Mississippi Valley Division,
Regional Planning and Environment Division South

Tangipahoa Parish, Louisiana Feasibility Study

Appendix E – Tangipahoa Parish Feasibility Study Plan Formulation Appendix

August 2024

CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1
Introduction

1.0 USACE Planning Process

This appendix provides supplemental plan formulation information for the Tangipahoa Parish, Louisiana Feasibility Study (study) that is contained in the Main Report of the Draft Integrated Feasibility Report and Environmental Assessment (DIFR/EA) and includes tables and maps used in the development, screening, evaluation and comparison of management measures and alternative plans.

The USACE planning process that was followed in the study, is a structured systematic and repeatable planning approach to ensure sound decisions are made in accordance with the processes laid out in the Planning Guidance Notebook (Engineer Regulation (ER)1105-2-103) and the Principles and Guidelines for Federal Water Resource projects. The six planning steps (Figure E: 1-1), though presented and discussed in a sequential manner for ease of understanding, usually occur iteratively and sometimes concurrently. Iterations of steps are conducted as necessary to formulate and evaluate efficient, effective, and reasonable array of alternative plans. As more information is acquired and developed, it may be necessary to reiterate some of the previous steps.

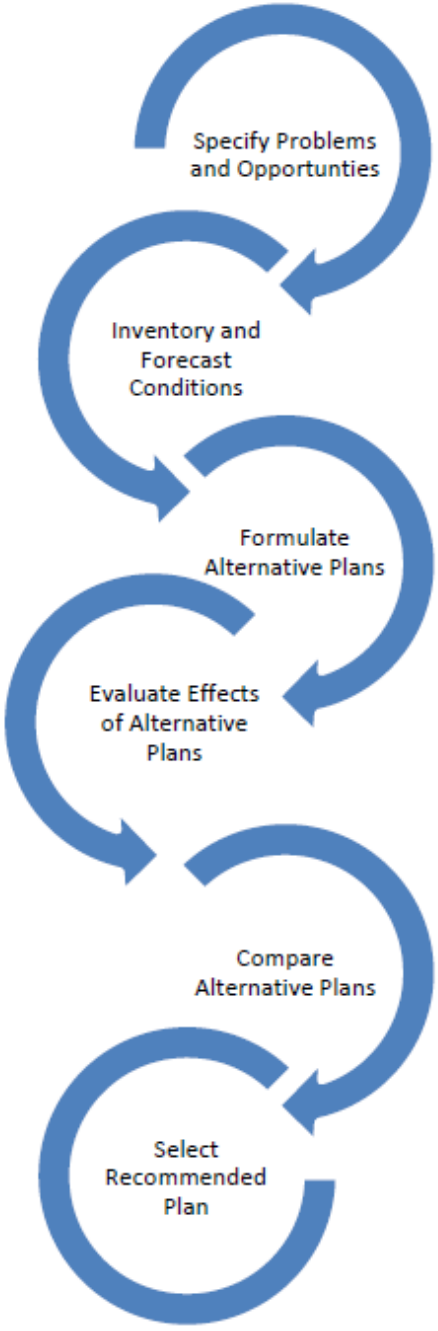

Figure E: 1-1. Six Step Planning Process

Step 1 (Problems and Opportunities – Section 2 of Main Report) focuses on identifying the problems and opportunities in the study area. The PDT needed to understand the issues within the study area and what was driving the issues. The PDT was then able to define the objectives of the study, or what the PDT hopes to achieve with a project and identify any constraints that limit potential solutions.

In Step 2 (Identification of Existing Conditions – Section 3 of Main Report), the PDT documents and understands the affected environment and the historic existing and future conditions related to flood risk management (FRM) in the study area. This was done by looking at historic and existing trends and forecasting changes in the future if no Federal actions are taken. The data and trends identified were used to define the future without project (FWOP) conditions, or the No Action Alternative. The FWOP condition is the default baseline to which all other alternatives are compared. The without-project condition is the same as the National Environmental Policy Act (NEPA) "no action" condition, and it assumes that the USACE would take no action to solve the problem.

Step 3 (Formulate Alternative Plans – Section 4 of Main Report) involves developing a wide range of potential actions or management measures (measures) the PDT could take to solve the problems and meet the planning objectives. Individual measures are combined to create different alternatives to meet the planning objectives. Alternative plans are a set of one or more management measures functioning together to address one or more planning objectives. A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives.

Input from the Coastal Protection and Restoration Authority Board of Louisiana (CPRAB), who is the non-Federal sponsor (NFS), Tangipahoa Parish, key stakeholders, and the public was very important during this planning step.

In early iterations of the planning process, the PDT narrowed the focus from many alternatives and measures to a smaller array of alternatives and measures. In Step 4 (Evaluate Effects of Alternative Plans and Measures – Section 5), the PDT looked at each potential measure and grouping of measures to form alternatives to see what its effects, benefits, costs, and potential impacts would be. This step involved using existing and new data to qualitatively determine and, in later iterations, model the physical, economic, and environmental conditions, along with measuring how well each alternative and measure performs at meeting the objectives and avoiding the constraints.

In Step 5 (Compare Alternative Plans – Section 6), the PDT compared each alternative plan to the other alternative plans, including the no action alternative. Based on the comparisons, the PDT was able to determine which alternatives perform the best and warrant further investigation.

Step 6 (Select Tentatively Selected Plan (TSP)– Section 7), was an additional screening step, where the selection of the tentatively selected plan (TSP) from the Final array of alternatives was informed by, among other things, economic modeling (HEC-FDA), hydrologic and hydraulic (H&H) modeling (HEC-RAS), analysis of ADCIRC results, USACE Class 4 cost estimates, engineering construction costs, design, supervision and administration costs, environmental impacts and mitigation, risk assessments and potential life safety concerns.

This DIFR-EA report is being released for concurrent public, agency, technical, independent external review, and policy review. Subsequent to the release of the DIFR-EA, the PDT will

conduct additional engineering, economic, and environmental investigations on the individual features of the Draft TSP which is comprised of a nonstructural plan. Using the information gathered by the PDT through these additional investigations, together with the consideration of comments received from the public, stakeholders, and the resource agencies, the PDT will further refine the design of the Draft TSP.

1.1 OVERVIEW OF STUDY AREA, PROBLEMS, OPPORTUNITIES, OBJECTIVES, AND CONSTRAINTS

The study area, problems, opportunities, objectives, and constraints are described in Sections 1 and 2 of the Main Report of the DIFR-EIS and are summarized here as a point of reference. This appendix supplements the information in Section 4 of the main report and includes tables and maps used in the development, screening, and evaluation of management measures and alternative plans.

The study area encompasses all of Tangipahoa Parish, which is approximately 823 square miles, located in southeastern Louisiana (Figure E: 1-2). Tangipahoa Parish is home to approximately 137,000 residents and 2,500 businesses. The parish is uniquely located at the crossroads of two Interstates, I-55, and I-12, which serve as national transportation corridors. The Parish extends from the Mississippi State line in the north to Lake Pontchartrain and Lake Maurepas to the south and extends from the eastern boundary with Washington and St. Tammany Parishes to the St. Helena and Livingston Parish boundaries in the west.

The Tangipahoa River vertically bisects the Parish and the study area. The parish is predominantly rural with an economic base comprised of truck, dairy, fish farms and timber industry. The most populated areas within the Parish include the cities of Hammond and Ponchatoula and the towns of Amite City (Parish seat), Independence, Kentwood, and Roseland. Interstates 55 and 12 serve as national transportation corridors and evacuation routes for the greater Metropolitan New Orleans, LA area. Tangipahoa Parish is one of the fastest-growing parishes in Louisiana.

The study area includes 30 hydrologic sub-basins, as defined by the United States Geological Survey (USGS), 12- digit hydrologic unit delineations (HUC12). Within the 30 sub-basins, 18 sub-basins have documented flooding, from storm surge or riverine flooding causing repetitive flood loss damages. These 18 sub-basins are identified on Figure E: 1-2. In cases where a sub-basin overlaps the neighboring parish, the entire sub-basin watershed was included in hydrology and hydraulic (H&H) analysis, however, the flood risk resolutions were developed only for areas within Parish boundary. Additionally, of the 30 hydrologic sub-basins, 21 of them had structures located within them which met our non-structural criteria.

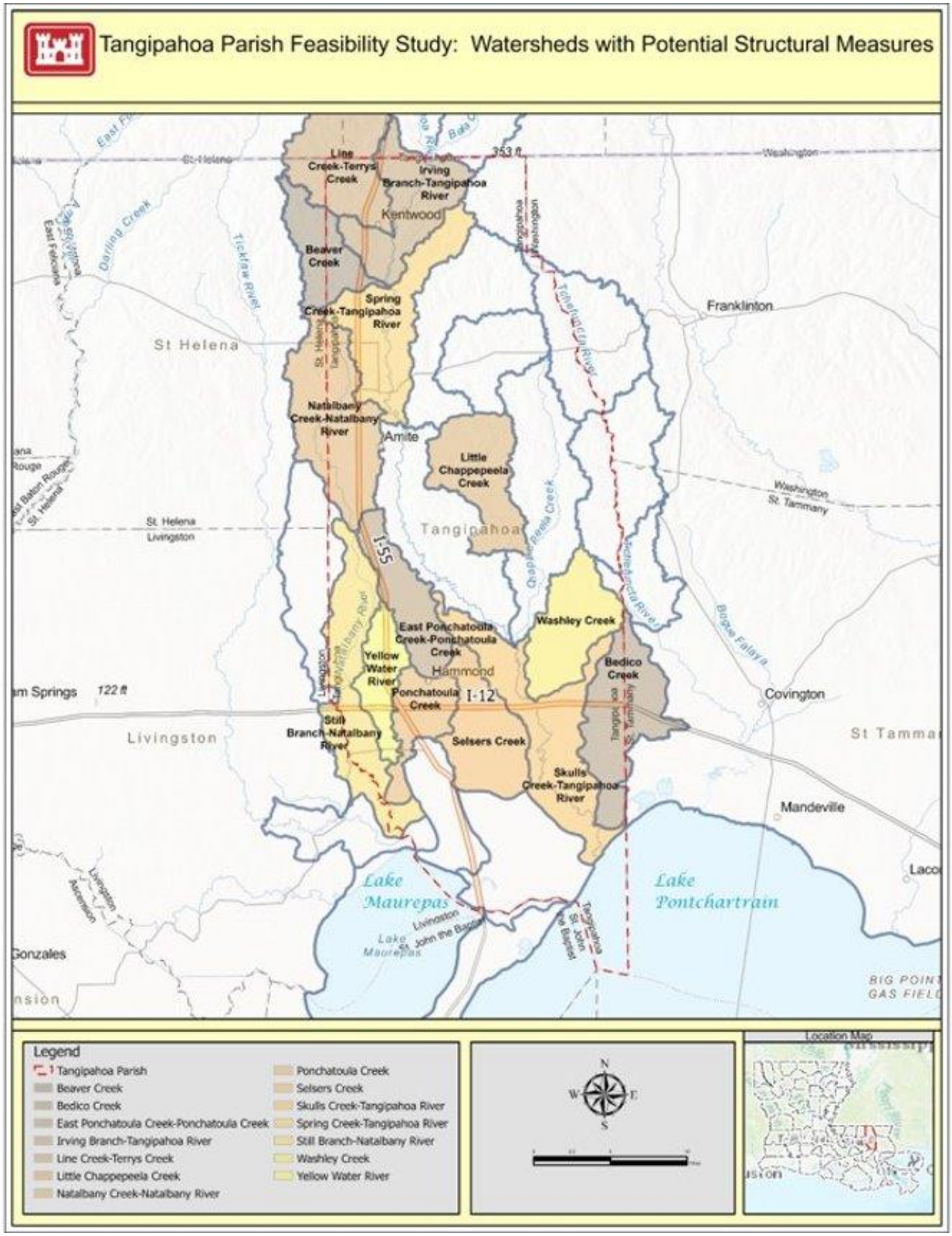

Figure E: 1-1. Tangipahoa Parish, Louisiana Feasibility Study Area

The study objectives and constraints are summarized below:

- Objective 1: Reduce the risk to public safety associated with riverine flood impacts to residential and nonresidential structures, evacuation routes, and access to critical infrastructure.
- Objective 2: Reduce economic loss due to flood damage to structures (i.e., businesses, residential, commercial, and public structures) from riverine flooding.
- Objective 3: Reduce impacts due to interruption of evacuation routes and a national transportation corridor, e.g., the I-12 and I-55.
- Objective 4: Increase community resiliency which is the sustained ability of a community to use available resources, before, during, and after riverine flooding events and/or coastal events.
- Objective 5: In conjunction with managing flood risk and reducing economic flood damages in the study area overall, act to benefit underserved communities and avoid disproportionate impacts to disadvantaged communities.

The constraints for the study that were used in the plan formulation are:

- To the maximum extent practicable, avoid promoting development within the floodplain (in accordance with E.O. 11988), which contributes to increased life safety risk.
- Proposed measures are limited to those that address problems associated with a minimum flow (800 cubic feet per second for a 10 percent AEP flood) and drainage area (1.5 square miles) requirements (ER 1165-2-21).

Additional considerations identified for plan formulation that would not require the removal of an alternative plan from consideration, but need to be assessed as part of the plan formulation process included:

- Avoid or minimize negative impacts to:
    - threatened and endangered (T&E) species and protected species and their critical habitats;
    - water quality;
    - cultural, historic, and Tribal-trust resources;
    - recreational areas in the Parish;
    - wildlife management areas, wetlands, and forests;
- Avoid locating project features on lands known to have hazardous, toxic, and radioactive waste (HTRW) and/or related concerns;

- Recognition that the Tangipahoa River is designated as a Louisiana Natural and Scenic River, which may require legislative changes to implement alternatives.

Consistency with local floodplain management plans by not inducing flooding in other areas.

SECTION 2
Formulation of Alternatives

This section provides information to supplement Section 4 of the DFIR/DEA. This section details Step 3 of the USACE planning process and presents the results of the plan formulation process. Alternatives were developed in consideration of the study area problems and opportunities, as well as objectives and constraints. Economic, social, and environmental benefits, impacts, and costs are to be identified, measured, and/or qualitatively characterized using the four Principles & Guidelines, which include acceptability, completeness, effectiveness, and efficiency.

The study area is impacted by riverine flooding from major rainfall events as well as storm surge from tropical events in the southern portion of the Parish. Authorization is currently limited to flood risk management. However, project formulation was conducted based on hydraulics associated with riverine flooding as well as coastal surge and compound flooding. This was done so the study team could identify flooding from both riverine flooding and coastal surge for future consideration. The non-federal sponsor is currently pursuing WRDA 2022 Section 8106(a) which will allow the PDT to "formulate alternatives to maximize the net benefits from the reduction of the comprehensive flood risk within the geographic scope of the study.

The initial plan formulation strategy was to focus on regional solutions (e.g., dams, detention basin, and diversion) followed by formulation based on economics damage centers (e.g., where the greatest consequences are) minimizing life loss, and/or more local protection. These measures/alternatives were developed based on previous reports and studies, NFS information, stakeholder/public input, new hydrology and hydraulics, geotechnical assessments, and professional judgment.

Initial array of alternatives was assembled by combining the remaining site-specific management measures. Because the study area has separate gravity drainage basins based on United States Geological Survey (USGS) hydrologic sub-basins, Alternatives were developed separately for each distinct drainage area. This plan formulation approach was based on separable elements as defined in Water Resources Development Act (WRDA) 1986 Section 103(f) and Engineer Regulation 1105-2-100, Appendix E, Paragraph E-3, Section c (2).

2.1 MANAGEMENT STRATEGIES AND MEASURES

Measures considered for this study are described in Section 4, Sub-section 4.1. Management measures are the building blocks of alternative plans. Sometimes an alternative plan is one measure. More often it is a set of measures. The categories of measures considered to reduce flood risk from the multiple sources of flooding included structural, nonstructural, and nature-based measures. The PDT identified management strategies under the structural, nonstructural, and nature-based categories to address flood

risk reduction Table E: 2-1 utilizing information on existing infrastructure, existing reports, and subject matter expertise consistent with FRM objectives. Input from the CPRA, Tangipahoa Parish, key stakeholders, and the public was very important during this planning step. All measures were evaluated and screened for capability to meet objectives and avoid constraints, for engineering and economic feasibility, and to maximize benefits provided over the 50-year period of analysis from 2033-2083. Measures that warranted continued consideration and met the success thresholds were assembled into alternative plans.

Table E: 2-1 identifies the types of structural, nonstructural, and nature-based actions that were initially identified to potentially reduce flood risk in the study area.

Table E: 2-1. Flood Risk Management Strategies

STRUCTURAL	NONSTRUCTRUAL	NATURAL / NATURE BASED
Detention Basin	Elevation, Residential	Riparian Habitat to slow inland water transfer
Diversion Channel	Dry Floodproofing, Residential	Reclamation of abandoned quarries for flood storage
Roadway Elevation	Wet Floodproofing, Nonresidential	Detention Ponds with Wetland Restoration
Levee / Floodwall / Pump Station	Property Acquisition Buyouts / Relocation (reuse of the floodplain)	Historic ridge restoration
Reservoir (unregulated)	Risk Communication with Public / Flood Warning System	Beneficial Use of Dredged Material
Water Control Structure	Optimize Operation of Existing Structures or Projects	River Cane restoration
Revetment (shoreline)	Evacuation Plans	
Channel Improvement / Dredging		
Snagging and Clearing		

Nonstructural measures (NS) reduce the human exposure or vulnerability to a flood hazard without altering the nature or extent of the flood hazard. NS measures are permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. NS measures differ from structural measures in that they focus on reducing consequences of flooding instead of focusing on reducing the probability of flooding. Nonstructural alternatives could be used in conjunction with any of the structural flood mitigation alternatives to optimize the cost/benefit ratio. Nonstructural measures addressed by the USACE National Nonstructural Floodproofing Committee include building

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

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

    - Nonphysical Nonstructural: Consists of flood warning system/evacuation plans. While adequate land use and floodplain management development regulations already exist, it warranted further evaluation.
    - Physical Nonstructural: Consists of property acquisition and relocation assistance, elevation, and/or flood proofing of structures.
- **Structural measures** are those that are physical modifications designed to reduce the frequency of damaging levels of flood inundation.

- **Nature-based measures (NB)** work with or restore natural processes with the aim of wave attenuation, storm surge reduction, slow and store floodwaters, wetlands or coastal habitat to store inland water.

The following thresholds were established for structural measure consideration in plan formulation:

- Channels with discharges greater than 800 cfs for the 10% Annual Exceedance Probability (AEP) event (10 Year) flood event were included for consideration. Areas where flow is less than the threshold is considered local drainage and out of the scope for structural measure consideration.

- Specific structural measures considered and designed for:

    - 1% AEP event (100yr-flood) for levees

    - 10% AEP event (10yr-flood) for detention basins

Following the identification and evaluation of the types of management actions that could reduce flood risk to the area, specific site management measures within the categories and types were then identified and compiled from previous reports, and recommendations and comments received from NFS, stakeholders, and the public. A full list of all the identified

site-specific management measures is presented in Table E: 2-2. Initially, a total of 195 measures were identification.

2.1.1 Screening of Measures

The management measures were initially screened on whether the measure meets planning objectives and avoids constraints as well as qualitative assessments of effectiveness, efficiency, and acceptability, which are three of the four Principles and Guidelines (P&G) evaluation criteria in planning studies. Tables E: 2-2 and 2-3 presents the initial screening of measure categories.

Table E: 2-2. Summary of Flood Risk Management Measures and Screening

Measure	Structural, Non-Structural, Nature/Natural	Meets Objective	Retained for further evaluation
Detention Basin	Structural	1,2,3,4,5	Yes
Reservoir (unregulated)	Structural	1,2,3,4,5	Yes
Diversion Channel	Structural	1,2,3,4,5	Yes
Roadway Elevation	Structural	1,2,3,4,5	Yes
Levee / Floodwall / Pump Station	Structural	1,2,3,4,5	Yes
Water Control Structure	Structural	1,2,3,4,5	Yes
Revetment (Shoreline)	Structural	1,2,3,4,5	Yes
Channel Improvement / Dredging	Structural	1,2,3,4,5	Yes
Snagging and Clearing	Structural	1,2,3,4,5	Yes
Elevation, Residential	Non-structural	1,2,4,5	Yes
Dry Floodproofing, Residential	Non-structural	1,2,4,5	Yes
Floodproofing, Nonresidential	Non-structural	1,2,4,5	Yes
Property Acquisition Buyouts / Relocation	Non-structural	1,2,4,5	Yes
Risk Communication with the public/Flood Warning System/Evacuation Plans	Non-structural	1,2,3,4,5	No. Evacuation plans have been developed by the Parish and if additional assistance needed, local partners would request through other USACE programs. Not captured under this feasibility study. Eliminated from consideration because the study area has an ample forecast/warning

Measure	Structural, Non-Structural, Nature/Natural	Meets Objective	Retained for further evaluation
			system provided by Parish and local government.
Reclamation of abandoned quarries for flood storage	Nature-based/ Natural	1,2,3,4,5	No. Locations not suitable / ineffective at reducing flood risk.
Wetland Restoration as Detention	Nature-based/Natural	1,2,3,4,5	Yes
Historic Ridge Restoration	Nature-based/Natural	1,2,4	Yes
Habitat Creation to attenuate waves	Nature-based/Natural	1,2,4	No. Marsh alone was eliminated as a standalone measure since it would be ineffective in significantly reducing the level of risk reduction. Additionally, these measures were proven viable in the coastal zone only and outside the scope of this study.
Riparian habitat to slow inland water transfer	Nature-based/Natural	1,2,4	No. Detention pond measures were more effective at storing inland water; areas to covert to riparian habitat for inland water storage were not found in needed areas.
River Cane Restoration (Louisiana Watershed Initiative)	Nature-based/Natural	1,2,4	Yes

After the types of structural, nonstructural, and nature-based measure strategies were established, an initial 59 site specific management actions, including structural and nature-based actions were identified for evaluation to reduce the risk of flood damages within the study area. Table E: 2-3 presents the full list of initial site-specific measures. Seventeen site-specific measures were initially screened and 43 structural measures were carried forward to develop the alternative plans. The screening criteria is included in “Descriptions” and indicated by shaded cells in Table E: 2-3 below.

Table E: 2-3 Site Specific Structural Measures and Screening

HUC SUB-BASIN	MEASURE ID	Category	Type	DESCRIPTION
Anderson Canal	AC 2	Nature Based	Ridge Construction and Plantings	Wind Fetch - Ridge Construction and Plantings Lake Maurepas. Screened for Efficiency.
Anderson Canal	AC 3	Structural	Shoreline Revetment	Rock berm along Lake Maurepas. Screened as construction is in progress to reduce shoreline erosion
Beaver Creek	**BC 1**	**Structural**	**Detention Basin**	**Beaver Creek Detention Basin near Village of Tangipahoa**
Beaver Creek	**BC 2 North**	**Structural**	**Detention Basin**	**Beaver Creek Detention Basin North of Village of Tangipahoa**
Beaver Creek	**BC 2 South**	**Structural**	**Detention Basin**	**Beaver Creek Detention Basin south of Village of Tangipahoa**
Bedico Creek	**BED 1**	**Structural**	**Roadway Elevation**	**Elevation of Firetower Rd - Hwy 22 to Hwy 190 (near I-12)**
Bedico Creek	**BED 2**	**Structural**	**Levee / Pump Station**	**Bedico Creek Levee / pump station 1**
Bedico Creek	**BED 3**	**Structural**	**Levee / Pump Station**	**Bedico Creek Levee and 2 pump stations 2**
Bedico Creek	**BED 4**	**Structural**	**Roadway Elevation**	**Roadway elevation Firetower Rd / Hwy 22 intersection.**
East Ponchatoula Creek / Ponchatoula Creek	**ECPC 1a, 1b**	**Structural**	**Levee / Pump Station**	**Hammond Levee and pump station**
East Ponchatoula Creek / Ponchatoula Creek	**ECPC 2**	**Structural**	**Levee / Pump Station**	**Hammond / Woodbridge levee and pump station, long**
East Ponchatoula	**ECPC 3**	**Structural**	**Levee**	**Hammond / Whitmar Levee**

Creek / Ponchatoula Creek				
East Ponchatoula Creek / Ponchatoula Creek	**ECPC 4**	**Structural**	**Diversion Channel**	**Diversion channel - Ponchatoula Creek**
East Ponchatoula Creek / Ponchatoula Creek	EC PC 5	Structural	Levee	Independence levee. Screened: FEMA maps showed inundation, however, modeling and Parish confirmed no flooding occurs up to 100 Year flood event.
Irving Branch Tangipahoa River	IBTR 1	Structural	Water Control Structure	Screened not effectiveness at reducing flood risk.
Little Chappepeela Creek	**LCC 1**	**Structural**	**Roadway Elevation**	**Roadway modifications of Briar Patch Cemetery Road**
Line Creek Terry's Creek	**LCTC 1**	**Structural**	**Water Control Structure and pump station**	**Kentwood pump station, water control structure**
Line Creek Terry's Creek	**LCTC 2**	**Structural**	**Water control structure and pump station**	**Kentwood pump station, water control structure**
Line Creek Terry's Creek	**LCTC 3**	**Structural**	**Levee, pump station, water control structure**	**Kentwood Levee, pump station, water control structure**
Natalbany Creek Natalbany River	**NCNR 1**	**Structural**	**Detention Basin**	**Detention Basin SW of Amite City**
Natalbany Creek Natalbany River	NCNR 1b	Structural	Detention Basin	Screened for cost effectiveness. Proposed location near Amite City cannot significantly reduce the volume of water that flows into the Tangipahoa River
North Pass / Pass Manchac	NPPM 1	Nature-Based	Ridge Construction and Plantings	Nature Based solution (constructed ridge and plantings) to reduce wind fetch along Lake Pontchartrain. Screened because ineffective at

				reducing flood risk.
North Pass / Pass Manchac	NPPM 2	Nature Based	Ridge Construction and Plantings	Nature Based solution (constructed ridge and plantings) to reduce wind fetch along Lake Maurepas. Screened because ineffective at reducing flood risk.
North Pass / Pass Manchac	NPPM 3	Structural	Rock Berm	Constructed rock berm to reduce wind fetch along Lake Maurepas Screened because ineffective at reducing flood risk.
Ponchatoula Creek	**PC 1a, b, c**	**Structural**	**Levee**	**Levee alignments east of Ponchatoula Creek,**
Ponchatoula Creek	**PC 2a, b**	**Structural**	**Levee**	**Levee alignments west of Ponchatoula Creek,**
Still Branch - Natalbany River	**SBNR 2**	**Structural**	**Detention Basin**	**Natalbany River detention basin - west / Indpendence**
Selsers Creek	**SC 1**	**Structural**	**Levee**	**Levee at Selsers Creek (Wild Oak)**
Selsers Creek	SC 2	Structural	Channel improvements	Screened. Flooding issue is not caused by tributary that falls within the study scope (less than 800 cfs) Drainage modifications near Blythwood subdivision
Selsers Creek	SC 3	Structural	Levee	Screened for ineffectiveness and significant environmental impacts. Levee near Selsers Creek - watersheds
Selsers Creek	**SC 4**	**Structural**	**Levee**	**Detention basin near Big Branch**
Selsers Creek	**SC 5**	**Structural**	**Detention Basin**	**Detention basin west of Selsers Creek/Chappepeela Sports Park**
Selsers Creek	SC 6	Structural	Detention Basin	Screened for ineffectiveness and significant environmental impacts. Detention basin Selsers Creek / Airport Road
Selsers Creek	SC 7	Structural	Reservoir	Screened for effectiveness and environmental impacts. Reservoir at Selsers Creek

				west of Airport Road
Selsers Creek	SC 8	Nature Based	Detention Basin	Screened for ineffectiveness. Nature based solution (creek restoration)
Selsers Creek	SC 9	Structural	Levee	Screened for effectiveness. Levee near Selsers Creek
Selsers Creek	**SC 10**	**Structural**	**Detention Basin**	**Detention basin at East of Selsers Creek**
Selsers Creek	**SC 11**	**Structural**	**Detention Basin**	**Detention basin at Selsers Creek (Wild Oak)**
Selsers Creek	**SC 12**	**Structural**	**Roadway Elevation**	**Roadway elevation of Hwy 22 and Sandhill Cemetery Rd. (added later per Parish)**
Skulls Creek - Tangipahoa River	**SCTR 2**	**Structural**	**Levee**	**Cow Branch Levee near Lee's Landing / South of I-22**
Skulls Creek – Tangipahoa River	SCTR 7	Nature Based	Historic Ridge	Nature Based – CPRA Master Plan berm on Lake Pontchartrain. Screened on effectiveness for this study although measure could be considered through other funding mechanisms as a resiliency measure for the wildlife management area and retention of wetland communities.
Skulls Creek - Tangipahoa River	SCTR 8	Nature Based	River Cane Restoration	Nature Based - Native cane restoration Tangipahoa River and Lake Pontchartrain / Near Joyce WMA. Screened because measure is ineffective at reducing flood damage risk within the scope of this study.
Skulls Creek - Tangipahoa River	**SCTR 9**	**Structural**	**Levee / Pump Station**	**Richardson Rd. Levee and pump station at Tangipahoa River**
Skulls Creek - Tangipahoa River	**SCTR 11**	**Structural**	**Levee**	**Laurel Oak Levee / South of I-12 South of Robert**
Skulls Creek - Tangipahoa River	**SCTR 12**	**Structural**	**Culvert Modification**	**Culvert Modification Sims Creek**

Skulls Creek - Tangipahoa River	**SCTR 14**	**Structural**	**Levee**	**Coburn Levee and pump station**
Skulls Creek - Tangipahoa River	**SCTR 15**	**Structural**	**Levee**	**Tangipahoa River Levee**
Skulls Creek - Tangipahoa River	**SCTR 16**	**Structural**	**Detention Basin**	**Tangipahoa River detention basin (east of Tickfaw)**
Skulls Creek - Tangipahoa River	SCTR 17	Nature Based	Riparian Habitat to Slow Inland Water Transfer	Nature Based detention basin - side channel restoration. Screened. Detention ponds were more effective at reducing flood risk.
Spring Creek / Tangipahoa River	**SPTR 1a & 1b**	**Structural**	**Levee / Pump Station**	**Village of Tangipahoa Levee and pump station**
Washley Creek	**WASH 1**	**Structural**	**Levee / Pump Station**	**Robert Levee and pump station, short**
Washley Creek	**WASH 2**	**Structural**	**Levee / Pump Station**	**Robert Levee and pump station**
Washley Creek	**WASH 3**	**Structural/Nature Based**	**Levee and Nature Based Detention basin**	**Robert Levee and nature based detention basin**
Washley Creek	**WASH 4**	**Structural**	**Detention Basin**	**Upper Washley Creek detention basin**
Multiple	**SNG-1**	**Structural**	**Snagging and Clearing**	**Tangipahoa River North Snagging and Clearing**
Multiple	**SNG-3**	**Structural**	**Snagging and Clearing**	**Tangipahoa River Middle Snagging and Clearing**
Multiple	**SNG 2**	**Structural**	**Snagging and Clearing**	**Tangipahoa River South Snagging and Clearing**
Multiple	**SNG 4**	**Structural**	**Snagging and Clearing**	**Natalbany River Snagging and Clearing**

Shaded cells are measures that were not carried forward for alternative development.

2.2 INITIAL ARRAY OF ALTERNATIVES

This section summarizes the strategies utilized to identify the initial array of structural and nonstructural alternatives based on initial data collection and professional judgement. The initial array was developed by combining the remaining site-specific management measures. Sixteen alternatives were developed separately by combining all measures related to a

given area or source of flooding and assigned within each distinct drainage area based on the USGS 12-digit hydrologic sub-basins affecting the study area (Table 2-4).

Tangipahoa Parish is comprised of 8 major watersheds and 30 hydrologic subbasins. Eighteen HUC sub-basins have documented flooding, from storm surge or riverine flooding causing repetitive flood loss damages. Twenty-one sub-basins have structures which meet our non-structural criteria for elevation or floodproofing. Structural alternatives were developed for each of the following areas: Beaver Creek, Bedico Creek, East Ponchatoula, Irving Branch, Line Creek, Little Chappepeela Creek, Natalbany Creek, Ponchatoula Creek, Selsers Creek, Skulls Creek, Spring Creek, Still Branch, Washley Creek and Lower Tangipahoa River. In areas where the hydrologic influence of the subbasins overlap, measures were evaluated in combination with other alternatives in the same vicinity. This plan formulation approach was based on separable elements as defined in WRDA 1986 Section 103(f) and Engineer Regulation 1105-2-100, Appendix E, Paragraph E-3, Section c (2).

Nonstructural plans for the entire parish were also evaluated, along with combined structural and nonstructural plans for the separate geographic areas.

The nomenclature for each Measure ID as seen in Table E: 2-4 is continued throughout Section 4. Each measure was given a unique alphanumerical value based upon the sub-watershed in which the measure would implement and then the order in which the measure was proposed and/or documented during the study for that sub-watershed.

Sixteen initial alternatives were assembled by combining the remaining 47 site-specific management measures. Table E: 2-4 lists the Initial Array of Alternatives.

- No Action Plan: NEPA regulations (40 CFR 1502.14(d)) requires that a No Action plan be considered as a viable alternative in the final array of plans. It represents future conditions that will likely occur if USACE takes no action. The No Action plan is included as Alternative 1.
- Comprehensive Nonstructural Plan: In accordance with Section 73 of the Water Resources Development Act of 1974, a minimum of one primarily nonstructural plan must be considered; therefore, Alternative 2, which is a Comprehensive Nonstructural Plan was carried forward to be evaluated for the entire parish, along with combined structural and nonstructural plans for the separate geographic areas.

Table E: 2-4. Initial Array of Alternatives

Alt ID	Sub Basin	Detention ponds (FRM)	Water Control Structures	Diversion channel	Pump stations	Levee, floodwall	Flood gates	Roadway Elevation	Snagging and Clearing
1	No Action								

Alt ID	Sub Basin	Detention ponds (FRM)	Water Control Structures	Diversion channel	Pump stations	Levee, floodwall	Flood gates	Roadway Elevation	Snagging and Clearing
	Parishwide								
2	Nonstructural Parishwide								
3	Beaver Creek	BC-1, BC-2N, BC-2S							
4	Bedico Creek				BED-2, BED-3	BED-2, BED-3		BED-1, BED-4 (combined into BED 5)	
5	East Ponchatoula Creek-Ponchatoula Creek			ECPC-4	ECPC-1a, ECPC-1b	ECPC-1a, ECPC-1b, ECPC-2, ECPC-3, ECPC-5	ECPC-1a, ECPC-1b, ECPC-2, ECPC-3		
6	Irving Branch – Tangipahoa River		IBTR 1						
7	Line Creek-Terrys Creek		LCTC-1, LCTC-2		LCTC-1, LCTC-2, LCTC-3	LCTC-3			
8	Little Chappepeela Creek							LCC-1	
9	Natalbany Creek-Natalbany River	NCNR-1, NCNR-1b							
10	Ponchatoula Creek				PC-1a, PC-1b, PC-1c, PC-2a, PC-2b	PC-1a, PC-1b, PC-1c, PC-2a, PC-2b			
11	Selsers Creek	SC-5, SC-10, SC-11			SC-1, SC-4				

Alt ID	Sub Basin	Detention ponds (FRM)	Water Control Structures	Diversion channel	Pump stations	Levee, floodwall	Flood gates	Roadway Elevation	Snagging and Clearing
12	Skulls Creek-Tangipahoa River	SCTR-16	SCTR-12		SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15	SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15	SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15		
13	Spring Creek-Tangipahoa River				SPTR-1a, SPTR-1b	SPTR-1a, SPTR-1b	SPTR-1a, SPTR-1b		
14	Still Branch-Natalbany River	SBNR-2							
15	Washley Creek	WASH-3, WASH-4			WASH-1, WASH-2	WASH-1, WASH-2	WASH-1, WASH-2		
16	Lower Tangipahoa, Yellow Water, Ponchatoula								SNG-1, SNG-2, SNG-3, SNG-4

2.3 SCREENING OF INITIAL ARRAY

During the evaluation of the initial array, alternatives were screened or refined based on additional information and modeling (Table E: 2-5). A total of 14 alternatives were not carried forward to for further alternative development. Five Alternatives (3, 6, 7, 9, and 14), were screened and removed from consideration. Alternative 3 was screened due to limited opportunities for detention basins to meet project objectives (i.e. currently serving as retention areas, no benefit, environmental impacts, and estimated damages appeared lower than estimated implementation costs). Alternatives 6 and 7, which proposed water control structures and pump stations to reduce risk from riverine flooding, were screened because the estimated damages avoided were lower than the estimated implementation cost. Alternative 9 was screened as HEC-RAS modelling showed this area was no longer flooding, which was then verified by the Parish. Alternative 14 was screened as potential damages avoided were not expected to exceed implementation costs.

Nonstructural alternatives were carried forward and continued to be evaluated within subbasin and in areas where structural and nature-based measure were screened. Nature-based features were screened due to limited flood risk reduction benefits and viability of locations. Alternatives were assessed using the same specific planning study criteria used to assess individual mitigation measures as described in Section 4.2.1 of the Main Report.

Table E: 2-5: Initial Array Screening to Focused Array of Alternatives

Alt ID	Subbasin	Alternative Description – Screening Criteria
1	No Action	Carried forward to the Final Array
2	Nonstructural	Carried forward to the Final Array
3	Beaver Creek	**Not carried forward to the Focused array. Screened Measures: BC-1, BC-2, and BC-3.** **FRM detention basins were screened. Approximately 1/3 of unit showed inundation already, proving ineffective and was expected that costs for the Detentions Basins would exceed the damages avoided.**
4	Bedico Creek	Measures carried forward to the Focused array BED-1 and BED-4. **Screened Measures: BED-2 and BED-3** **Both levees were removed from this alternative. Potential damages avoided are not expected to exceed implementation cost. Potential significant environmental concerns related to impacts to quality forested areas within this location.**
5	East Ponchatoula Creek-Ponchatoula Creek	Measures carried forward to the Focused array: ECPC1a, ECPC1b, ECPC-2 and ECPC-3. **Screened Measures: ECPC-4 and ECPC-5.** **Channel Diversion was screened due to effectiveness. Several exist in the area already and no viable location was determined. The Independence Levee was screened as being out of scope as the H&H modelling determined this area was not flooded and was confirmed by the Parish.**
6	Irving Branch Tangipahoa River	Not Carried forward to the Focused array. **Screened Measure: IBTR-1** **The water control structure along the railroad would have been designed to block the water from backing up through the railroad along Highway 51. This measure was screened as the potential damages avoided were not expected to exceed implementation costs since it primarily provided flood risk reduction to only three structures.**
7	Line Creek-Terrys Creek	Not Carried forward to the Focused array. **Screened Measure: LCTC-1, LCTC-2, LCTC-3** **The Water Control Structures and Pump Stations (LCTC-1 and LCTC-2) were screened after further analysis did not show significant hydrology impacts in this area. The Kentwood Levee (LCTC3) was screened as the system proved ineffective and only provided protection to 2 structures and therefore the potential damages avoided were not expected to exceed implementation costs.**
8	Little Chappepeela	Measures carried forward to the Focused array: LCC-1 **Screened Measures: None** **Raise Briar Patch Cemetery Road, southeast of Amite City, just east of the**

Alt ID	Subbasin	Alternative Description – Screening Criteria
		Tangipahoa Parish School Board Wildlife Management Area.
9	Natalbany Creek-Natalbany River	Not Carried forward to the Focused array. **Screened Measures: NCNR-1 and NCNR-1b** **The Bankston Detention Basin (NCNR-1) was screened after further analysis did not show significant hydrology impacts in this area. Additionally, the Alternate Detention Basin (NCNR-1b) was screened as the detention basin proved ineffective as a result of being located too high in the watershed to be able to significantly reduce the volume of water that flows into the Tangipahoa River.**
10	Ponchatoula Creek	Measures carried forward to Focused array: PC-2a, PC-2b **Screened Measures: PC-1a, PC-1b, and PC-1c** **The Pecan Ridge Levee proved ineffective and provided benefits to approximately 12 structures; therefore the potential damages avoided were not expected to exceed implementation costs.**
11	Selsers Creek	Measures carried forward to Focused array: SC-1, SC-4, SC-5, SC-10, and SC-11, SC- 12 (added) **Screened Measures: No additional screening to Focused array.**
12	Skulls Creek-Tangipahoa River	Measures carried forward to Focused array: SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15, SCTR-16 **Screened Measures: SCTR-12** **The culvert replacement at I-12 along Sims Creek was screened as the potential damages avoided were not expected to exceed implementation costs.**
13	Spring Creek-Tangipahoa River	Measures carried forward to Focused array: SPTR-1a, SPTR-1b **Screened Measures: No additional screening to Focused array.**
14	Still Branch-Natalbany River	Not Carried forward to the Focused array. **Screened Measures: SBNR-2** **The Independence Detention Basin proved ineffective as the potential damages avoided were not expected to exceed implementation costs.**
15	Washley Creek	Measures carried forward to Focused array: WASH-1, WASH-2, WASH-3, and WASH-4 **Screened Measures: No additional screening to Focused array.**
16	Lower Tangipahoa, Yellow Water, Ponchatoula	Measures carried forward to Focused array: SNG-1, SNG-2, SNG-3, and SNG-4 **Screened Measures: No additional screening to Focused array.**

Shaded cells are measures that were not carried forward for alternative development.

2.4 FOCUSED ARRAY OF ALTERNATIVES

Seventy-three nonstructural and structural management Additional details on the Focused Array of Alternatives, which were the alternatives that remained after screening the Initial Array, are included below. The Focused Array included 11 alternatives, made up of 29

measures and is illustrated in Table E: 2-6. Maps depicting the Focused Array are presented in Appendix B and Appendix J

Table E: 2-6. Tangipahoa Parish, Louisiana Feasibility Study Focused Array of Alternatives (Measures in bold indicates screened measures that were not carried forward)

Alt ID	Subbasin	Detention ponds (FRM)	Pump stations	Levee, floodwall	Flood gates	Roadway Elevation	Snagging and Clearing
1	No Action Parishwide						
2	Nonstructural Parishwide						
4	Bedico Creek					BED-1, BED-4	
5	East Ponchatoula Creek-Ponchatoula Creek		ECPC-1a, ECPC-1b	ECPC-1a, ECPC-1b, ECPC-2, ECPC-3	ECPC-1a, ECPC-1b, ECPC-2, ECPC-3		
8	Little Chappepeela Creek					LCC-1	
10	Ponchatoula Creek		PC-2a, PC-2b	PC-2a, PC-2b			
11	Selsers Creek	SC-5, SC-10, SC-11	SC-1, SC-4				
12	Skulls Creek-Tangipahoa River	SCTR-16	SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15	SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15	SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15		
13	Spring Creek-Tangipahoa River		SPTR-1a, SPTR-1b	SPTR-1a, SPTR-1b	SPTR-1a, SPTR-1b		
15	Washley Creek	WASH-3, WASH-4	WASH-1, WASH-2	WASH-1, WASH-2	WASH-1, WASH-2		
16	Lower Tangipahoa, Yellow Water, Ponchatoula						SNG-1, SNG-2, SNG-3, SNG-4

2.4.1 Screening of the Focused Array of Alternatives:

The screening criteria of the Focused Array resulted in ultimate removal of all structural alternatives. No structural plans were carried forward to the Final Array of Alternatives. The majority of the structural measures were screened due to lack of cost effectiveness or were found to be ineffective at meeting planning objectives. The majority were screened at this higher level because the benefits did not support developing the measure any further. Appendix B and Appendix J include mapping and further details on the evaluation and screening of structural alternatives within the study area.

The measures in the Focused Array were evaluated, compared, and screened against the following criteria: effectiveness, costs, economic benefits, life safety, impact to environmental resources, environmental justice (social vulnerability), and P&G evaluation criteria. The screening was informed by preliminary economic modeling (HEC-FDA), H&H modeling (HEC-RAS and analysis of ADCIRC results) and updated cost estimates. CEMVS Engineering Division developed the estimated levee lengths, quantities, borrow quantities, etc. of the structural measures by using data from previous projects and reports prepared by (or for) USACE, NFS, and stakeholders, study specific H&H modeling, and best engineering judgment. Based on the evaluations, the PDT was able to determine which alternatives and measures performed the best and warranted further investigation.

Rough order of magnitude (ROM) cost estimates were developed for the Focused Array. The screening for the Initial Array used cost estimates from previous studies and reports and those costs were updated and or escalated costs to provide a more recent cost estimate. Cost estimates for compensatory mitigation resulting from for direct impacts to marsh and BLH habitat were also estimated and included in the total revised costs for the Focused Array of Alternatives.

Potential benefit and inducement areas (subsections) for each remaining structural measure were delineated. These areas identify where potential flood risk reduction or inducement might occur with the implementation of the measure within the alternative. These approximate benefit areas represented rough estimation of potential flood risk reduction and were used to identify structures that would likely benefit from implementation of each measure. Both reduction and inducement estimates were formulated using a combination of existing model documentation and best engineering judgement. Literature sources and prior studies estimated benefits were also used.

Below is a summary of assumptions applied to the delineated areas for calculating preliminary benefits when estimated with the lowering or reduction of water surface elevation (WSE) from prior studies were not available. It should be noted that any WSE lowering given in a range resulted in a median value, which was applied during the economic analysis.

- FRM Levees or Floodwalls: Reduce damages by 90 percent for rainfall/riverine flood damages for events up to and including the 200-year. No reductions assumed for more extreme events (500 year).

- The Expected Annual Damages (EAD) values for the structures within the potential benefit areas were calculated to estimate the maximum potential benefits that could accrue to each measure within an alternative. The EAD totals were then converted to a maximum cost supported by dividing by the capital recovery factor. The maximum cost supported estimates were then further refined by developing an estimated flood lowering for each of the measures and using that value to adjust the potential maximum cost supported for each measure within an alternative.
    - The PDT then compared the maximum cost supported estimate for each measure to the ROM cost estimates to screen out measures and alternatives that would likely not be economically justified.

For initial screening, the majority of the structural measures were screened due to cost effectiveness or were found to be ineffective at meeting planning objectives. Many of the structural measures were determined to be technically unfeasible because of broadly dispersed (rural) populations. The majority were screened at this higher level because the benefits did not support developing the measure any further. These included the screening of Alternatives 4, 6, 7, and 8 (Table E: 2-7)

Table E: 2-7. Initial Screening of the Focused Array

Alt ID	Focused Array of Alternatives	Screening Notes
4	East Ponchatoula Creek-Ponchatoula Creek	Screened Alternative Screened measures: EPPC-1a, EPPC-1b, EPPC-2, EPPC-3. Additional modeling showed that most areas were not shown to be present within the 100-year floodplain at which maximum benefits would be derived and the estimated Implementation costs would exceed the potential damages avoided.
6	Ponchatoula Creek	Screened Alternative Screened Measures: PC-2a and PC-2b. Additional modeling showed that most areas were not shown to be present within the 100-year floodplain at which maximum benefits would be derived and the estimated implementation costs would exceed the potential damages avoided.
7	Selsers Creek	Screened Alternative Screened Measures: SC-1, SC-4, SC-5, SC-10, SC-11. The remaining measures all had significant environmental impacts. Additional modeling also showed that these measures would prove to be ineffective and therefore the estimated implementation costs would exceed the potential damages avoid.
8	Skulls Creek-Tangipahoa River	Screened Alternative Screened Measures: SCTR-2, SCTR-9, SCTR-11, SCTR-14, SCTR-15, SCTR-16. Benefits for each of the measures were minimal and proven not to be cost-

Alt ID	Focused Array of Alternatives	Screening Notes
		effective. The estimated implementation costs would exceed the potential damages avoided.

The PDT further refined and assessed four remaining structural alternatives. Based on HEC-RAS model results, these remaining structural alternatives as part of the focused array showed to be hydraulically effective in flood risk reduction. One of these alternatives is located in an area of EJ concern. The PDT refined the previous analysis for these remaining alternatives using P&G evaluation criteria, conducting an Abbreviated Risk Assessment (ARA), and developing refined construction quantities and associated construction costs for analysis of the benefit-cost-ratios for the following remaining structural alternatives.

During this analysis, the nomenclature of the alternatives were updated and described below.

Final Screening of the Focused Array:

Alternative 3: Washley Creek / Robert Levee (WASH 2.2): H&H modeling indicated that the alternative would be considered effective for flood reduction at the 1% AEP flood event, however, was not considered cost effective. The estimated total project cost was $204M, which did not include additional costs, such as interest during construction, O&M, or mitigation for induced flooding of structures. If these costs were included, it would further lessen the estimated Benefit-cost ratio (BCR) of approximately 0.5. Therefore, these two alternatives were screened and not carried forward into the final array. In addition, WASH 3 was determined to have significant environmental impacts. This Alternative was previously described as Alternative 15.

Alternative 4: Beaver Creek / Tangipahoa River / Village of Tangipahoa Levee (SPTR 1a & 1b): This alternative consists of a levee and pump station along the north and east sides of the Village of Tangipahoa near Beaver Creek. The Village of Tangipahoa is considered an EJ community. Further evaluation was completed related to life safety and social vulnerability. In addition, the H&H modeling indicated that the proposed alternative would be effective for flood reduction at the 1% AEP flood event. The total cost was estimated at $14.17M with an estimated project supported cost is approximately $5M and an estimated EAD of $180,000. The alternative was screened due to cost ineffectiveness. This Alternative was previously described above as Alternative 13.

Alternative 5: Bedico Creek Roadway Elevation and Alternative 6: Little Chappepeela / Cooper Creek Roadway Elevation (BED 5): These alternatives were developed to address the risk of life safety during flooding of roadways. The team conducted an analysis of direct and indirect life risk on roads using HEC Life Sim threshold. While there were areas identified that exceeded low clearance thresholds, it was determined that there are reasonably short, safe alternate routes that may be taken if these roadways are impassible and ensuring that no communities were cut off during a flood. While the roadways may be

dangerous, the presence of alternative routes for evacuation and access to emergency services means the risk to life safety is minimal and may be mitigated by temporary actions, such as roadblocks. This Alternative was previously described above as Alternative 4. See Section 3 for more description on Life Safety Assessment.

Alternatives 7a & 7b: Snagging and Clearing of a portion of the Tangipahoa River with and without a portion of Chappepeela Creek (SNG 1 / SNG 3): It was determined that the proposed actions would reduce water surface elevations (WSE), however further analysis showed that the reduction in stages for most structures were minor (hundredths of a foot). Total estimated cost for Alternative 7a is $15,98M and Alternative 7b is $27.88M. These costs did not include additional costs, such as long-term O&M, mitigation costs, etc. Snagging and clearing is not considered cost effective for Alt 7a and Alt 7b, with BCR of 0.4 and 0.3, respectively. This Alternative was previously described as Alternative 16.

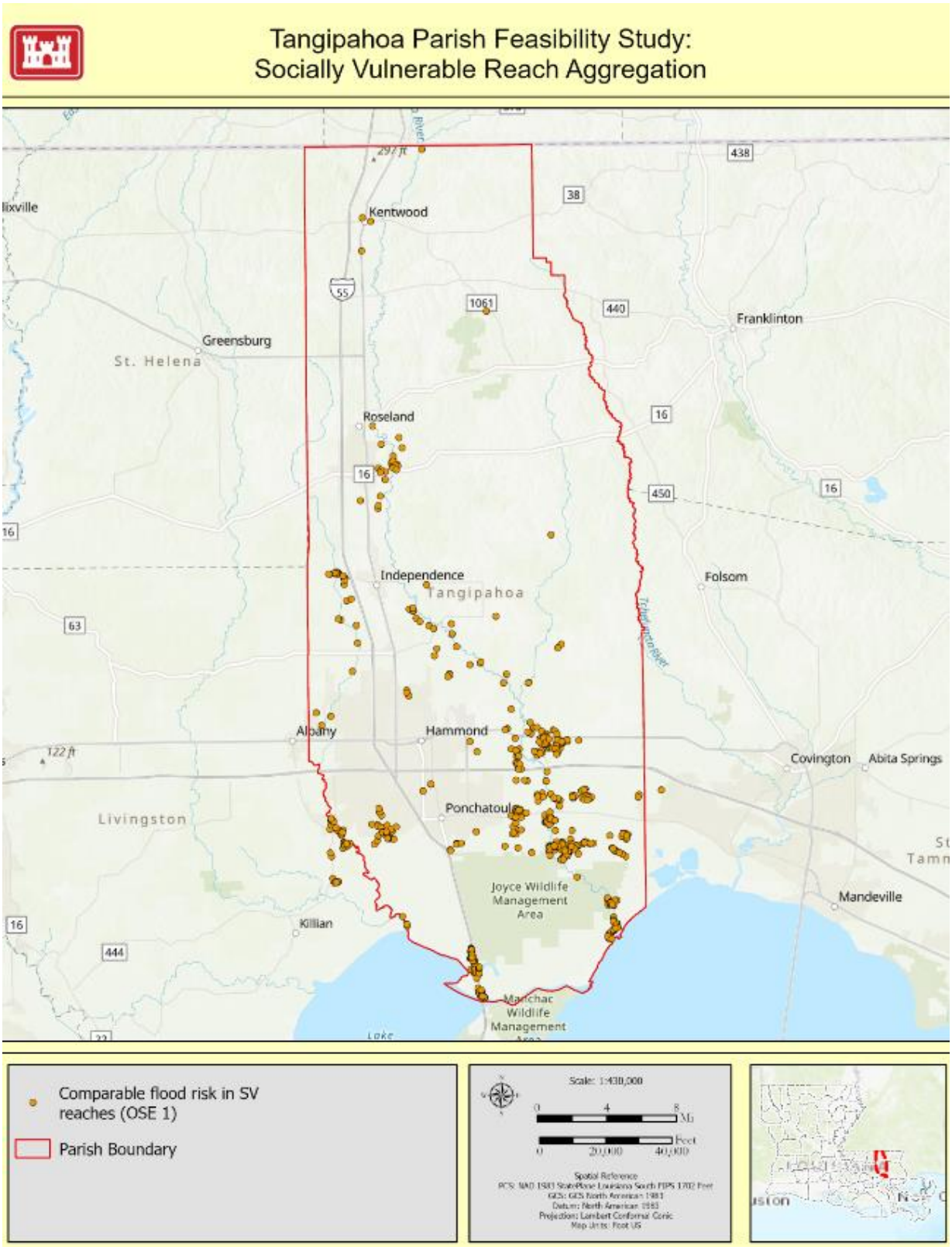

Figure E: 2-1. Socially Vulnerable Reach Aggregation

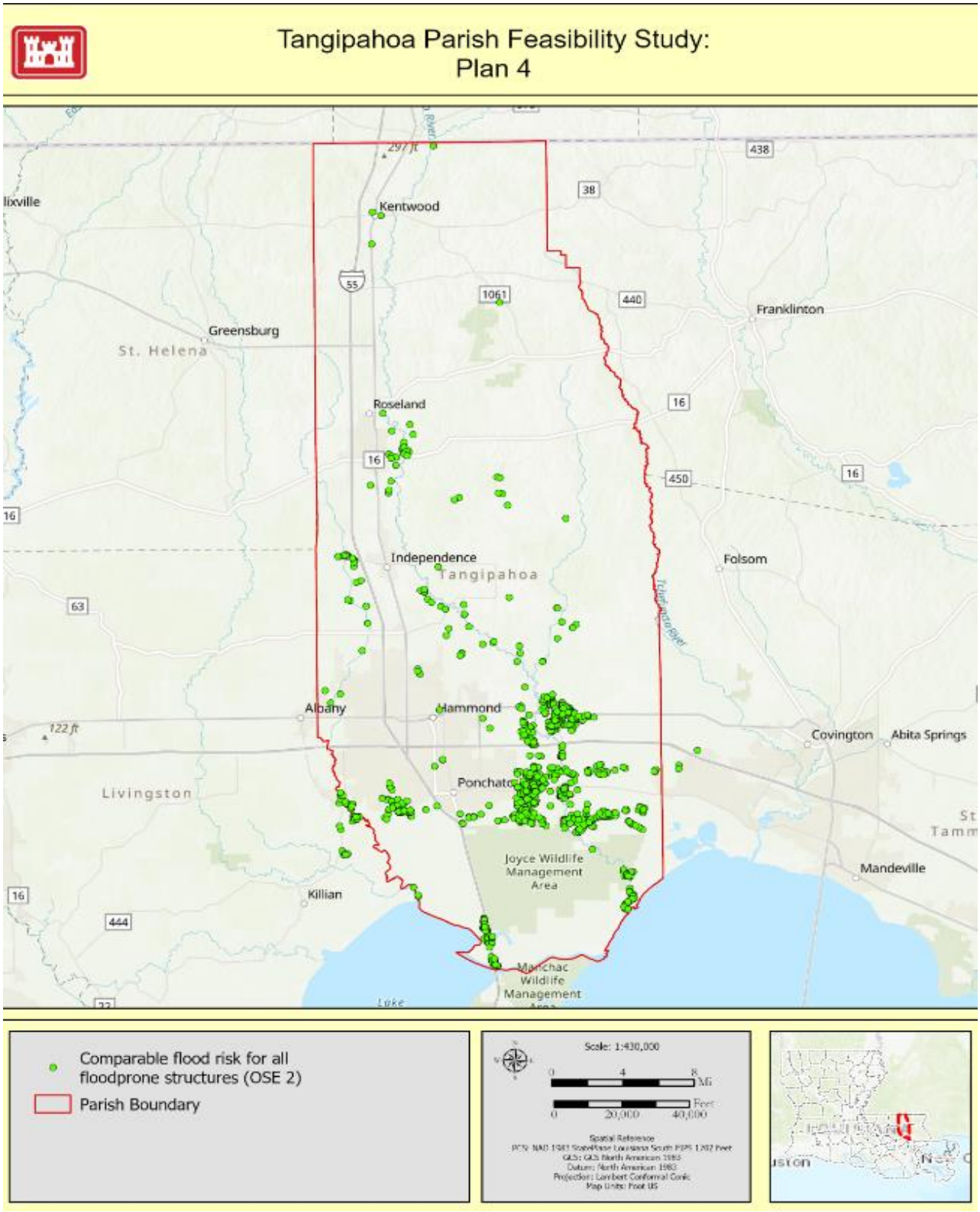

Figure E: 2-2. Plan 4

2.5 NONSTRUCTURAL PLAN DEVELOPMENT AND EVALUATION

As described in the DFIR/DEA, all structural alternatives were eliminated from further consideration, leaving only nonstructural alternatives for reducing flood risk across the study area. The PDT reconsidered the single nonstructural plan in the focused array and developed additional nonstructural alternatives for evaluation resulting in the Final Array of Alternatives, including the No Action Plan.

For more detail on nonstructural plan development, see Appendix G: Economic and Social Consideration

2.5.1 Nonstructural Aggregation

Benefits from nonstructural measures were estimated using procedures similar to those used in calculating benefits from structural measures (Sec 219 of WRDA 1999). All nonstructural plans employed the USACE “logical aggregation method” which according to USACE Planning Bulleting (PB) 2019-03, nonstructural analyses are to be conducted using the method. Rather than the individual structure, selected groups of structures are aggregated and become the unit of analysis and each such group is a separable element that must be incrementally justified.

The study area was initially divided into 100 reaches with each of the structure points functioning as a station. These settings were used to calculate flood damages using version 1.4.3 of the HEC-FDA certified model. Five reaches were removed from non-structural action consideration as they were outside of the study area. Those areas were kept in the modelling to show the residual risk in those areas. Figure E: 2-3 shows the study are reach boundaries.

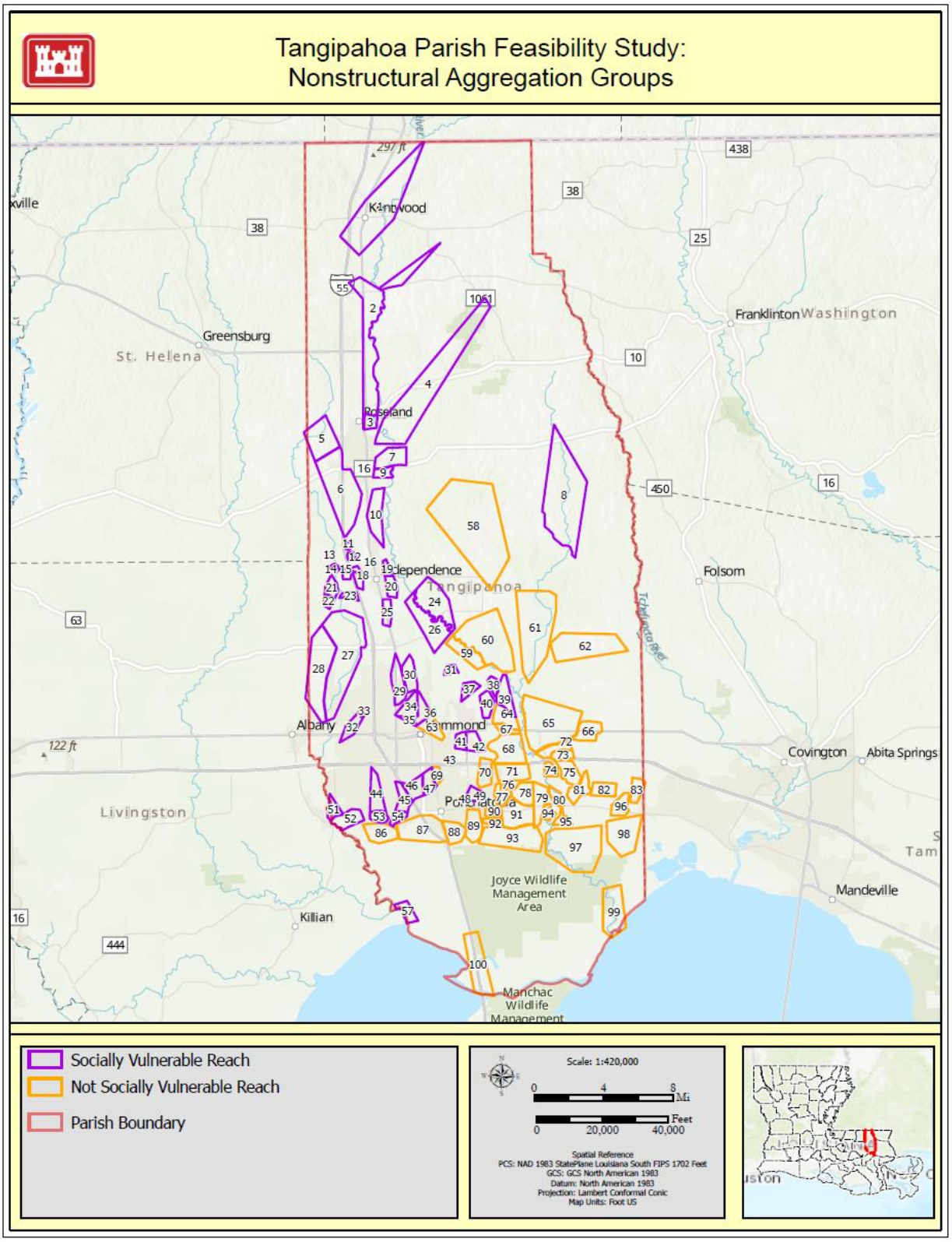

Figure E: 2-3: Nonstructural Aggregation Areas/Reaches

Upon further evaluation it was determined that some of our reaches, which we also used for our nonstructural aggregation areas were delineated too finely. As a result, the PDT reevaluated the reaches by combining them based on community cohesion while still maintaining an emphasis on keeping hydrologically dissimilar areas separate. The result is that the FDA model uses the initial reaches, and we aggregated results and analyzed them on the basis of the new aggregation groupings which are shown below in Figure 2-4.

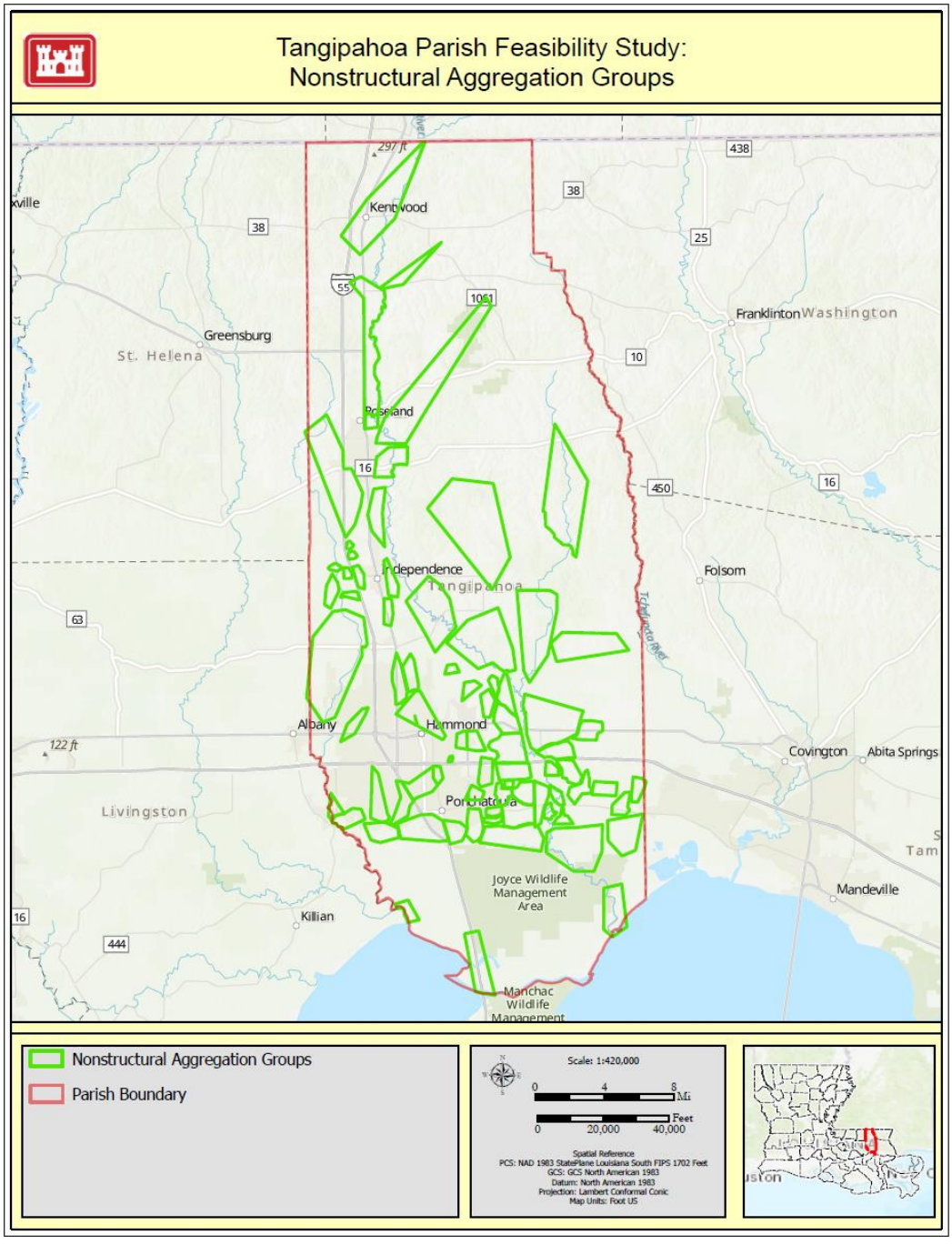

Figure E: 2-4. Refined Nonstructural Aggregation Areas

2.5.2 Nonstructural Plan Formulation

The categories of potential types of nonstructural management measures were evaluated to assist in identifying a broad range of plans during the plan formulation process. The general evaluation provided information regarding the types of actions that could be used to address planning objectives while avoiding constraints. A nonstructural assessment was completed to evaluate the effectiveness of implementing physical nonstructural measures, including structure elevations for residential structures, dry floodproofing for nonresidential structures, and property acquisitions and nonphysical measures, such as flood warning systems and evacuation plans. For evaluation purposes, the nonphysical measures, which consists of flood warning systems/evacuation plans were screened in the evaluation since there are no economic benefits that can be derived, but these measures are intended to reduce incremental risk at low cost. Regardless of the recommended plan chosen, the residual risk with the plan in place, along with the potential consequences, will be communicated to the NFS to become a requirement of any communication and evacuation plan.

The following nonstructural measures and criteria were evaluated:

- Elevation of residential structures: Structures are elevated to a level predicted to 2033, 1% AEP BFE + 2' to a maximum of 13 feet above ground level. Modular homes were included in the assessment A structure elevation height sensitivity analysis was completed on BFE, BFE + 1' and BFE + 2' to determine which height maximized net NED benefits. BFE + 2' was determined to have the highest net NED benefits. This analysis was done using predicted 2033 H&H data. An analysis using 2083 H&H data will be conducted post-TSP. Modular homes are included in plans.

- Dry Floodproofing of non-residential structures: Non-residential structures that receive flood depths not greater than 3 feet above the adjacent ground.

It is to be noted that additional analysis will be conducted post TSP that may include increments of elevation heights, the potential for additional nonstructural measures, such as wet floodproofing.

An inventory of residential and nonresidential structures was developed using the NSI 2022 data for the study area. Section 3.4.1 describes the National Structure Inventory and the study area boundary. Nonstructural plan development in the final array relied on the comparison of the costs and benefits of floodplain aggregations on a reach level. Table 2-8 shows the total number of structures in the inventory by category which were within the 2083 H&H model extents as developed by the HEC-RAS model. There are approximately 50,000 total structures in the Parish, however only 4,631 are located within the largest inundation extent produced by HEC-RAS, the 0.2% AEP event. As a result, only those structures which lie within the largest inundation extent were included in modeling.

Table E: 2-8: Number of Structures by Category

Residential	Commercial	Industrial	Public	Total Structures
4,381	179	48	23	4,631

2.5.3 Nonstructural Plan Development and Screening

Maximize Economic Benefits: A Nonstructural plan was developed to maximize economic benefits, which is Plan 1.

Consideration of total net benefits:
Initial approach:
Plan 2 and Plan 4: Initially, The PDT expanded upon the NED plan to develop two plans utilizing aggregated groups based on include additional structures with comparable flood hazard risk but with less structure value, which were generally located in socially vulnerable aggregated groups. Formulated based on average flood depths to the average in the subaggregation. A “lower bound” was established by using average depth of 0.5’ above FFE in the aggregate. (0.4-0.6’ were examined in GIS to determine if included). An upper bound was established by examining the comparable flooding up to 2% AEP (NED plan max benefit). Evaluation was completed on 10%, 4%, 2%, and 1% AEP flood events.

- Plan 2: Plan 1 + comparable flood risk in SV reaches - Include structures in Plan 1 and include floodprone socially vulnerable (SVI 2020 0.9 percentile) areas up to the 2% AEP (50 Yr). Included 691 total structures and 144 SV structures. (Obj 1,2,4, & 5). Included socially vulnerable reaches with an average depth of flooding of half a foot or greater at the 2% AEP (Obj. 4 & 5).

- Plan 4: Plan 1 + comparable flood hazard for all reaches: Includes structures in Plan 2 and all (SV & non-SV) flood prone structures up to 2% AEP (50 Yr) (Obj. 4 & 5) Included all reaches with an average depth of flooding of half a foot or greater at the 2% AEP (Obj. 4 & 5). (Reaches)

Refined approach:
Plans 3a, 3b, 3c:
Aggregation groups were refined into 62 groupings which allowed the team to develop alternatives using a “community cohesion approach, CDC SVI classifications, and similar flood risk, i.e. source of flooding.” Three additional alternatives were incrementally developed These plans include the same as the NED Plan and incrementally expanded to be inclusive of structures in areas which may not maximize or even have positive net NED benefits but nonetheless experience similar or greater levels of flooding at different frequencies. Each aggregation group increment was evaluated based on social vulnerability, flood hazard depth and frequency, community cohesion, critical infrastructure, and incremental net NED benefits. As such, each incremental structure included

experiences frequent flood hazards which are enough to disrupt the day-to-day life of the people living and working in said structures.

The CDC's Social Vulnerability Index (SVI) uses the American Community Survey (BOC) to quantify a community's ability to respond and cope with a hazardous event. Within the overall SVI, there are four subthemes that are incorporated, which include Socioeconomic Status, Household Characteristics, Racial & Ethnic Minority Status, and Housing Type & Transportation. To identify areas experiencing social vulnerability, a 90th percentile threshold was initially applied across the four themes, in addition to the overall vulnerability. However, with the release of the CDC's 2022 SVI information, communities have been grouped into quartiles which delineate social vulnerability into Low (0-0.25 percentile), Low-Medium (0.25 to 0.50), Medium-High (0.5 to 0.75), and High (0.75-1). For the purposes of this study, we considered a community to be experiencing social vulnerability if its SVI percentile fell into the Medium-High or High categories. Additionally, when reevaluating our reaches into aggregation areas, we made note of social vulnerability but did not separate out segments of a community which hit the Medium-High or High SVI thresholds. The reasoning for this is that evaluating flood risk and flood hazard on a community-wide basis was determined to be more appropriate than specifically highlighting and evaluating socially vulnerable portions of the study area on their own.

Acquisition / Buyout:
A nonstructural alternative plan (Plan 5) evaluated acquisition and relocation for all structures located in the 10% AEP aggregated floodplain and a targeted, smaller scale approach focused on areas of significant and frequent flooding. Buyouts and acquisitions were assessed by evaluating frequency and magnitude of depth of flooding. Nonstructural Plan 5 included structures located in FEMA designated floodway, received flood depths equal to or greater than 4'-5' at the FFE, and in clusters to avoid negative impacts associated with community cohesion. In total, there are 82 structures in the 10% AEP with greater than 4' inundation above the FFE. Specifically, 23 structures in the 10% AEP with greater than 5 feet of inundation above the FFE and 59 structures in the 10% AEP with greater than 4 feet of inundation above the FFE.

In this alternative, the costs of acquisitions, with relocation assistance to displaced persons, were compared with the expected annual damages reduced by the demolition of structures from the floodplain. A detailed assessment was completed that included an economic analysis to assess the cost of acquisition and relocation of structures. The estimate of the cost of acquiring structures was computed once model execution was completed. Acquisition costs are based on the cost of acquiring the parcel of land, the structure(s) built on the land, an architectural survey, and miscellaneous costs associated with the acquisition process. The depreciated replacement value of the structure (excluding any contents) was used to represent the cost of the structure, which was described as being sourced from RS Means 2024 square foot cost data. The cost of performing an architecturally survey is

required to identify potential cultural resources concerns with demolition of historic structures. Finally, the cost of demolition, deed changes, legal fees, and re-grading the surface were estimated and included as miscellaneous costs. These miscellaneous costs associated with acquisition were sourced from the 2024 USACE Amite River and Tributaries East of the Mississippi River, Louisiana Feasibility Report. Acquisition costs by structure were summed to yield an estimate of total structure cost.

Relocation costs were based on the cost of relocating a tenant residential occupant, as required per Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (URA), that has been removed from the acquired parcel. Relocation costs include purchasing a suitably located piece of property commensurate with the acquired parcel and the costs associated with the URA. Costs associated with URA include assisting the occupant with moving costs and incidentals for residential structures and moving costs, searching expenses, and re-establishing costs for non-residential structures. The URA costs amount to $200,000 on average per structure. Relocation costs by structure were summed to yield an estimate of total structure relocation cost. The total acquisition and relocation costs were added together and applied on a per structure basis to estimate a cost of acquisition and relocation. The costs for relocation/acquisition do not include estimated land value.

The evaluation of acquisitions at the 10% AEP proved inefficient, therefore, the PDT reevaluated and attempted targeted acquisitions. The PDT evaluated geographic areas that were clustered together with similar flood characteristics. None of the targeted acquisitions proved viable. This was partially due to most of the area often receiving damages resulting from widespread, low-level flooding. These targeted acquisitions would have resulted in a “Swiss cheese” approach that would have acquired one property on a street, but not others. Additionally, the total footprint of acquired structures would not have been sizable enough to have sufficient recreational or environmental benefits.

For the analysis of the nonstructural alternative as a standalone alternative, acquisitions were not carried forward to the final array because the cost of the alternative exceeded the damages reduced (benefits). Logical groupings were evaluated to prevent singular buyouts or resulting in the buyout of several additional parcels that would not contribute to the planning objectives. In the targeted buyout areas, the costs would increase due to acquiring more parcels, where other nonstructural measures would be both viable and more cost-effective options.

2.6 SUMMARY OF SCREENING

For evaluation purposes, the cost of elevating and flood proofing was used to determine the cost of the nonstructural plans since the study area is most often receiving damages resulting from widespread, low-level flooding; raising and floodproofing were determined to be more

cost effective than other nonstructural measures such as buyouts or relocations when assessing on a grouping of aggregations. Plans 2 and 4 were screened to better assess total net benefits from an incremental approach and aggregation was refined. Additionally, the buyout and relocation plan of floodprone areas (Plan 5) was screened because it provided limited risk reduction benefits and would leave communities disconnected without substantial beneficial reuse of the floodplain established.

Plan 1 (NED plan) and Plans 3a, 3b, 3c were carried forward to the final array.

2.7 FINAL ARRAY OF ALTERNATIVES

Four nonstructural plans have been carried forward to the final array; they include elevating residential structures and floodproofing non-residential structures. Elevating residential structures for the plans in the final array relied on a target elevation of the projected 2033 1% AEP stage plus two feet, not to exceed 13 feet and floodproofing non-residential structures up to 3 feet using dry floodproofing strategies. The PDT will reevaluate the proposed elevation heights using projected the 2083 1% AEP stage.

Plan 0: No Action Plan

The “No Action” Alternative is developed using existing conditions and forecasting data used to define the future without-project (FWOP) condition. The future without-project condition is the default baseline to which all other alternatives are compared. The without-project condition is the same as the NEPA “no action” condition and it assumes that no action would be taken to address the problem.

Plan 1: Nonstructural NED Plan Identification

Eligibility for nonstructural measures in Plan 1 relied on the optimization of the floodplain aggregations in Figure E: 2-x: Refined Nonstructural Aggregation Areas. For each reach, the floodplain aggregation that received the highest net NED benefits, when compared to the annualized cost, was selected for inclusion in the plan. Table E: 2-9 displays the number of structures eligible for nonstructural measures. Plan 1 consists of the floodproofing or elevation of 597 structures. Of the total aggregation areas, 27 aggregation areas were optimized at the 0.1% AEP floodplain, 3 aggregation areas were optimized at the 0.04% AEP floodplain, and 2 were optimized at the 0.02% AEP floodplain.

Plan 3a: NED + Increment 1: 10% AEP Flood Frequency Comprehensive Increment

Plan 3a includes the same structures as the NED Plan but was incrementally expanded to be inclusive of structures in areas which may not maximize or even have positive net NED benefits but nonetheless experience similar or greater levels of flooding at the 10% AEP than those included in the NED plan. Each aggregation group increment was evaluated based on social vulnerability, flood hazard depth and frequency, community cohesion, critical infrastructure, and incremental net NED benefits. As such, each incremental structure included experiences frequent flood hazards which are enough to disrupt the day-to-day life of the people living and working in said structures. This plan would provide a meaningful

benefit to eligible community members experiencing social vulnerability via decreased recovery time and their related expenditures, as well as increased safety of their home, and decreased flood insurance premiums from hazard mitigation. Plan 3a includes floodproofing or elevating 675 structures.

Plans 3b: NED + Increment 2: 4% AEP Flood Frequency Comprehensive Increment

Plan 3b is the total net benefits plan. Plan 3b includes the same structures as the Plan 3a but was incrementally expanded to be inclusive of structures in areas which may not maximize or even have positive net NED benefits but nonetheless experience similar or greater levels of flooding at the 4% AEP than those in the NED plan. In some cases, Plan 3b included structures in the 2% AEP event as long as there were compelling comprehensive benefits reasons to do so. Similarly, some areas were included at the 10% AEP floodplain where there were not comprehensive benefits reasons to include a larger area Each aggregation group increment was evaluated based on social vulnerability, flood hazard depth and frequency, community cohesion, critical infrastructure, and incremental net NED benefits. That being said, a balance between incremental net benefits, flood hazard and frequency, as well as social vulnerability, and community cohesion was sought while still ensuring that critical infrastructure was included. The result of this analysis was that on average, structures in socially vulnerable communities were included if the incremental net NED benefits were in excess of (more positive than) -$5,000 annually per structure. The team did not pick this number, but rather this is the result of weighing incremental net NED benefits against various other social effects benefits as well as flood hazard and frequency on an incremental basis. Plan 3b would include elevating 1006 residential structures and floodproofing 82 nonresidential structures.

Plan 3c: NED + Increment 3: 2% AEP Flood Frequency Comprehensive Increment

Plan 3c continues to build upon the previous increments. All of the previous benefits are still present and the extra benefits beyond the previous increment are focused on increased other social effects benefits and a wider floodplain. Plan 3c is the most inclusive plan, allowing for more aggregation areas to have a level of inclusion at the 2% AEP floodplain than any of the previous plans while still being constrained by total comprehensive benefits and similar or greater levels of flooding as the NED Plan. That is to say, we did not include areas at the 2% AEP which didn't at minimum have similar depths of flooding to comparable NED justified areas at the 2% AEP. In developing plans, this plan was determined to have the highest benefits in the other social effects category given that it provides the most benefits for socially vulnerable communities and improves community resiliency and cohesion more than the previous plans. However, it has the lowest net NED benefits of the four plans in the final array while still providing more NED benefits than costs. Plan 3c would include elevating1147 residential structures and floodproofing 87 nonresidential structures.

Table E: 2-9. Structures Eligible for Nonstructural Measures by Plan

Plans in Final Array	Elevate	Floodproof	Total Structures
Plan 1 (NED)	539	58	597
Plan 3a	616	59	675
Plan 3b	1006	82	1088
Plan 3c	1147	87	1234

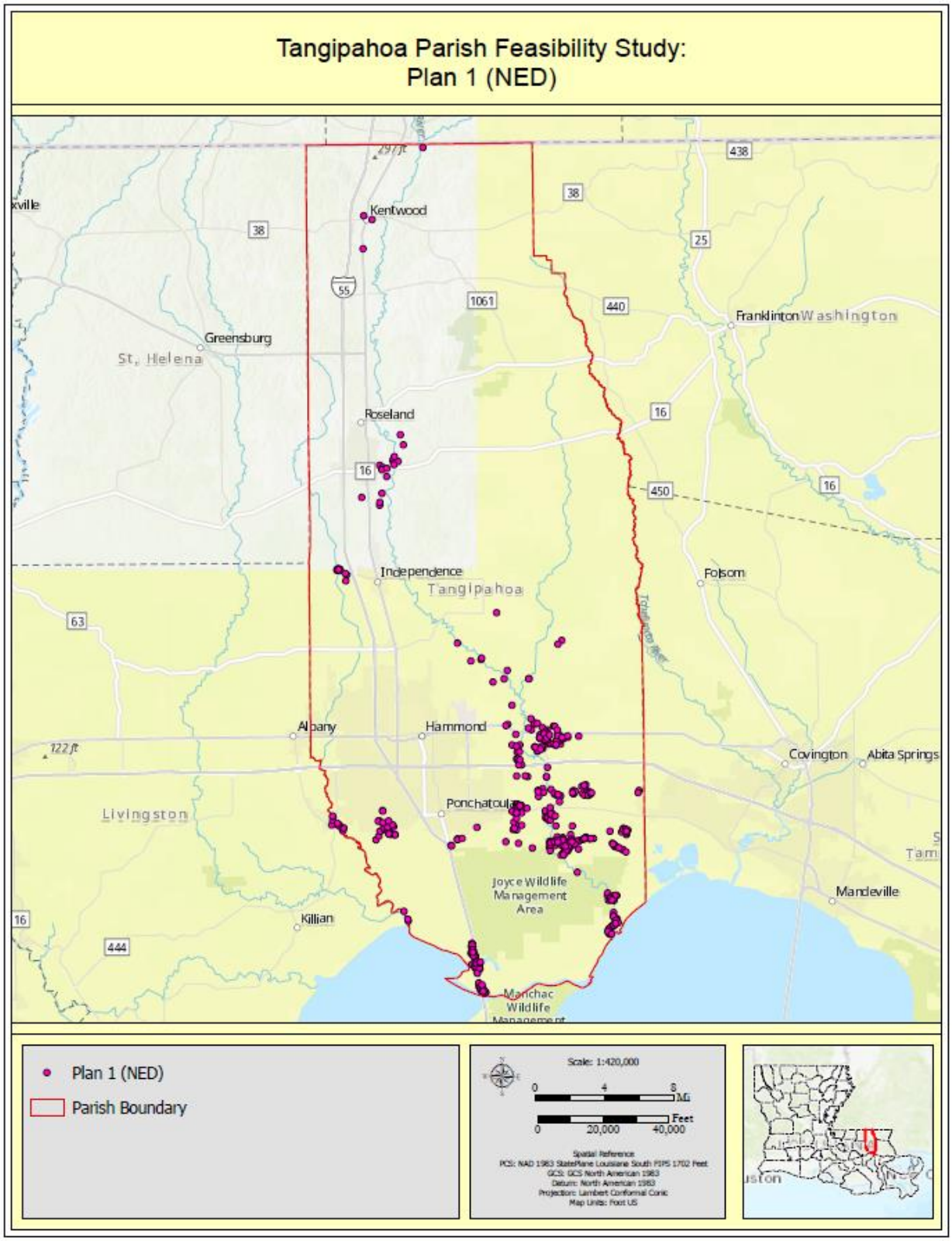

Figure E: 2-5. Nonstructural NED Plan (Plan 1)

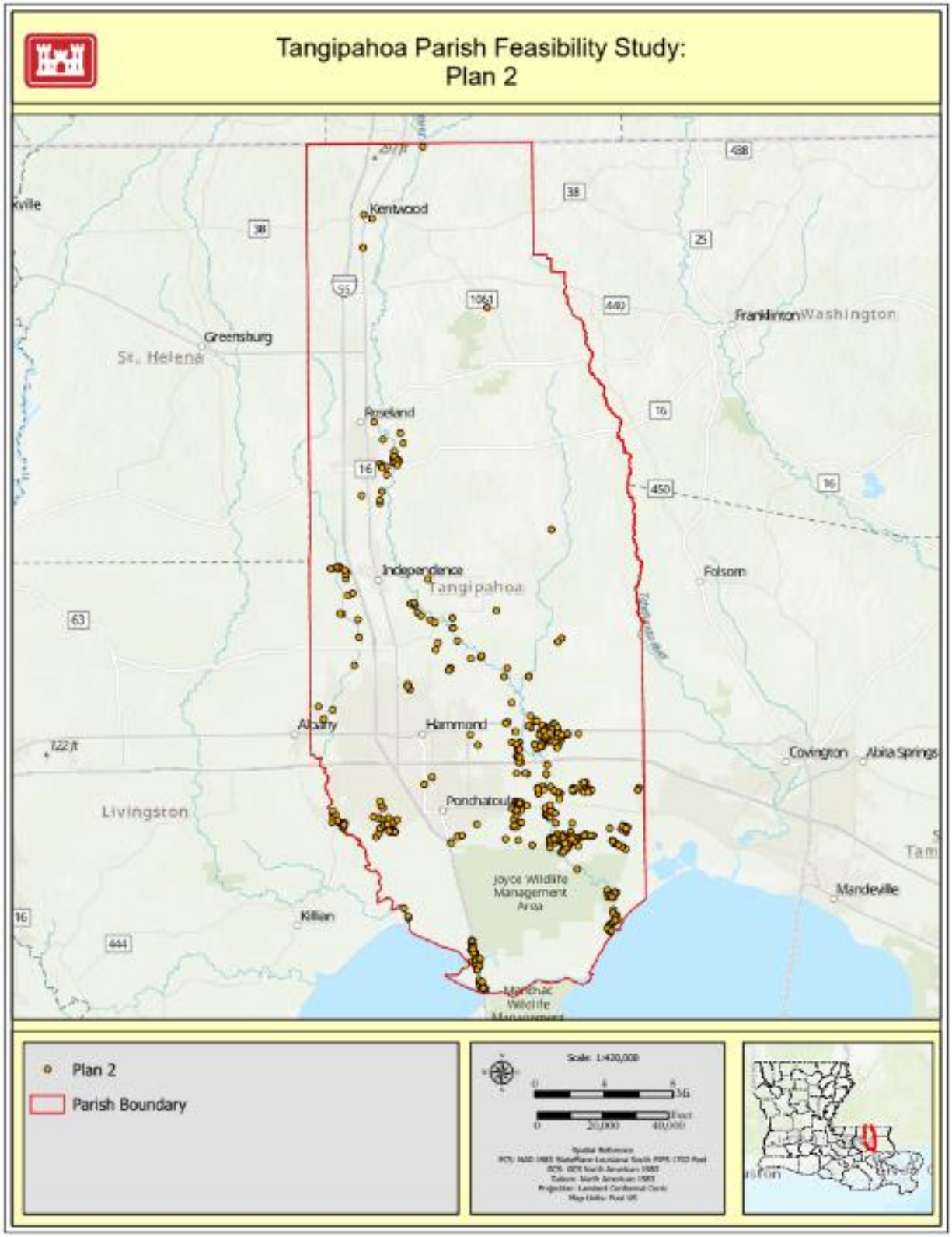

Figure E: 2-6. Nonstructural Plan 2

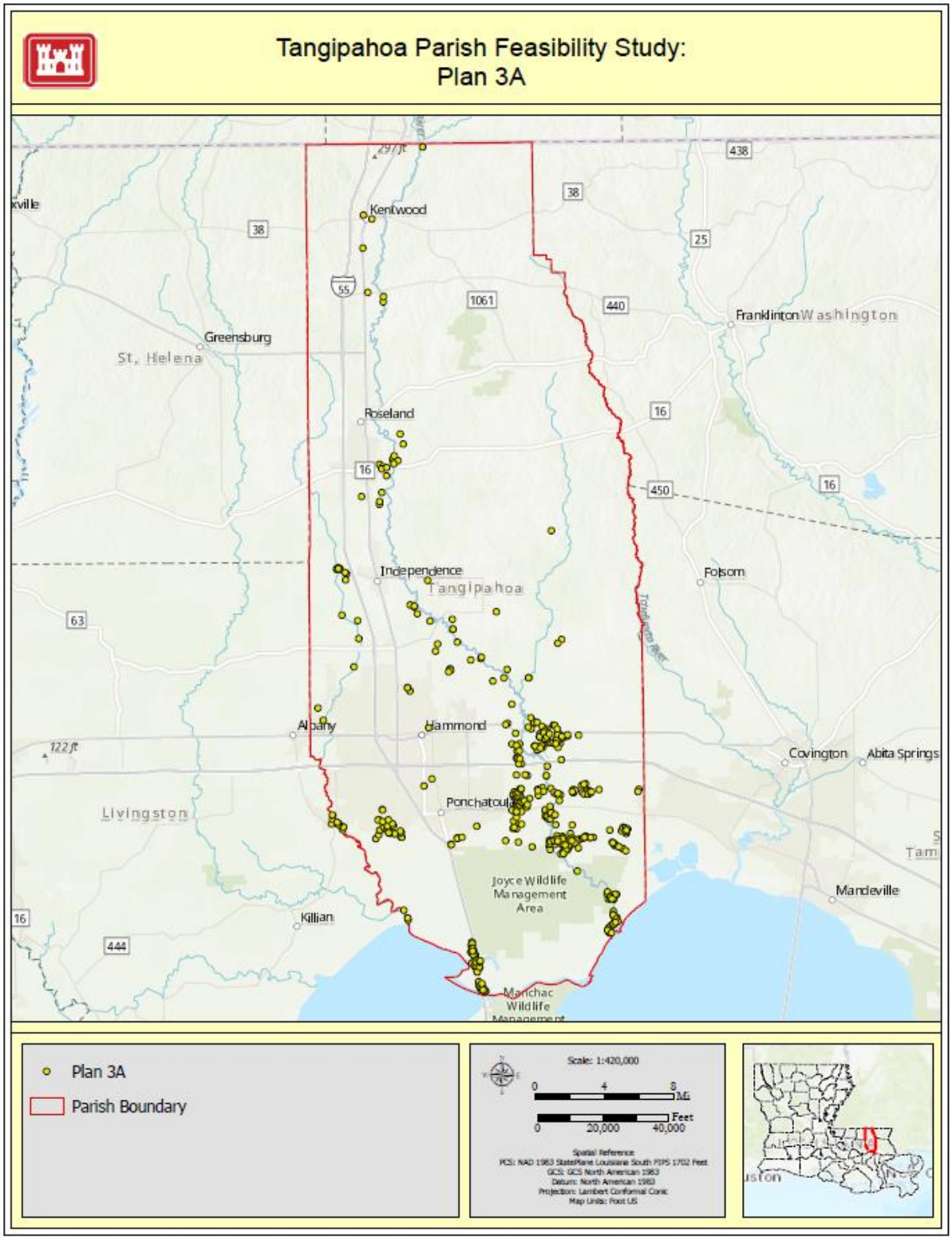

Figure E: 2-7. Nonstructural Plan 3a

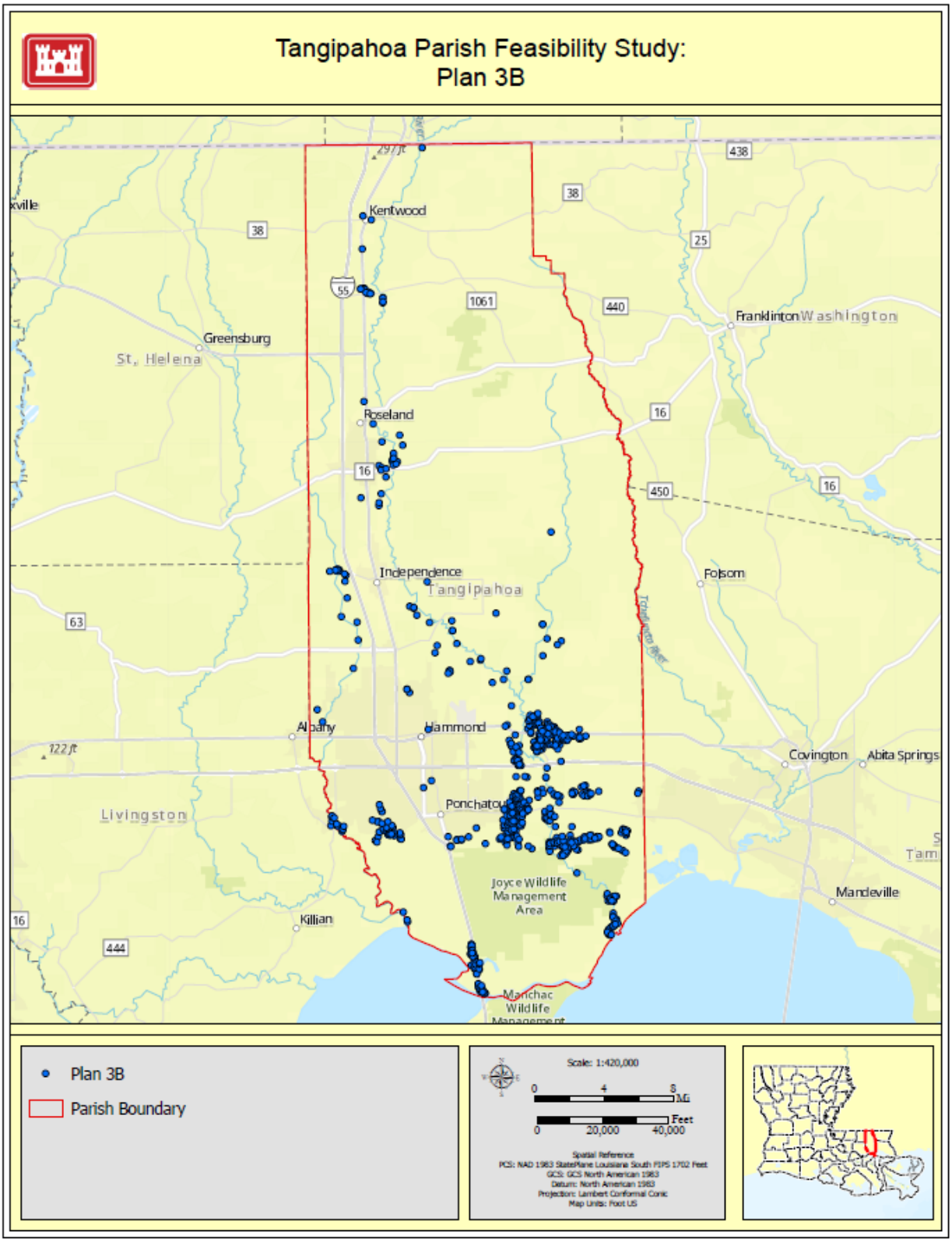

Figure E: 2-8. Nonstructural Plan 3b

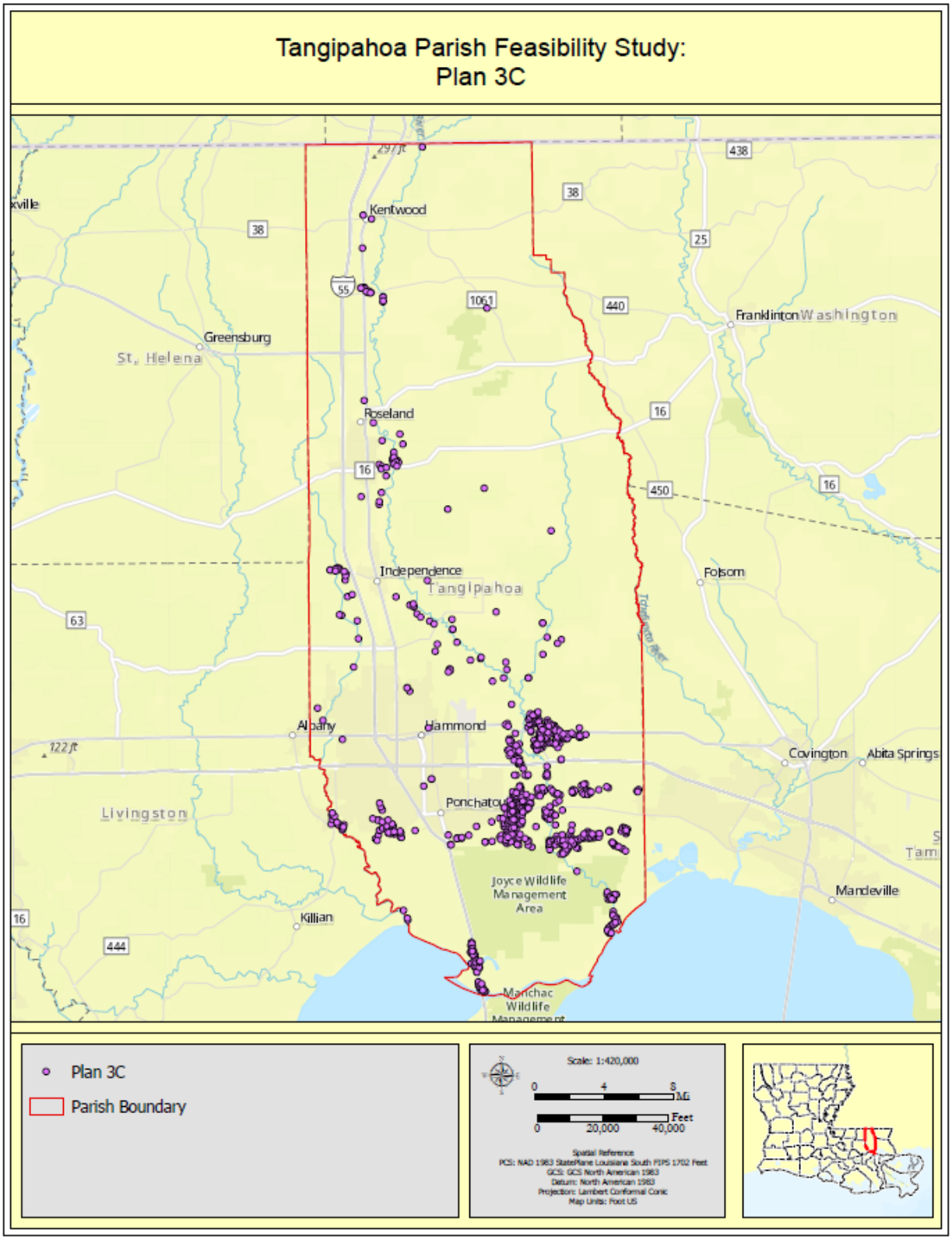

Figure E: 2-9. Nonstructural Plan 3c

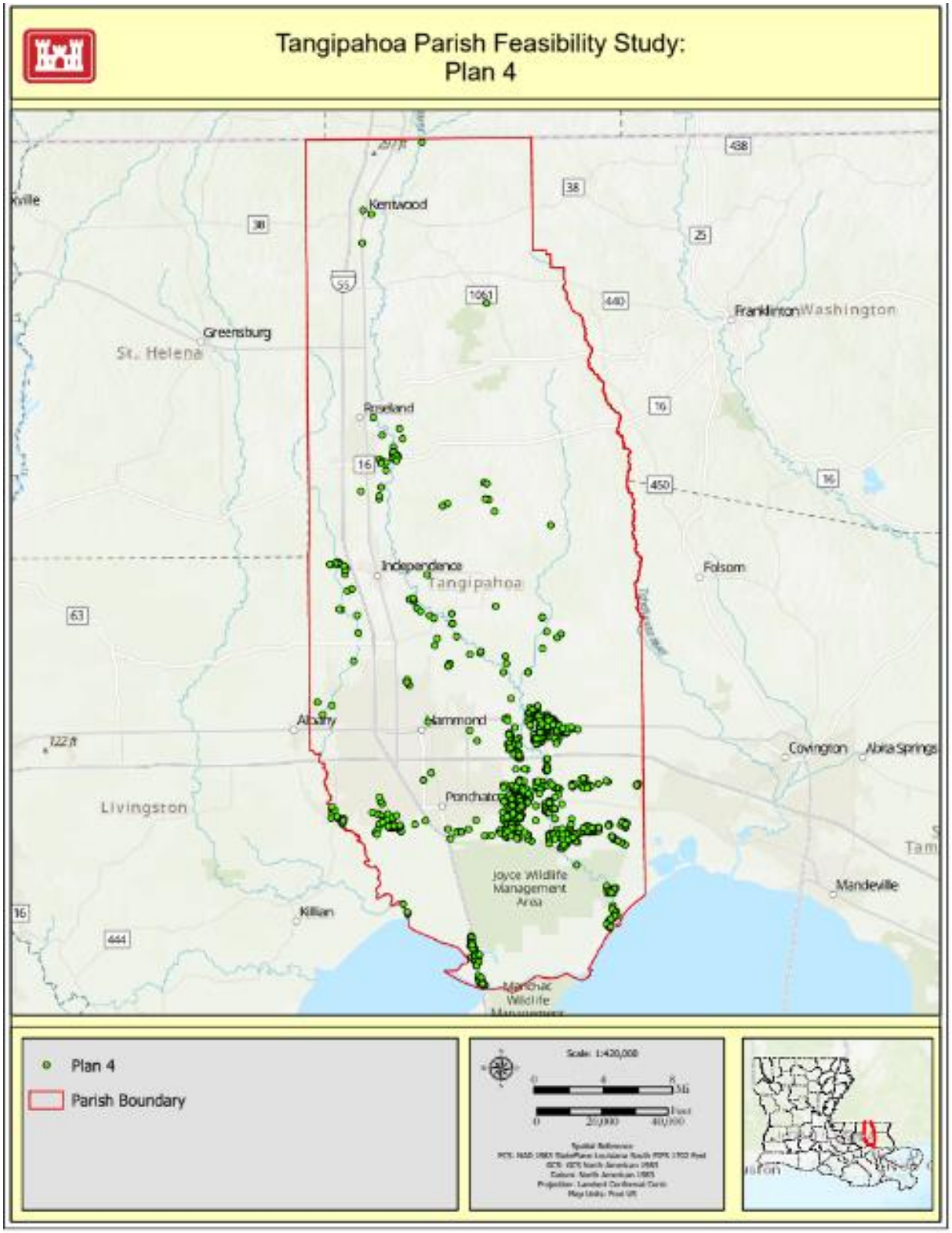

Figure E: 2-10. Nonstructural Plan 4

SECTION 3
List of Acronyms and Abbreviations

DIFR/EA	Draft Integrated Feasibility Report and Environmental Assessment
ER	Engineer Regulation
PDT	Project Delivery Team
FRM	Flood Risk Management
FWOP	Future Without Project
NEPA	National Environmental Policy Act
USACE	United States Army Corps of Engineers
CPRAB	Coastal Protection and Restoration Authority Board of Louisiana
NFS	Non-Federal Sponsor
HEC-FDA	Hydrologic Engineering Center – Flood Damage Reduction Analysis
HEC-RAS	Hydrologic Engineering Center – River Analysis System
ADCIRC	Advanced Circulation Model
TSP	Tentatively Selected Plan
HUC	Hydrologic Unit Code
FEMA	Federal Emergency Management Agency
E.O.	Executive Order
AEP	Annual Exceedance Probability
T&E	Threatened and Endangered
HTRW	Hazardous, Toxic, and Radioactive Waste
CSRM	Coastal Storm Risk Management
FPMS	Flood Plain Management Services
SJ	Silver Jackets
PAS	Planning Assistance to States
USGS	United States Geological Survey
WRDA	Water Resources Development Act
CEMVS	St. Louis District
LIDAR	Light Detection and Ranging
NNBF	Natural and Nature based features

OMRR&R	Operation, Maintenance, Repair, Replacement and Rehabilitation
ROM	Rough Order of Magnitude
WSE	Water Surface Elevation
EAD	Expected Annual Damages
EJ	Environmental Justice
FFE	First Floor Elevation
URA	Uniform Relocation Assistance and Real Property Acquisition Act
NED	National Economic Development
OSE	Other Social Effects
SVI/SOVI	Social Vulnerability Index
CDC	Centers for Disease Control and Prevention