | RB-5 | 5 GCS + 48 acres riparian | $2,437,175 | $13,000 | $917 | $99,847 |
| Short Fork | SF-1 | 9 GCS | $1,749,981 | $13,000 | $1,234 | $75,935 |
| | SF-4 | 9 GCS+ 12 acres riparian | $1,903,004 | $13,000 | $1,305 | $81,401 |
| | SF-5 | 9 GCS+ 106 acres riparian | $2,883,620 | $13,000 | $1,833 | $116,504 |

*Table L: 7-3. Environmental Restoration Average Annual Benefits & Costs*

| ***Stream*** | **Alt #** | **Alternative Description** | **AAHUs** | **Average Annual Cost** | **AACost/ AAHU** |
|---|---|---|---|---|---|
| *Camp Creek* | CP-1 | 7 GCS | 24 | $86,227 | $3,593 |
| | CP-4 | 7 GCS + 47 acres riparian | 61 | $104,736 | $1,717 |
| | CP-5 | 7 GCS + 98 acres riparian | 98 | $123,744 | **$1,263** |
| *Cane Creek* | CN-1 | 9 GCS | 3 | $71,603 | $23,868 |
| | CN-4 | 9 GCS + 6 acres riparian | 9 | $74,820 | $8,313 |
| | CN-5 | 9 GCS + 66 acres riparian | 54 | $97,022 | **$1,797** |
| *Horn Lake Creek* | HLC-1 | 14 GCS | 45 | $264,425 | $5,876 |
| | HLC-4 | 14 GCS+ 17 acres riparian | 60 | $271,704 | $4,528 |
| | HLC-5 | 14 GCS+ 64 acres riparian | 101 | $289,046 | **$2,862** |
| *Hurricane Creek* | HC-1 | 9 GCS | 6 | $105,109 | $17,518 |
| | HC-4 | 9 GCS+ 22 acres riparian | 25 | $114,338 | $4,574 |
| | HC-5 | 9 GCS+ 160 acres riparian | 140 | $165,518 | **$1,182** |
| *Johnson Creek* | JC-1 | 11 GCS | 20 | $124,663 | $6,233 |
| | JC-4 | 11 GCS+ 43 acres riparian | 59 | $141,576 | $2,400 |
| | JC-5 | 11 GCS+ 122 acres riparian | 113 | $170,996 | **$1,513** |
| *Lick Creek* | LC-1 | 3 GCS | 3 | $33,926 | $11,309 |
| | LC-4 | 3 GCS+ 11 acres riparian | 11 | $39,048 | $3,550 |
| | LC-5 | 3 GCS+ 36 acres riparian | 24 | $48,133 | **$2,006** |
| *Mussacuna Creek* | MC-1 | 3 GCS | 3 | $42,430 | $14,143 |
| | MC-4 | 3 GCS+ 9 acres riparian | 11 | $49,073 | $4,461 |
| | MC-5 | 3 GCS+ 57 acres riparian | 40 | $66,796 | **$1,670** |
| *Nolehoe Creek* | NL-1 | 11 GCS | 28 | $117,800 | $4,207 |
| | NL-4 | 11 GCS+17acres riparian | 43 | $125,223 | $2,912 |
| | NL-5 | 11 GCS +32 acres riparian | 54 | $130,922 | **$2,424** |
| *Nonconnah Creek* | NoN-1 | 7 GCS | 1 | $54,472 | $54,472 |
| | NoN-4 | 7 GCS+ 5 acres riparian | 6 | $57,348 | $9,558 |
| | NoN-5 | 7 GCS+107 acres riparian | 65 | $95,188 | **$1,464** |
| *Red Banks* | RB-1 | 5 GCS | 10 | $80,770 | $8,077 |
| | RB-4 | 5 GCS+24 acres riparian | 28 | $90,776 | $3,242 |
| | RB-5 | 5 GCS + 48 acres riparian | 46 | $99,847 | **$2,171** |
| *Short Fork* | SF-1 | 9 GCS | 6 | $75,935 | $12,656 |
| | SF-4 | 9 GCS+ 12 acres riparian | 17 | $81,401 | $4,788 |
| | SF-5 | 9 GCS+ 106 acres riparian | 84 | $116,504 | **$1,387** |

## 7.2 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

Despite the variance in how the individual alternatives were ran through the CE/ICA model, the one trend that always progressed was that alternative #5, which includes grade control + 25% of riparian acreage available adjacent to grade control, is always the alternative for each model run that optimizes costs and benefits and is most efficient relative to the other two alternatives within the same creek.

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 11 best buy plans and 76 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.

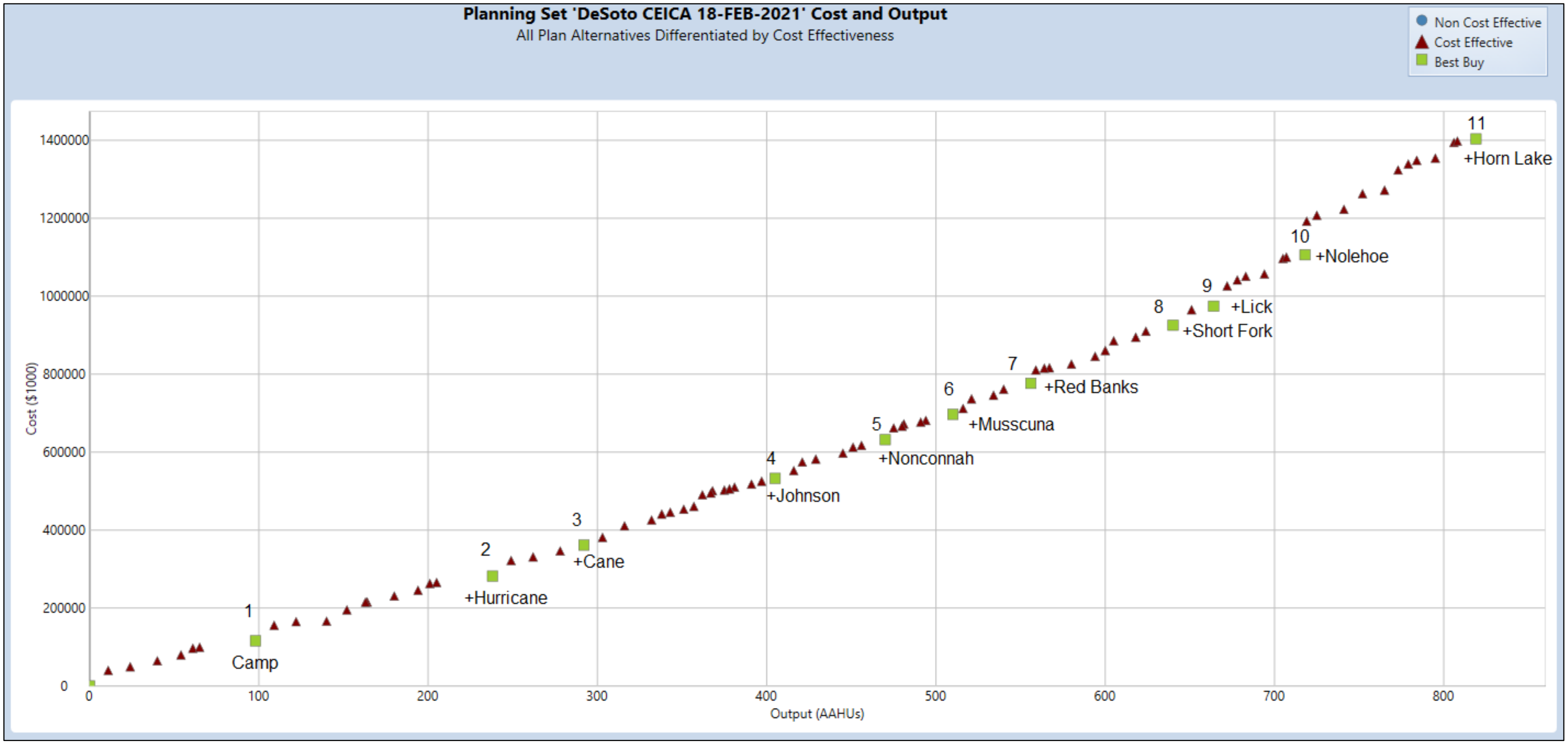


*Figure L: 7-2. North DeSoto CEICA Cartesian Plot*

### 7.3 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.

Typically, in the evaluation of Best Buy Alternatives, 'break points' are identified in either the last column in Table L:7-3, or in the stir-step progression from left to right in Figure L: 7-3. Break points are defined as significant increases or jumps in incremental cost per output, such that subsequent levels of output may not be considered "worth it". Identification of such break points can be subjective. For the North DeSoto environmental analysis, the break points were not as obvious as other studies around the country, where a large jump occurs. There appears to be a break point between Lick Creek and Nolehoe Creek, where the incremental annual cost jumps $400, and then another $400 to buy up to Horn Lake Creek. While these appear to be break points, these are relative to other studies around the country. For example, the $2,900 average annual cost per habitat unit is high relative to the other creeks within North DeSoto but remains highly competitive verses other restoration studies across the country. As a result, 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-5 | 7 GCS + 98 acres riparian | 98 | $116,000 | $1,184 |
| *Hurricane Creek* | HC-5 | 9 GCS+ 160 acres riparian | 140 | $166,000 | $1,186 |
| *Cane Creek* | CN-5 | 9 GCS + 66 acres riparian | 54 | $79,000 | $1,463 |
| *Johnson Creek* | JC-5 | 11 GCS+ 122 acres riparian | 113 | $171,000 | $1,513 |
| *Nonconnah Creek* | NoN-5 | 7 GCS+107 acres riparian | 65 | $99,000 | $1,523 |
| *Mussacuna Creek* | MC-5 | 3 GCS+ 57 acres riparian | 40 | $65,000 | $1,625 |
| *Red Banks* | RB-5 | 5 GCS + 48 acres riparian | 46 | $80,000 | $1,739 |
| *Short Fork* | SF-5 | 9 GCS+ 106 acres riparian | 84 | $149,000 | $1,774 |
| *Lick Creek* | LC-5 | 3 GCS+ 36 acres riparian | 24 | $49,000 | $2,042 |
| *Nolehoe Creek* | NL-5 | 11 GCS +32 acres riparian | 54 | $131,000 | $2,426 |
| *Horn Lake Creek* | HLC-5 | 14 GCS+ 64 acres riparian | 101 | $298,000 | $2,950 |
| ***TOTAL NER PLAN*** | | | **819** | **$1,403,000** | **$1,713** |

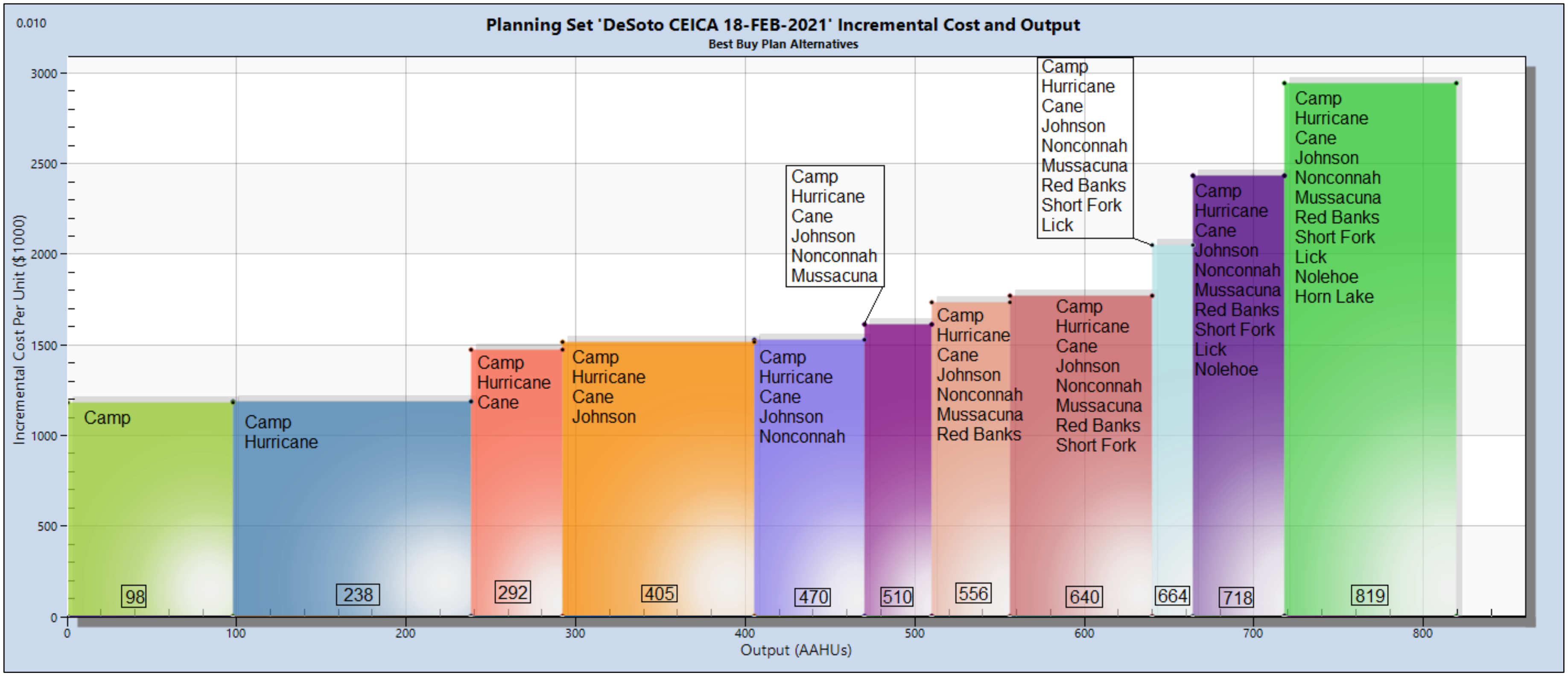


*Figure L: 7-3. North DeSoto CEICA Box Plot*

# Section 8
# Supplemental Tables

Supplemental Table 1
North DeSoto County Feasibility Study
Depth-Damage Relationships for Structures and Contents

**Residential 1-Story on Slab (Oreswoutbsmt)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 2.5 | 2.7 |
| 0.0 | 13.4 | 2.0 |
| 1.0 | 23.3 | 1.6 |
| 2.0 | 32.1 | 1.6 |
| 3.0 | 40.1 | 1.8 |
| 4.0 | 47.1 | 1.9 |
| 5.0 | 53.2 | 2.0 |
| 6.0 | 58.6 | 2.1 |
| 7.0 | 63.2 | 2.2 |
| 8.0 | 67.2 | 2.3 |
| 9.0 | 70.5 | 2.4 |
| 10.0 | 73.2 | 2.7 |
| 11.0 | 75.4 | 3.0 |
| 12.0 | 77.2 | 3.3 |
| 13.0 | 78.5 | 3.7 |
| 14.0 | 79.5 | 4.1 |
| 15.0 | 80.2 | 4.5 |
| 16.0 | 80.7 | 4.9 |

**Residential 2-Story on Slab (Treswoutbsmt)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 2.5 | 2.7 |
| 0.0 | 13.4 | 2.0 |
| 1.0 | 23.3 | 1.6 |
| 2.0 | 32.1 | 1.6 |
| 3.0 | 40.1 | 1.8 |
| 4.0 | 47.1 | 1.9 |
| 5.0 | 53.2 | 2.0 |
| 6.0 | 58.6 | 2.1 |
| 7.0 | 63.2 | 2.2 |
| 8.0 | 67.2 | 2.3 |
| 9.0 | 70.5 | 2.4 |
| 10.0 | 73.2 | 2.7 |
| 11.0 | 75.4 | 3.0 |
| 12.0 | 77.2 | 3.3 |
| 13.0 | 78.5 | 3.7 |
| 14.0 | 79.5 | 4.1 |
| 15.0 | 80.2 | 4.5 |
| 16.0 | 80.7 | 4.9 |

**Residential Mobile Home (Mobhome)**

| Depth in Structure | Structure Lower Percent | Structure Percent Damage | Structure Higher Percent |
|---|---|---|---|
| -1.1 | 0.0 | 0.0 | 0.0 |
| -1.0 | 6.1 | 6.4 | 7.7 |
| -0.5 | 6.9 | 7.3 | 8.8 |
| 0.0 | 9.4 | 9.9 | 11.9 |
| 0.5 | 41.2 | 43.4 | 52.1 |
| 1.0 | 42.5 | 44.7 | 53.6 |
| 2.0 | 43.6 | 45.9 | 55.1 |
| 3.0 | 44.3 | 46.6 | 55.9 |
| 4.0 | 44.5 | 46.8 | 56.2 |
| 5.0 | 48.5 | 51.0 | 61.2 |
| 6.0 | 63.5 | 66.9 | 80.2 |
| 7.0 | 63.5 | 66.9 | 80.2 |
| 8.0 | 64.0 | 67.3 | 80.8 |
| 9.0 | 64.0 | 67.3 | 80.8 |
| 10.0 | 64.0 | 67.3 | 80.8 |
| 11.0 | 64.0 | 67.3 | 80.8 |
| 12.0 | 64.0 | 67.3 | 80.8 |
| 13.0 | 64.0 | 67.3 | 80.8 |
| 14.0 | 64.0 | 67.3 | 80.8 |

**Residential 1-Story Apartment on Slab (Apt1)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 1.0 | 0.5 |
| 1.0 | 12.5 | 1.6 |
| 2.0 | 20.4 | 1.6 |
| 3.0 | 25.9 | 1.8 |
| 4.0 | 31.7 | 1.9 |
| 5.0 | 33.5 | 2.0 |
| 6.0 | 37.5 | 2.1 |
| 7.0 | 39.4 | 2.2 |
| 8.0 | 42.2 | 2.4 |
| 9.0 | 45.0 | 2.4 |
| 10.0 | 45.0 | 2.4 |
| 11.0 | 45.0 | 2.4 |
| 12.0 | 45.0 | 2.4 |
| 13.0 | 45.0 | 2.4 |
| 14.0 | 45.0 | 2.4 |
| 15.0 | 45.0 | 2.4 |
| 16.0 | 45.0 | 2.4 |

**Residential 1-Story on Slab (Oreswoutbsmt) — Contents**

| Depth in Structure | Contents Percent Damage | Contents Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 2.4 | 2.1 |
| 0.0 | 8.1 | 1.5 |
| 1.0 | 13.3 | 1.2 |
| 2.0 | 17.9 | 1.2 |
| 3.0 | 22.0 | 1.4 |
| 4.0 | 25.7 | 1.5 |
| 5.0 | 28.8 | 1.6 |
| 6.0 | 31.5 | 1.6 |
| 7.0 | 33.8 | 1.7 |
| 8.0 | 35.7 | 1.8 |
| 9.0 | 37.2 | 1.9 |
| 10.0 | 38.4 | 2.1 |
| 11.0 | 39.2 | 2.3 |
| 12.0 | 39.7 | 2.6 |
| 13.0 | 40.0 | 2.9 |
| 14.0 | 40.0 | 3.2 |
| 15.0 | 40.0 | 3.5 |
| 16.0 | 40.0 | 3.8 |

**Residential 2-Story on Slab (Treswoutbsmt) — Contents**

| Depth in Structure | Contents Percent Damage | Contents Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 2.4 | 2.1 |
| 0.0 | 8.1 | 1.5 |
| 1.0 | 13.3 | 1.2 |
| 2.0 | 17.9 | 1.2 |
| 3.0 | 22.0 | 1.4 |
| 4.0 | 25.7 | 1.5 |
| 5.0 | 28.8 | 1.6 |
| 6.0 | 31.5 | 1.6 |
| 7.0 | 33.8 | 1.7 |
| 8.0 | 35.7 | 1.8 |
| 9.0 | 37.2 | 1.9 |
| 10.0 | 38.4 | 2.1 |
| 11.0 | 39.2 | 2.3 |
| 12.0 | 39.7 | 2.6 |
| 13.0 | 40.0 | 2.9 |
| 14.0 | 40.0 | 3.2 |
| 15.0 | 40.0 | 3.5 |
| 16.0 | 40.0 | 3.8 |

**Residential Mobile Home (Mobhome) — Contents**

| Depth in Structure | Contents Lower Percent | Contents Percent Damage | Contents Higher Percent |
|---|---|---|---|
| -1.0 | 0.0 | 0.0 | 0.0 |
| -0.5 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5 | 90.0 | 95.0 | 100.0 |
| 1.0 | 92.0 | 96.0 | 100.0 |
| 1.5 | 94.0 | 97.0 | 100.0 |
| 2.0 | 96.0 | 98.0 | 100.0 |
| 3.0 | 98.0 | 99.0 | 100.0 |
| 4.0 | 100.0 | 100.0 | 100.0 |
| 5.0 | 100.0 | 100.0 | 100.0 |
| 6.0 | 100.0 | 100.0 | 100.0 |
| 7.0 | 100.0 | 100.0 | 100.0 |
| 8.0 | 100.0 | 100.0 | 100.0 |
| 9.0 | 100.0 | 100.0 | 100.0 |
| 10.0 | 100.0 | 100.0 | 100.0 |
| 11.0 | 100.0 | 100.0 | 100.0 |
| 12.0 | 100.0 | 100.0 | 100.0 |
| 13.0 | 100.0 | 100.0 | 100.0 |
| 14.0 | 100.0 | 100.0 | 100.0 |

**Residential 1-Story Apartment on Slab (Apt1) — Contents**

| Depth in Structure | Contents Percent Damage | Contents Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.5 |
| 1.0 | 21.7 | 2.1 |
| 2.0 | 30.4 | 3.8 |
| 3.0 | 39.0 | 4.4 |
| 4.0 | 45.0 | 5.1 |
| 5.0 | 47.9 | 5.7 |
| 6.0 | 51.9 | 6.3 |
| 7.0 | 55.7 | 6.7 |
| 8.0 | 59.3 | 7.1 |
| 9.0 | 60.6 | 7.6 |
| 10.0 | 60.6 | 7.6 |
| 11.0 | 60.6 | 7.6 |
| 12.0 | 60.6 | 7.6 |
| 13.0 | 60.6 | 7.6 |
| 14.0 | 60.6 | 7.6 |
| 15.0 | 60.6 | 7.6 |
| 16.0 | 60.6 | 7.6 |

Supplemental Table 2
North DeSoto County Feasibility Study
Depth-Damage Relationships for Structures and Contents

**Commercial**
**General Office (OfficeCom)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.8 | 0.0 |
| 0.0 | 1.6 | 0.0 |
| 1.0 | 13.5 | 0.5 |
| 2.0 | 19.4 | 0.7 |
| 3.0 | 25.4 | 1.3 |
| 4.0 | 25.4 | 1.3 |
| 5.0 | 33.5 | 1.4 |
| 6.0 | 33.5 | 1.4 |
| 7.0 | 33.5 | 1.4 |
| 8.0 | 33.5 | 1.4 |
| 9.0 | 33.5 | 1.4 |
| 10.0 | 59.1 | 2.3 |
| 11.0 | 59.1 | 2.3 |
| 12.0 | 59.1 | 2.3 |
| 13.0 | 59.1 | 2.3 |
| 14.0 | 59.1 | 2.3 |
| 15.0 | 75.0 | 2.5 |
| 16.0 | 75.0 | 2.5 |

**Commercial**
**Storage Building (StorageCom)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.5 | 0.0 |
| 0.0 | 1.1 | 0.0 |
| 1.0 | 11.8 | 0.5 |
| 2.0 | 19.9 | 0.7 |
| 3.0 | 25.4 | 1.3 |
| 4.0 | 25.4 | 1.3 |
| 5.0 | 34.2 | 1.4 |
| 6.0 | 34.2 | 1.4 |
| 7.0 | 34.2 | 1.4 |
| 8.0 | 34.2 | 1.4 |
| 9.0 | 34.2 | 1.4 |
| 10.0 | 51.7 | 2.3 |
| 11.0 | 51.7 | 2.3 |
| 12.0 | 51.7 | 2.3 |
| 13.0 | 51.7 | 2.3 |
| 14.0 | 51.7 | 2.3 |
| 15.0 | 75.0 | 2.5 |
| 16.0 | 75.0 | 2.5 |

**Commercial**
**Retail Building (Retail)**

| Depth in Structure | Structure Lower Percent | Structure Percent Damage | Structure Higher Percent |
|---|---|---|---|
| -2.0 | 0.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.2 | 0.1 | 0.3 |
| 1.0 | 7.6 | 5.7 | 9.5 |
| 2.0 | 8.3 | 6.2 | 10.4 |
| 3.0 | 11.4 | 8.6 | 14.2 |
| 4.0 | 15.0 | 12.8 | 17.2 |
| 5.0 | 15.8 | 13.4 | 18.2 |
| 6.0 | 15.8 | 13.4 | 18.2 |
| 7.0 | 15.8 | 13.4 | 18.2 |
| 8.0 | 22.2 | 18.9 | 25.5 |
| 9.0 | 26.6 | 22.6 | 30.1 |
| 10.0 | 28.7 | 24.4 | 30.1 |
| 11.0 | 28.7 | 27.3 | 30.1 |
| 12.0 | 28.7 | 27.3 | 30.1 |
| 13.0 | 32.4 | 30.1 | 34.0 |
| 14.0 | 39.7 | 37.7 | 41.7 |
| 15.0 | 41.2 | 39.1 | 43.3 |
| 16.0 | 41.2 | 39.1 | 43.3 |

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.7 | 0.0 |
| 0.0 | 2.0 | 0.0 |
| 1.0 | 20.0 | 0.1 |
| 2.0 | 34.3 | 0.1 |
| 3.0 | 45.4 | 0.2 |
| 4.0 | 45.4 | 0.2 |
| 5.0 | 63.9 | 0.2 |
| 6.0 | 63.9 | 0.2 |
| 7.0 | 63.9 | 0.2 |
| 8.0 | 63.9 | 0.2 |
| 9.0 | 63.9 | 0.2 |
| 10.0 | 91.4 | 0.4 |
| 11.0 | 91.4 | 0.4 |
| 12.0 | 91.4 | 0.4 |
| 13.0 | 91.4 | 0.4 |
| 14.0 | 91.4 | 0.4 |
| 15.0 | 100.0 | 0.4 |
| 16.0 | 100.0 | 0.4 |

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 1.0 | 20.7 | 1.0 |
| 2.0 | 33.7 | 4.5 |
| 3.0 | 47.4 | 5.9 |
| 4.0 | 47.4 | 5.9 |
| 5.0 | 65.6 | 8.8 |
| 6.0 | 65.6 | 8.8 |
| 7.0 | 65.6 | 8.8 |
| 8.0 | 65.6 | 8.8 |
| 9.0 | 65.6 | 8.8 |
| 10.0 | 93.6 | 11.1 |
| 11.0 | 93.6 | 11.1 |
| 12.0 | 93.6 | 11.1 |
| 13.0 | 93.6 | 11.1 |
| 14.0 | 93.6 | 11.1 |
| 15.0 | 100.0 | 11.3 |
| 16.0 | 100.0 | 11.3 |

| Depth in Structure | Structure Lower Percent | Structure Percent Damage | Structure Higher Percent |
|---|---|---|---|
| -2.0 | 0.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 |
| 1.0 | 35.3 | 15.3 | 55.3 |
| 2.0 | 48.2 | 28.2 | 68.2 |
| 3.0 | 54.1 | 34.1 | 74.1 |
| 4.0 | 54.3 | 34.3 | 74.3 |
| 5.0 | 54.8 | 34.8 | 74.8 |
| 6.0 | 54.8 | 34.8 | 74.8 |
| 7.0 | 54.8 | 34.8 | 74.8 |
| 8.0 | 54.8 | 34.8 | 74.8 |
| 9.0 | 54.8 | 34.8 | 74.8 |
| 10.0 | 98.9 | 78.9 | 100.0 |
| 11.0 | 99.9 | 79.9 | 100.0 |
| 12.0 | 100.0 | 80.0 | 100.0 |
| 13.0 | 100.0 | 80.0 | 100.0 |
| 14.0 | 100.0 | 80.0 | 100.0 |
| 15.0 | 100.0 | 80.0 | 100.0 |
| 16.0 | 100.0 | 80.0 | 100.0 |

Supplemental Table 3
North DeSoto County Feasibility Study
Depth-Damage Relationships for Structures and Contents

**Commercial**
**Restaurant (Restaurant)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.3 | 0.0 |
| 0.0 | 1.2 | 0.0 |
| 1.0 | 17.6 | 0.5 |
| 2.0 | 30.3 | 0.7 |
| 3.0 | 39.2 | 1.3 |
| 4.0 | 39.2 | 1.3 |
| 5.0 | 54.2 | 1.4 |
| 6.0 | 54.2 | 1.4 |
| 7.0 | 54.2 | 1.4 |
| 8.0 | 54.2 | 1.4 |
| 9.0 | 54.2 | 1.4 |
| 10.0 | 72.9 | 2.3 |
| 11.0 | 72.9 | 2.3 |
| 12.0 | 72.9 | 2.3 |
| 13.0 | 72.9 | 2.3 |
| 14.0 | 72.9 | 2.3 |
| 15.0 | 90.0 | 2.5 |
| 16.0 | 90.0 | 2.5 |

**Agriculture**
**Farm Barn (Barn)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 1.0 | 10.0 | 1.0 |
| 2.0 | 20.0 | 2.0 |
| 3.0 | 25.0 | 2.5 |
| 4.0 | 25.0 | 2.5 |
| 5.0 | 34.0 | 3.4 |
| 6.0 | 34.0 | 3.4 |
| 7.0 | 34.0 | 3.4 |
| 8.0 | 34.0 | 3.4 |
| 9.0 | 34.0 | 3.4 |
| 10.0 | 50.0 | 5.0 |
| 11.0 | 50.0 | 5.0 |
| 12.0 | 50.0 | 5.0 |
| 13.0 | 50.0 | 5.0 |
| 14.0 | 50.0 | 5.0 |
| 15.0 | 75.0 | 7.5 |
| 16.0 | 75.0 | 7.5 |

**Public**
**School or Church (School)**

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.4 | 0.0 |
| 0.0 | 0.6 | 0.0 |
| 1.0 | 15.3 | 0.5 |
| 2.0 | 26.1 | 0.7 |
| 3.0 | 33.0 | 1.3 |
| 4.0 | 33.0 | 1.3 |
| 5.0 | 44.0 | 1.4 |
| 6.0 | 44.0 | 1.4 |
| 7.0 | 44.0 | 1.4 |
| 8.0 | 44.0 | 1.4 |
| 9.0 | 44.0 | 1.4 |
| 10.0 | 60.0 | 2.3 |
| 11.0 | 60.0 | 2.3 |
| 12.0 | 60.0 | 2.3 |
| 13.0 | 60.0 | 2.3 |
| 14.0 | 60.0 | 2.3 |
| 15.0 | 75.0 | 2.5 |
| 16.0 | 75.0 | 2.5 |

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 1.0 | 24.5 | 0.3 |
| 2.0 | 43.7 | 0.9 |
| 3.0 | 55.0 | 1.2 |
| 4.0 | 55.0 | 1.2 |
| 5.0 | 76.4 | 1.5 |
| 6.0 | 76.4 | 1.5 |
| 7.0 | 76.4 | 1.5 |
| 8.0 | 76.4 | 1.5 |
| 9.0 | 76.4 | 1.5 |
| 10.0 | 96.0 | 1.9 |
| 11.0 | 96.0 | 1.9 |
| 12.0 | 96.0 | 1.9 |
| 13.0 | 96.0 | 1.9 |
| 14.0 | 96.0 | 1.9 |
| 15.0 | 100.0 | 1.9 |
| 16.0 | 100.0 | 1.9 |

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 1.0 | 5.0 | 0.5 |
| 2.0 | 10.0 | 1.0 |
| 3.0 | 20.0 | 2.0 |
| 4.0 | 20.0 | 2.0 |
| 5.0 | 30.0 | 3.0 |
| 6.0 | 30.0 | 3.0 |
| 7.0 | 30.0 | 3.0 |
| 8.0 | 30.0 | 3.0 |
| 9.0 | 30.0 | 3.0 |
| 10.0 | 50.0 | 5.0 |
| 11.0 | 50.0 | 5.0 |
| 12.0 | 50.0 | 5.0 |
| 13.0 | 50.0 | 5.0 |
| 14.0 | 50.0 | 5.0 |
| 15.0 | 100.0 | 10.0 |
| 16.0 | 100.0 | 10.0 |

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|
| -2.0 | 0.0 | 0.0 |
| -1.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 1.0 | 25.5 | 0.1 |
| 2.0 | 39.0 | 0.1 |
| 3.0 | 50.0 | 0.2 |
| 4.0 | 50.0 | 0.2 |
| 5.0 | 62.0 | 0.2 |
| 6.0 | 62.0 | 0.2 |
| 7.0 | 62.0 | 0.2 |
| 8.0 | 62.0 | 0.2 |
| 9.0 | 62.0 | 0.2 |
| 10.0 | 80.0 | 0.4 |
| 11.0 | 80.0 | 0.4 |
| 12.0 | 80.0 | 0.4 |
| 13.0 | 80.0 | 0.4 |
| 14.0 | 80.0 | 0.4 |
| 15.0 | 100.0 | 0.4 |
| 16.0 | 100.0 | 0.4 |

Supplemental Table 4
North DeSoto County Feasibility Study
Depth-Damage Relationships for Structures and Contents

| **Industrial General Office (OfficeInd)** | | | **Industrial Storage Warehouse (StorageInd)** | | | **Public Less Damagable Struc (Pub1)** | | | **Public More Damagable Struc (Pub2)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth in Structure | Structure Percent Damage | Structure Standard Deviation | Depth in Structure | Structure Percent Damage | Structure Standard Deviation | Depth in Structure | Structure Percent Damage | Structure Standard Deviation | Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
| -2.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 |
| -1.0 | 0.8 | 0.0 | -1.0 | 0.5 | 0.0 | -1.0 | 0.0 | 0.0 | -1.0 | 0.0 | 0.0 |
| 0.0 | 1.6 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1.0 | 13.5 | 0.5 | 1.0 | 11.8 | 0.5 | 1.0 | 4.0 | 0.8 | 1.0 | 10.0 | 2.0 |
| 2.0 | 19.4 | 0.7 | 2.0 | 19.9 | 0.7 | 2.0 | 6.0 | 1.2 | 2.0 | 14.0 | 2.8 |
| 3.0 | 25.4 | 1.3 | 3.0 | 25.4 | 1.3 | 3.0 | 10.0 | 2.0 | 3.0 | 26.0 | 5.2 |
| 4.0 | 25.4 | 1.3 | 4.0 | 25.4 | 1.3 | 4.0 | 10.0 | 2.0 | 4.0 | 26.0 | 5.2 |
| 5.0 | 33.5 | 1.4 | 5.0 | 34.2 | 1.4 | 5.0 | 12.0 | 2.4 | 5.0 | 29.0 | 5.8 |
| 6.0 | 33.5 | 1.4 | 6.0 | 34.2 | 1.4 | 6.0 | 12.0 | 2.4 | 6.0 | 29.0 | 5.8 |
| 7.0 | 33.5 | 1.4 | 7.0 | 34.2 | 1.4 | 7.0 | 12.0 | 2.4 | 7.0 | 29.0 | 5.8 |
| 8.0 | 33.5 | 1.4 | 8.0 | 34.2 | 1.4 | 8.0 | 12.0 | 2.4 | 8.0 | 29.0 | 5.8 |
| 9.0 | 33.5 | 1.4 | 9.0 | 34.2 | 1.4 | 9.0 | 12.0 | 2.4 | 9.0 | 29.0 | 5.8 |
| 10.0 | 59.1 | 2.3 | 10.0 | 51.7 | 2.3 | 10.0 | 18.0 | 3.6 | 10.0 | 46.0 | 9.2 |
| 11.0 | 59.1 | 2.3 | 11.0 | 51.7 | 2.3 | 11.0 | 18.0 | 3.6 | 11.0 | 46.0 | 9.2 |
| 12.0 | 59.1 | 2.3 | 12.0 | 51.7 | 2.3 | 12.0 | 18.0 | 3.6 | 12.0 | 46.0 | 9.2 |
| 13.0 | 59.1 | 2.3 | 13.0 | 51.7 | 2.3 | 13.0 | 18.0 | 3.6 | 13.0 | 46.0 | 9.2 |
| 14.0 | 59.1 | 2.3 | 14.0 | 51.7 | 2.3 | 14.0 | 18.0 | 3.6 | 14.0 | 46.0 | 9.2 |
| 15.0 | 75.0 | 2.5 | 15.0 | 75.0 | 2.5 | 15.0 | 20.0 | 4.0 | 15.0 | 50.0 | 10.0 |
| 16.0 | 75.0 | 2.5 | 16.0 | 75.0 | 2.5 | 16.0 | 20.0 | 4.0 | 16.0 | 50.0 | 10.0 |

| Depth in Structure | Structure Percent Damage | Structure Standard Deviation | Depth in Structure | Structure Percent Damage | Structure Standard Deviation | Depth in Structure | Structure Percent Damage | Structure Standard Deviation | Depth in Structure | Structure Percent Damage | Structure Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -2.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 | -2.0 | 0.0 | 0.0 |
| -1.0 | 0.7 | 0.0 | -1.0 | 0.0 | 0.0 | -1.0 | 0.0 | 0.0 | -1.0 | 0.0 | 0.0 |
| 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1.0 | 20.0 | 0.1 | 1.0 | 20.7 | 1.0 | 1.0 | 13.0 | 2.6 | 1.0 | 33.0 | 6.6 |
| 2.0 | 34.3 | 0.1 | 2.0 | 33.7 | 4.5 | 2.0 | 16.0 | 3.2 | 2.0 | 40.0 | 8.0 |
| 3.0 | 45.4 | 0.2 | 3.0 | 47.4 | 5.9 | 3.0 | 20.0 | 4.0 | 3.0 | 50.0 | 10.0 |
| 4.0 | 45.4 | 0.2 | 4.0 | 47.4 | 5.9 | 4.0 | 20.0 | 4.0 | 4.0 | 50.0 | 10.0 |
| 5.0 | 63.9 | 0.2 | 5.0 | 65.6 | 8.8 | 5.0 | 25.0 | 5.0 | 5.0 | 50.0 | 10.0 |
| 6.0 | 63.9 | 0.2 | 6.0 | 65.6 | 8.8 | 6.0 | 25.0 | 5.0 | 6.0 | 50.0 | 10.0 |
| 7.0 | 63.9 | 0.2 | 7.0 | 65.6 | 8.8 | 7.0 | 25.0 | 5.0 | 7.0 | 50.0 | 10.0 |
| 8.0 | 63.9 | 0.2 | 8.0 | 65.6 | 8.8 | 8.0 | 25.0 | 5.0 | 8.0 | 50.0 | 10.0 |
| 9.0 | 63.9 | 0.2 | 9.0 | 65.6 | 8.8 | 9.0 | 25.0 | 5.0 | 9.0 | 50.0 | 10.0 |
| 10.0 | 91.4 | 0.4 | 10.0 | 93.6 | 11.1 | 10.0 | 25.0 | 5.0 | 10.0 | 50.0 | 10.0 |
| 11.0 | 91.4 | 0.4 | 11.0 | 93.6 | 11.1 | 11.0 | 25.0 | 5.0 | 11.0 | 50.0 | 10.0 |
| 12.0 | 91.4 | 0.4 | 12.0 | 93.6 | 11.1 | 12.0 | 25.0 | 5.0 | 12.0 | 50.0 | 10.0 |
| 13.0 | 91.4 | 0.4 | 13.0 | 93.6 | 11.1 | 13.0 | 25.0 | 5.0 | 13.0 | 50.0 | 10.0 |
| 14.0 | 91.4 | 0.4 | 14.0 | 93.6 | 11.1 | 14.0 | 25.0 | 5.0 | 14.0 | 50.0 | 10.0 |
| 15.0 | 100.0 | 0.4 | 15.0 | 100.0 | 11.3 | 15.0 | 25.0 | 5.0 | 15.0 | 50.0 | 10.0 |
| 16.0 | 100.0 | 0.4 | 16.0 | 100.0 | 11.3 | 16.0 | 25.0 | 5.0 | 16.0 | 50.0 | 10.0 |

Supplemental Table 5
North DeSoto County Feasibility Study
Depth-Damage Relationships Autos and Other Flood Related Damages

**Other**
**Flood Related Damage Costs**

| Depth in Structure | Structure Lower Percent | Structure Percent Damage | Structure Higher Percent |
|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5 | 0.0 | 5.2 | 6.4 |
| 1.0 | 0.0 | 6.8 | 8.3 |
| 2.0 | 0.0 | 8.2 | 10.0 |
| 3.0 | 0.0 | 9.6 | 11.8 |
| 4.0 | 12.4 | 11.2 | 13.6 |
| 5.0 | 14.0 | 12.6 | 15.4 |
| 6.0 | 15.7 | 14.1 | 17.3 |
| 7.0 | 17.3 | 15.6 | 19.0 |

**Autos**
**Residential Autos (AUTO)**

| Depth in Structure | Structure Lower Percent | Structure Percent Damage | Structure Higher Percent |
|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5 | 0.0 | 0.0 | 0.0 |
| 1.0 | 100.0 | 100.0 | 100.0 |
| 1.5 | 100.0 | 100.0 | 100.0 |
| 2.0 | 100.0 | 100.0 | 100.0 |
| 3.0 | 100.0 | 100.0 | 100.0 |
| 4.0 | 100.0 | 100.0 | 100.0 |
| 5.0 | 100.0 | 100.0 | 100.0 |
| 6.0 | 100.0 | 100.0 | 100.0 |