WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

ENGINEERING
APPENDIX B

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General

The Study area is located west of the Bonnet Carre Spillway between the Mississippi River and Lakes Pontchartrain and Maurepas in Southeast Louisiana. The project's purpose is to provide hurricane and storm damage risk reduction to developed areas of St. Charles, St. John the Baptist and St. James Parishes. Three structural levee alignments (Levee Alignments A, C and D) were evaluated (each with several features, including levees, floodwalls, floodgates and pumping stations) in order to select the best approach to reduce hurricane/tropical storm surge

(hereafter “storm surge”) in communities throughout the study area. Each alternative also evaluated environmental measures designed to protect and/or minimize the impacts to nearby wetlands and transportation evacuation routes (such as I-10 and U.S. 61) located in the study area. More information on the alternatives that were considered can be found in the **Screening Phase (Background) Information** section of this Appendix.

Information provided herein describes the details of the Levee System of the Recommended Plan (drawings of the alignment, known as Alignment C, can be found in Annex 3 of this Appendix). Details on the final design of the localized storm surge risk reduction system are incorporated into Chapter 5 of the main report and at the end of the Plan Formulation Appendix. The Recommended Plan is based on modeling for a 100-year level of risk reduction in the Baseline Year of 2020. This is also known as the base year and is part of a 50 year planning horizon that is generally used for U. S. Army Corps of Engineers (USACE) projects. The year 2020 was decided as the base year for economic and hydraulic conditions since it is possible that the proposed levee could be designed and constructed by then with sufficient funding and authorization.

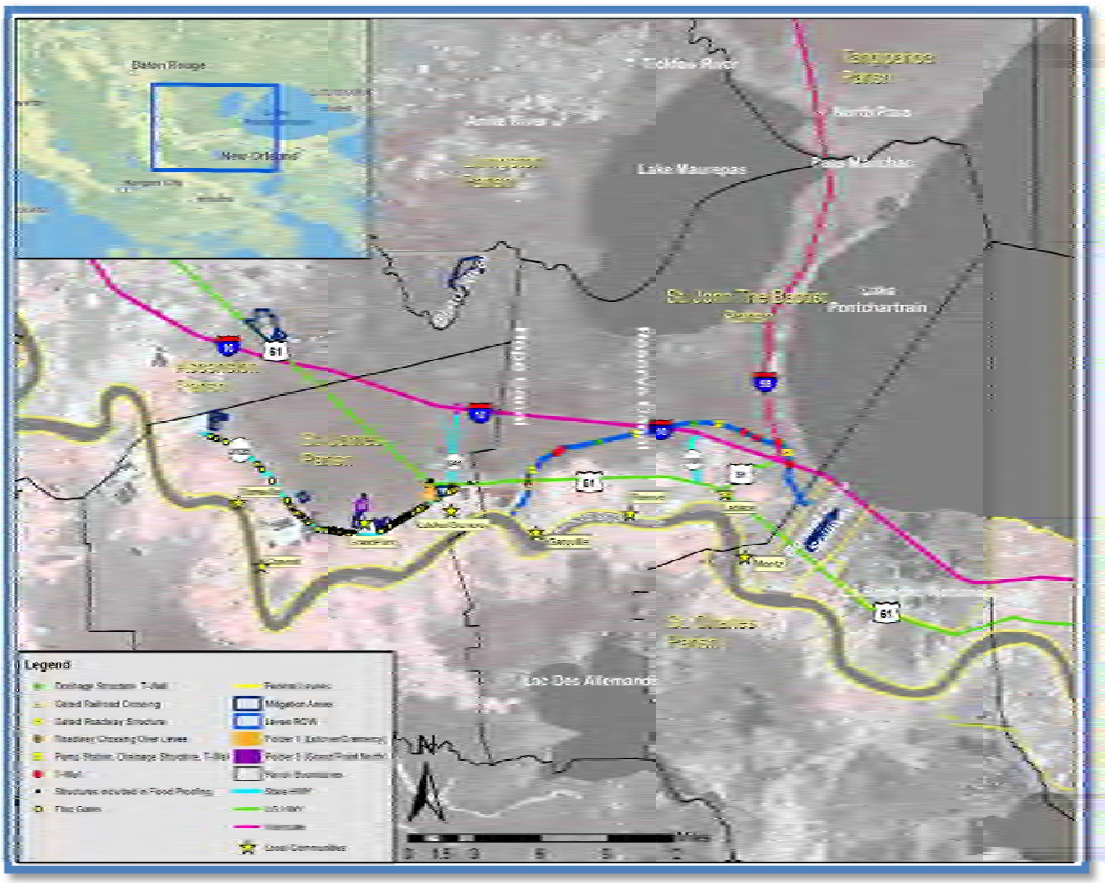


Figure 1: Overview of Risk Reduction System (Alignment C)

The Recommended Plan (known as Alignment C) for the West Shore-Lake Pontchartrain (WSLP) study includes the construction of an 18.27-mile (96,500 ft) levee system around the communities of Montz, LaPlace, Reserve and Garyville. This system also includes the construction of localized storm surge risk reduction measures in St. James Parish. An overview of the entire risk reduction system is shown in Figure 1.

Levee System

The levee system would begin at the upper guide levee of the Bonnet Carre Spillway, north of an underground utility pipeline right of way and US-61. The levee would head northwest paralleling the pipeline right of way and pass under I-10. Past I-10, the levee would enclose the I-10 and I-55 interchange and cross US-51. It would then track north of I-10 and a pipeline transmission corridor. Past the Belle Terre/I-10 exit, the levee would pass back under I-10 and parallel the pipeline corridor through wetlands until it crosses Hope Canal. The levee would then turn south; cross the pipeline transmission corridor and then extend to the Mississippi River Levee System (MRL)

The levee system would reduce the risk of flooding for over 7,000 structures and four miles of I-10 located in the system. Inclusion of this segment of I-10 could allow for an earlier re-entry route for residents and emergency responders in southeast Louisiana, including residents in the New Orleans metropolitan area.

The construction of the structural component of the project, hereafter referred to as the “levee system”, would be based on a 1% probability storm level of risk reduction and a 2020 intermediate RSLR condition. In order to maintain the 1% probability storm level of risk reduction system over the period of evaluation (50 years) the levee system would include future levee lifts based on the 2070 intermediate RSLR conditions. For example, at the starting point of the upper guide levee of the Bonnet Carre Spillway the levee would be constructed to a top of levee elevation of 15 ft. NAVD88 in 2020. In the future, the levee at this point would be lifted to a final elevation of 19.5 ft. NAVD88 based on the 2070 intermediate RSLR conditions. This is the highest elevation point of the constructed levee system. The levee would start at this height and taper down to a final top levee elevation of 8.5 ft. NAVD88 near the MRL. The final 2070 top levee elevation near the MRL would be 16 ft. NAVD88.

The system would consist of earthen levees, floodwalls (T-Walls), floodgates, drainage canals, a flood-side ditch for hydraulic connectivity for wetlands north and south of the system, drainage structures and pump stations along the alignment, and mitigation measures (Figure 5-2). Structures through the levee would be built to the 2070 intermediate RSLR condition, to prevent costly future retrofits required for anticipated changing sea levels.

Starting at the upper guide levee of the Bonnet Carre Spillway and heading west along the levee, the project would construct a 646 linear foot (hereafter “LF”) T-Wall to pass under the existing I-10 overpass. Past this point, an 1,100 cubic feet per second (cfs) pump station with three 68" outfalls would be built at Montz Canal, which is very near the I-55 northbound entrance ramp. The pump station, when the system is closed, would mainly remove rainwater flows from the Woodland, the River Forest and the Prescott Canals. A 267 LF T-Wall and two 6' x 18' x 27' gated drainage structures would also be constructed at this location. This location and all locations with pump stations or drainage structures would be connected to a flood side ditch and a protected side canal that would parallel the entire levee length. The canals would be used to maintain the existing connection between swamps located inside and outside of the levee system. The protected side canal would also serve as a redundancy connection if one of the pump stations failed during an event.

Past the Montz Canal, at the location of US-51, a 188 LF gated structure would be placed through the levee. Directly west of US-51, a 247 LF T-Wall would cross under I-55. The levee would continue to the west until the levee intercepts the first pipeline crossings near Vicknair Canal. Two sections of T-Walls would be used for these pipeline crossing, a 550 LF T-Wall, and a 623 LF T-Wall. Half of the 35 required pipeline relocations would be at these two locations. For purposes of this report, it is expected that all of the pipeline relocations would be

compensable. Relocations are expected to take place in the proposed levee right-of-way (ROW) or existing pipeline ROW. Determination of the compensability of these relocations will be determined during the engineering and design phase of this project if it is authorized.

Continuing west, the levee would then cross Ridgefield Canal. Ridgefield Canal is located between the I-10 Louisiana Department of Transportation and Development (LADOTD) weigh station and the I-10/LA 3188 exit. A 200 cfs pump station with three 30" outfalls would be built at Ridgefield Canal. The pump station, when the system is closed, would mainly remove rainfall flows from Laplace Plantation, Perriloux, Ridgefield, Tebo and Vicknair canals. A 244 LF T-Wall with two 6' x 18' x 267' gated drainage structures would also be constructed at this location.

West of the Ridgefield Canal, a 100 LF floodgate would be constructed at the location of the Perriloux Canal to allow rainfall flows to flow through the levee when the system is not closed.

West of the I-10/LA 3188 exit, a 247 LF T-Wall would be constructed to cross back under I-10. The levee would continue to parallel the pipeline corridor through wetlands until it reaches Reserve canal. A 400 cfs pump station with three 48" outfalls would be built at this location. The structures at this location would also include two 6' x 20' x 25' drainage structures with a boat bay and 335 LF of T-Walls. Small boats would still be able to pass through the drainage structure when the system is open.

Continuing west, the levee would then cross Mississippi Bayou. A 6' x 10' x 25' drainage structure with a 267 LF T-Wall would be constructed at this location.

The levee would then continue west toward Hope Canal, until it reaches the next major set of pipeline crossings. All of the remaining major pipeline relocations would be at this location. Two sections of T-Walls would be used for these pipeline crossings: a 400 LF T-Wall and a 300 LF T-Wall. As with the other pipelines, for purposes of this report, it is expected that the pipeline relocations would be compensable. Relocations are expected to take place in the proposed levee ROW or existing pipeline ROW at this location. Determination of the compensability of these relocations will be determined during the engineering and design phase of this project if it is authorized.

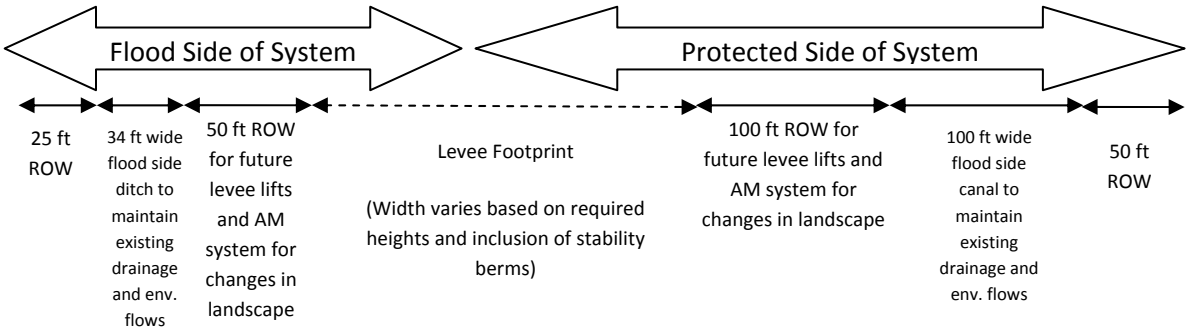
The levee would then continue west until it reaches Hope Canal. A 450 cfs pump station with three 54" outfalls would be constructed at this location. Currently, the design and cost includes a 6' x 20' x 25' drainage structure and a 247 LF T-Wall, but the Hope Canal location is also the same location of the State of Louisiana's proposed Mississippi Reintroduction into Maurepas Swamp diversion. The WSLP project has been coordinating activities between the project development teams, but for the purposes of the WSLP feasibility design, we do not consider the diversion project as a future landscape feature, since the State has not identified funding and has filed an incomplete permit application to USACE for construction of the project. USACE would continue to monitor the status of the diversion project. The team expects that if the diversion project moves forward it would be constructed on the flood side of the levee and would parallel the levee from Hope Canal to the MRL.

When the levee turns south, past Hope Canal to tie into the MRL, the levee would cross US-61, a pipeline ROW, and two railroad tracks. US-61 would be raised to hump over the levee at the crossing point. The pipeline crossing would include a 301 LF T-Wall, while the two railroad crossings would include a 150 LF gate structure and a 50 LF gate structure.

In all, there would be a total of 5,001 LF of T-Walls, 4 pump stations with associated drainage structures, 2 drainage structures, one gated road crossing, and 2 gated railroad crossings.

4.69 miles of the upper guide levee of the Bonnet Carre Spillway from the spillway control structure to the WSLP tie-in point would be included in the WSLP levee system, but there would be no construction activities associated with this Bonnet Carre levee. Existing levee heights are high enough to prevent 1% probability storm surge from entering the WSLP system during storms. The construction of the WSLP tie-in point would be to set to elevation of 15 ft. NAVD88 while the current upper guide levee elevation is 15.5 ft. NAVD88. The upper guide levee heights in the future would be monitored to determine if sections of the Bonnet Carre Spillway levee would need future lifts to prevent overtopping of storm surges into the WSLP system.

All levee right-of-ways would have the following typical dimensions:



The 50-ft. and 100-ft. rights-of-way adjacent to the levee footprints would be used for future levee lifts. The levee would be lifted five times over the period of evaluation. The first two lifts would be used to obtain a 1% probability storm level of risk reduction system in 2020. Additional levee lifts to maintain a 1% probability storm level of risk reduction system would take place in years 2030, 2045 and in 2060.

9,000,000 cubic yards (cy) of compacted fill and un-compacted fill would be required to create and maintain the levee over the period of evaluation. A portion of the initial fill material, if suitable, would be obtained from the canals and ditch, approximately 1,678,000 cy. Borings indicate that the top 4 ft of the cross section of these features would not be suitable as levee fill material. The top 4 ft of material; approximately 1,685,000 cy, would be used beneficially at mitigation plan sites, or disposed of appropriately by the contractor. The remaining fill for the levee, approximately 7,322,000 cy, would be obtained from the Bonnet Carre Spillway.

The levee footprint would vary based on the designed cross section and required top of levee heights by each levee section. The top of the levee would have a 10' wide crown and the protected side of the levee system would be based on a 1:3 side slope, with some reaches including a geotechnical stability berm. 3,400,000 square yards of geotextile fabric would be placed under the levee footprint and approximately 80,000 cubic yards of aggregate limestone would be used to build a road on the levee crown.

The total levee construction ROW would be 1,235 acres. Real Estate agreements would be acquired on all features. A perpetual flood protection levee easement would be acquired for the 669 acres of the levee and floodwall features. A perpetual flood protection levee easement would be acquired for the 33 acres of the T-Walls. For the two canals, a 519-acre perpetual drainage ditch easement would be acquired. For the remaining features, the 4 pump stations would require 9 acres and the 3 gated crossings would require 5 acres (to be acquired based on fee, excluding minerals). In addition to the permanent easements, 49 acres of temporary access easements and 12 acres of temporary work area easements would be acquired. These

temporary access and work access areas would be on existing roadways or developed areas of the project area and would not be in environmentally sensitive areas.

All of the impacts from the constructed features would be to either swamp habitats or Bottom Land Hardwood (BLH). There would be a direct removal of 1,112 acres of swamp habitats and 123 acres of BLH habitats. Using a wetland value assessment (WVA) under the intermediate sea level rise scenario the project would be required to mitigate for a direct loss of 595.3 average annual habitat units (AAHUs) of swamp and 95.5 AAHUs of BLH. In addition to the direct removal of acres of habitat due to construction, the project would enclose 8,432 acres of swamp and 89 acres of BLH.

Hydrologic connectivity would be maintained to the extent practicable through water control structures except during closure for hurricanes or tropical storms. When the system is closed, pumps would operate on average for 1.7 storms per year, which equates to a closure of structures on average 8.5 days per year. This expected rate of closure would be the same regardless of the actual rate of RSLR as closure of the system is tied to tropical storm events and the elevation trigger would be adjusted as sea level rises. The risk reduction system is only authorized to address storm surge caused by hurricane and tropical storm events. It is not authorized to mitigate for or reduce impacts caused by higher day-to-day water levels brought about by increases in sea level rise alone. Any operational changes implemented to address changing SLR conditions or for any other non-project-related purpose would be considered a separate project purpose requiring separate authorization, new NEPA documentation, and / or permit approvals.

The levee is designed to maintain hydrologic connectivity to the extent practicable. In order to minimize a reduction in efficiency of drainage affecting water quality and increased impoundment on the protected side of the system, the levee design includes drainage structures and canals located on both the flood side and protected side of the levee. In order to mitigate for any impacts caused by the potential delay in water movement, the team developed a WVA that accounts for delays in water movement. Because 366 acres of the total 455 acres of enclosed BLH is already impacted by existing roadways and railroad tracks, the BLH indirect impacts were calculated to total 89 acres. Using a WVA under the intermediate RSLR scenario, the project would have to mitigate for the indirect loss of 494.5 AAHUs of swamp and 3.1 AAHUs of BLH. The project would also be required to mitigate for a direct loss of 595.3 AAHUs of swamp and 95.5 AAHUs of BLH. The total required mitigation for both the direct and indirect impacts from the construction of the risk reduction levee system is 1,188.03 AAHUs.

Localized Storm Surge Risk Reduction Measures

The Recommended Plan includes localized storm surge risk reduction measures for structures in the communities of Gramercy, Lutcher and Grand Point, which are located outside of the proposed levee system (Figure 5-2). These localized storm surge risk reduction measures focused on addressing existing damages in St. James Parish, while still being economically justified and environmentally compliant. See Chapter 3.9 and Appendix E for information concerning plan formulation and design of the localized storm surge risk reduction measures. These measures include berms and flapgates on existing drainage and roadway features. Floodproofing measures (e.g., raising of certain residential structures and construction of smaller berms around certain individual non-residential structures) are limited to a few structures located outside of the larger localized storm surge risk reduction measures. All of the measures focus on providing a risk reduction above the 1% probability storm stages in Year 2020. The Non-Federal Sponsor (NFS) will be required to maintain these features to their initially-constructed design height for as long as the project remains authorized. The future level of risk reduction is dependent on the actual rate of RSLR.

Gramercy Area

In the Gramercy and Lutcher area, north of LA Hwy. 3125, a 10,100 LF berm would be built to provide risk reduction to 275 structures, herein referred to as "**Polder 1 (Gramercy Berm)**." The berm would be constructed to a 6.5' NAVD88 elevation. The berm in Year 2020 would provide risk reduction above the 1% probability storm stages. Storm stages in St. James Parish are below +6.5' NAVD88 elevation in Year 2020. As discussed in Chapter 3, in the future, the berm's effectiveness depends on the actual rate of RSLR.

The berm would parallel both sides of LA Hwy. 20, and parallel the railroad track along US-61 (Airline Highway). To the south, the berm would tie into LA Hwy. 3125 to close off the system. LA Hwy. 3125 is key feature for all of the localized storm surge risk reduction features. The entire roadway is above 6.5' NAVD88 elevation and will be used as a tie-in point for the berm. The design of the berm is based on a 4' wide crown and 3:1 side slopes. Using local Light Detection and Ranging (LiDAR) data, it was assumed that the existing ground elevation under the berm would be at an elevation of approximately 4.3' NAVD88. Using this assumption, the proposed berm would have an average height of 2.2' with an average width of 18', and require 237,000 cy of compacted fill for construction. The berm would also include two floodgates to allow existing drainage to flow through the berm when not under surge events. A pump system to operate and remove rainwater during tropical / hurricane storm events will be included in the features. The pump system will be approximately 217 cfs. The berm would be placed in a location so as not to interfere with existing local drainage.

In reviewing the berm footprint, there is a risk of affecting approximately 0.29 acres of forested wetlands. Attempts would be made to avoid these areas during construction. Due to the current uncertainty in avoiding these areas, we have included costs for mitigating for these forested wetlands in the total construction cost.

Grand Point Area

In the Grand Point area, north of LA Hwy. 3125, the Recommended Plan includes one berm, "**Polder3 (Grand Point North**)". Polder3 (Grand Point North) would provide risk reduction to 71 structures. The berm would be a complete ring around the structures in the northern portion of Grand Point, near the Grand Point Boat Launch. The berm would be 10,400 LF, and would include a 4' wide crown and 3:1 side slopes. The berm would be constructed to a 6.5' NAVD88 elevation. Initially, in Year 2020, the berm would provide risk reduction above the 1% probability storm stages. Storm stages in St. James Parish are below a 6.5' NAVD88 elevation in Year 2020. Future level of risk reduction is dependent on the actual rate of RSLR.

Using local LiDAR data, it was assumed that the existing ground elevation under the berm would be approximately 4' NAVD88. Using this assumption, the proposed berm would have an average height of 2.5' with an average width of 20', and require 286,800 cy of compacted fill for construction. The berm would also include one floodgate to allow existing drainage to flow through the berm when not under surge events. A pump system to operate and remove rain water during tropical / hurricane storm events will be included in the features. The pump system will be approximately 140 cfs. The berm would be placed in a location so as not to interfere with existing local drainage. The berm would also be placed very near the edge of the property owners' parcels where feasible. This would minimize the loss of use of any property.

In reviewing the berm footprint, there is a risk of affecting approximately 0.81 acres of forested wetlands. Attempts would be made to avoid these areas during construction. Due to the

current uncertainty in avoiding these areas, we have included costs for mitigating for these forested wetlands in the total construction cost.

Flood Risk Reduction Under LA Highway 3125

In addition to the berms north of LA Hwy. 3125, the Recommended Plan is to use 13 miles of LA Hwy. 3125 and its existing foundation as a localized storm surge risk reduction feature. Currently, the roadway elevation is above 6.5' NAVD88 in elevation. At present, the 1% probability storm stages in Year 2020 flow through the culverts under the roadway in the opposite direction from natural drainage. By closing off the culverts with one-way flap gates and a drainage canal with a floodgate during surge events, the plan would provide risk reduction to 19,500 acres and 4,295 structures south of LA Hwy. 3125. Although there are a limited number of structures that are impacted by the 1% probability storm stages, this closure reduces the risk of a large portion of the Parish's critical sugarcane crops from flooding from this type of storm surge event. If the Parish in the future makes improvements to LA Hwy. 3125, any additional height added to the entire highway could add to the structures risk reduction level behind the highway. Due to the fact that the roadway is being used as a flood risk reduction feature, the local sponsor will be required to maintain the system's initial level of risk reduction. This includes the berm tie-in points to the roadway and 13 miles of the roadway itself. If the roadway requires maintenance and would be degraded below its original elevation, the work should take place outside of hurricane season. If it is not possible to work outside of hurricane season, interim flood risk measures should be implemented to maintain the original level of risk reduction provided by the roadway.

The Recommended Plan includes 145 flap gate closures, two floodgates and two small berms (Noranda and Uncle Sam). The Noranda berm ties the highway into high ground east of Gramercy. The Uncle Sam berm divides the developed area behind LA Hwy. 3125 from an area that is primarily agricultural land. By dividing these two areas, the local community can focus its reduction efforts in the future. Future improvements could be focused on sections of the highway that have structures behind the highway, approximately 7 miles vs. 13 miles. The area west of the Uncle Sam berm includes an area of 8,175 acres, but only includes one structure that has a first floor elevation below the 1% probability storm stages. The total length of the berms is approximately 645 LF.

Due to the nature of the flooding south of LA Hwy. 3125, it is assumed that the 19,500 acres would have ample storage capacity to hold any rainfall during the surge events. Even if some acres of crops are flooded from rainfall, it would be much less severe than if storm surge was allowed to flow under LA Hwy. 3125.

Remaining Structures in St. James Parish

Eighty structures were evaluated outside of the economically-justified and unjustified berms. Only 23 of the 80 structures have a first floor elevation below the 1% probability storm stages in Year 2020. Based on this evaluation, the Recommended Plan includes 14 residential structures that would be raised to the stage associated with the Year 2070 intermediate RSLR 1% probability storm stages; 4 non-residential structures would be floodproofed to 3 feet above the ground elevation; and smaller berms would be constructed for 5 light industrial/warehouse facilities. The 14 residential structures are being raised to the Year 2070 height because it is more cost effective to raise a home once.

The incremental first cost for the levee system in the Recommended Plan is $676,598,000. The incremental first cost for the localized storm surge risk reduction system in the Recommended Plan is $41,493,000. The total first cost for the Recommended Plan is $718,091,000.

Hydraulics and Hydrology

Interior Modeling Methodology (Without-Project and With-Project - Alignment C)

Hydrology

General. The hydrologic model was developed utilizing HEC-HMS 3.5. Rainfall runoff hydrographs were generated throughout the system for synthetic rain events. Synthetic flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 1-, 5-, 10-, 25-, 50-, 100-, 200- and 500-year (recurrence interval) have been selected as having special significance for floodplain management. As an example, the 10-year and 100-year floods have a 10 percent and 1 percent chance of occurring and of being equaled or exceeded during any year, respectively. Rainfall totals for these frequency events were derived from the NOAA Atlas 14 Precipitation Frequency Data Server (PFDS).

Drainage Basin Area Delineation. The drainage basin areas were directly taken from the ADvanced CIRCulation (ADCIRC) model. ADCIRC is a system of computer programs for solving time-dependent, free-surface circulation and transport problems in two and three dimensions. These programs utilize the finite element method in space allowing the use of highly flexible, unstructured grids. In areas where newer models were available, the ADCIRC basins were supplemented with newer and more relevant basin delineation. Those particular areas were in St. John the Baptist Parish. The basin areas from that model were overlaid and merged with the original ADCIRC basins.

Basin Parameter Determination. For each of the drainage areas delineated within the watersheds, estimates were made of the homogeneous surface characteristics and soil properties needed to characterize the runoff potential. These data define the individual characteristics of each of the drainage areas as direct input parameters for the hydrologic model.

Each sub-basin (storage area) requires an entry of seven pieces of data, or hydrologic parameters, in order to compute a hydrograph: the name of the sub-basin; the sub-basin size, the initial loss rate, the percent of the sub-basin that is impervious; the Soil Conservation Service (SCS) curve number (CN); the lag time and the base flow in cubic feet per second.. The model is made up of several sub-basin elements, each containing these seven pieces of data, and an outflow channel system that can carry the runoff downstream where it may combine with other runoff to generate a flood wave in the watercourse.

Soil Type and Land Use. The SCS curve number is related to soil type, land use and antecedent moisture conditions. More information about the background and use in the SCS curve number method can be found at USDA Natural Resource Conservation Service (NRCS). The curve number is a non-dimensional value that ranges between 1 and 100 that the SCS method uses to represent the potential for surface runoff from a watershed. Higher CN values indicate higher potential runoff, corresponding with a lower amount of rainfall “losses”. The major factors that determine CN are the hydrologic soil group, cover type, treatment, hydrologic condition and antecedent runoff condition.

The curve numbers listed in Appendix A of the HEC-HMS Technical Reference Manual for every land use type are sub-classified into different hydrologic soil groups. SCS soil maps were downloaded from the web site http://soildatamart.nrcs.usda.gov and clipped with the watershed borders in GIS. Two different hydrologic soil types are found in the modeled watersheds (C &

D).

The digitized land use shape file was intersected with the soil shape file using ArcGIS, resulting in 22 different CN surface types: 11 land use types, each with two different hydrologic soil types. In the attribute table, the area of every sub-element was calculated using the area formula in the field calculator. These areas were then tabulated in ArcGIS, using the watershed sub-basin name as row theme and the surface types as columns. The resulting table was exported to Microsoft Excel, where the corresponding CNs were assigned to every soil-land use category.

Initial Losses. Initial losses were computed using the SCS loss rate method. In this method, 20% of the maximum retention is taken to be the initial abstraction or "initial loss in inches". Runoff losses for the model were determined by the SCS CN method. The equation is as follows:

$$I_a = 0.2 * (\frac{1000}{CN} - 10)$$

Lag Time Calculations. Some sub-basins are extremely low-lying, offering little change in slope and have large areas available for the storage of water. Modeling these areas utilizing mostly traditional hydrologic engineering methods could be inaccurate based on the fact that most methods do not compensate for such small slopes and such large areas available for storage. Sub-basins were modeled in HEC-HMS utilizing the SCS unit hydrograph procedure. The SCS method can be used for urban areas that are less than 2,000 acres or 3.1 sq. mi. Lag Time calculations were computed for each sub-basin using the SCS lag time equation which includes the slope of the sub-basin, the length of travel and the SCS curve number. The Lag Time calculation equation used is as follows:

$$T_L = L^{0.8} * \frac{(S+1)^{0.7}}{(1900 * y^{0.5})}$$

Where:

T_L= Sub-basin Lag Time (hr)

L = Hydraulic Length (ft)

S = (1000/CN) – 10

CN = Sub-basin Average Curve Number

y = Average Sub-basin Land Slope (%)

Flow path lengths were measured from the farthest point in the sub-basin to the lowest point in the sub-basin. These paths were determined by visual inspection of the Light Detection and Ranging (LiDAR) imagery. Using ArcGIS Spatial Analyst Slope feature, a slope grid was produced from the LiDAR imagery. The grid is the slope of a particular pixel in relation to its eight neighboring pixels. The average sub-basin land slope of each sub-basin was calculated using Zonal Statistics from Spatial Analyst Tools. After calculating the necessary input data, the data was entered into the SCS Lag Time equation for each sub-basin. Next, the Lag Time was

then entered into the appropriate sub-basin in HEC-HMS. HEC-HMS was run and rainfall runoff hydrographs were computed for each sub-basin. Then, the rainfall runoff hydrographs were entered as input to the HEC-RAS hydraulic model.

Table 1 lists the parameters described above used in the existing conditions hydrologic model.

Storage	Lag (min)	Area (Sq Mi)	CN	Impervious (%)	Initial (in)
SA 1	79.07	0.739	81.78	13.81	0.446
SA 10	109.61	1.230	82.43	15.76	0.426
SA 11	55.47	0.401	89.44	78.92	0.236
SA 12	108.97	1.669	80.59	18.49	0.482
SA 13	70.18	0.696	82.17	12.72	0.434
SA 14	84.86	1.181	83.36	4.45	0.399
SA 15	104.20	0.756	80.88	30.63	0.473
SA 16	78.88	0.562	77.05	9.10	0.596
SA 17	74.48	1.017	75.81	1.07	0.638
SA 18	56.13	0.150	77.35	6.77	0.586
SA 19	85.94	0.532	81.08	8.55	0.467
SA 2	124.66	1.519	80.66	18.30	0.479
SA 20	63.46	0.183	79.50	6.77	0.516
SA 21	138.33	1.122	81.81	26.05	0.445
SA 22	50.64	0.487	81.42	6.93	0.456
SA 23	57.82	0.480	81.56	32.69	0.452
SA 24	63.83	0.504	78.16	25.96	0.559
SA 25	36.27	0.243	76.94	6.04	0.599
SA 26	69.25	1.190	80.42	3.98	0.487
SA 27	77.24	0.929	81.06	5.78	0.467
SA 28X	37.89	0.461	82.16	7.28	0.434
SA 28Y	55.94	0.309	81.72	3.95	0.447
SA 29	86.07	0.921	81.52	12.92	0.453
SA 29C	120.99	0.571	82.83	3.64	0.415
SA 3	37.62	0.503	84.63	42.58	0.363
SA 30	63.53	0.701	80.98	35.08	0.470
SA 30C	61.66	0.297	81.42	3.83	0.457
SA 31	93.81	1.823	81.02	29.86	0.469
SA 31C	35.27	0.153	82.23	7.87	0.432
SA 32	116.31	1.342	78.94	31.48	0.534
SA 33	111.25	0.801	78.80	32.40	0.538
SA 34	62.32	0.839	79.41	34.82	0.519
SA 35	87.93	0.460	78.59	27.91	0.545
SA 36	89.92	0.690	77.57	20.23	0.578
SA 37	150.33	1.346	78.77	2.88	0.539
SA 38	59.33	0.404	78.63	30.99	0.544
SA 39	79.40	0.595	77.26	11.42	0.589
SA 39C	97.01	0.949	76.04	0.66	0.630
SA 4	64.38	0.859	81.94	28.75	0.441
SA 40P	277.53	8.502	81.94	0.74	0.441
SA 41	119.15	0.347	76.54	17.51	0.613
SA 41P	203.21	5.770	82.01	0.89	0.439
SA 42P	163.17	2.514	77.71	2.60	0.574
SA 43P	120.44	2.503	76.09	0.69	0.629
SA 44C	25.66	0.156	79.64	25.37	0.511

SA 5	78.19	1.105	83.53	22.72	0.394
SA 6	59.25	0.304	81.91	28.90	0.442
SA 7	48.51	0.508	78.86	21.18	0.536
SA 8	138.25	2.073	77.05	13.32	0.596
SA 9	65.84	0.785	79.61	4.22	0.512

Table 1: HEC-HMS parameters for Existing Conditions

Table 2 lists the parameters described above used in the with-project hydrologic model.

Storage Area	Lag Time (min)	Area (sq mi)	CN	Impervious (%)	Initial Abstraction (in)
SA 1	80.51	0.612	81.58	15.63	0.452
SA 10	109.56	1.230	82.47	15.04	0.425
SA 100	12.72	0.096	82.78	2.38	0.416
SA 101	59.64	0.541	76.77	4.76	0.605
SA 102	32.95	0.083	81.98	7.14	0.440
SA 11	55.64	0.401	89.44	79.80	0.236
SA 12	108.66	1.669	80.60	18.60	0.481
SA 13	70.24	0.696	82.20	13.23	0.433
SA 14	84.86	1.181	83.35	4.21	0.400
SA 15	104.33	0.756	80.87	30.76	0.473
SA 16	78.82	0.562	77.05	9.22	0.596
SA 17	74.44	1.017	75.80	1.06	0.639
SA 18	17.48	0.049	80.83	4.71	0.474
SA 19	85.78	0.532	81.08	8.41	0.467
SA 2	125.22	1.519	80.67	17.79	0.479
SA 20	62.99	0.183	79.50	7.52	0.516
SA 21	138.37	1.122	81.82	26.17	0.444
SA 22	50.63	0.487	81.42	6.83	0.456

SA 23	57.73	0.480	81.59	32.44	0.451
SA 24	63.24	0.504	78.14	24.13	0.560
SA 25	36.56	0.243	76.86	5.20	0.602
SA 26	69.54	1.190	80.42	3.70	0.487
SA 27	77.30	0.929	81.08	5.67	0.467
SA 28X	37.73	0.461	82.18	6.99	0.434
SA 28Y	56.51	0.309	81.72	4.08	0.447
SA 29	85.78	0.921	81.50	12.65	0.454
SA 29C	120.72	0.571	82.84	3.91	0.414
SA 3	37.22	0.503	84.62	42.44	0.363
SA 30	63.38	0.701	80.99	33.76	0.469
SA 30C	62.05	0.297	81.38	3.42	0.458
SA 31	94.23	1.823	81.00	30.00	0.469
SA 31C	35.32	0.153	82.23	5.67	0.432
SA 32	116.40	1.342	78.94	31.52	0.534
SA 33	110.80	0.801	78.78	33.27	0.539
SA 34	62.92	0.839	79.46	33.69	0.517
SA 35	88.29	0.460	78.61	28.45	0.544
SA 36	90.34	0.690	77.58	21.87	0.578
SA 37	150.02	1.346	78.78	2.95	0.539
SA 38	59.37	0.404	78.66	30.82	0.543
SA 39	79.16	0.595	77.30	12.89	0.587
SA 39C	97.03	0.949	76.04	0.59	0.630
SA 4	64.38	0.859	81.96	29.11	0.440
SA 40P	103.36	2.212	81.59	0.37	0.451
SA 41	119.20	0.347	76.54	17.47	0.613

SA 41P	155.34	4.550	81.99	0.48	0.439
SA 42P	161.39	2.397	77.79	3.00	0.571
SA 43P	118.85	2.362	75.99	0.77	0.632
SA 44C	25.66	0.156	79.65	26.03	0.511
SA 5	78.40	1.105	83.53	22.66	0.394
SA 6	59.78	0.304	81.97	28.63	0.440
SA 7	48.60	0.508	78.90	21.46	0.535
SA 8	138.66	2.073	77.06	13.76	0.595
SA 9	37.06	0.310	80.77	6.86	0.476

Table 2: HEC-HMS parameter for With-Project (Alignment C)

Reach Parameter Calculation. The model is tied together by a series of routing reaches and junctions where several flow paths join into one channel as the flood wave moves downstream. A reach represents a portion of the natural channel that carries the flood. The velocity of the water moving through the reach and the amount of channel storage available to the water determines the rate or speed of translation of the flood wave. The more storage that is available, the less speed of translation and the longer duration of flood effects that are observed. The model parameters can be selected to account for channel and overbank storage using several routing techniques that are options in the software. As the base flow is negligible in modeling large events, no base flow method was used.

Rainfall. Frequency-based synthetic rainfall (Table 3) was used for each sub-basin in the model. The rainfalls were taken from NOAA Atlas 14 Precipitation Frequency Data Server (PFDS). A 24-hour storm duration (total rain time) was chosen based on time of concentration and to remain consistent with other studies conducted by the U.S. Army Corps of Engineers.

Duration	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr	200 Yr	500 Yr
5 minutes	0.59	0.73	0.84	1.00	1.13	1.26	1.40	1.58
15 minutes	1.06	1.3	1.51	1.79	2.02	2.25	2.50	2.82
1 hour	2.14	2.68	3.16	3.84	4.40	4.98	5.59	6.43
2 hours	2.68	3.39	4.01	4.93	5.70	6.50	7.36	8.56
3 hours	3.03	3.84	4.58	5.70	6.64	7.65	8.75	10.3
6 hours	3.65	4.67	5.61	7.05	8.27	9.60	11.05	13.12

12 hours	4.34	5.57	6.69	8.39	9.83	11.38	13.06	15.46
24 hours	5.07	6.47	7.74	9.65	11.25	12.96	14.82	17.45

Table 3: Frequency-Based Synthetic Rainfall Distributions for St. John the Baptist Parish

Since HEC-HMS only has probability for the 50 percent to the 0.2 percent rainfall, the SCS storm (NRCS) total rainfall depth was used for the 1-year rainfall event. The total depth for the 1-year rainfall according to NOAA Atlas 14 Precipitation Frequency Data Server is 4.50 inches. The time distribution selected for this area was Type 1.

Hydraulics

Geometry

Topographic Data Used. The 5x5 meter LiDAR field data (downloaded from http://atlas.lsu.edu/LiDAR) was used to define topographic features because it gave a better resolution than the 30x30 DEM (Digital Elevation Model) method. The field point data was categorized into the following sets: a set of raw points, a set of edited points and a contour line shapefile. The metadata file, which was also included, describes the projection of the data points and their level of accuracy.

The contour line shapefile, consisted of vector lines with elevation data at two-foot intervals. This contour vector data was then used in a GIS (Geographic Information System) program to display any desired projection.

Datum. The Datum used for the modeling project is NAVD88 (Epoch 2004.65). This Datum was used throughout the development of the model and all stages and elevations reported in this document are to this datum. No conversions of data due to datum discrepancies were required in the model.

Once the HEC-HMS hydrological model was completed, the runoff hydrographs were placed as input into the HEC-RAS hydraulic model. The hydraulic model consists of canals, storage areas and structures (such as bridges, pumping stations, inline weirs and lateral weirs).

Canal Alignments and Connections. The basic alignment of canals, storage areas and connections was taken from the USACE ADCIRC West Shore-Lake Pontchartrain model. It was then modified by adding lateral weirs representing areas conducive to bank overflow into the various parts (Storage Areas) of the model. LiDAR imagery was used to establish top-of-bank elevations for lateral weirs.

Canal Cross Sections. The detailed area of St. John the Baptist Parish was taken from the HEC-RAS model developed by Burk-Kleinpeter, Inc. (BKI). The dimensions of other canals were determined by conducting a reconnaissance-level survey of the most important canals and their related crossings.

The Manning's "N" values were taken from the HEC-RAS Technical Reference Manual for typical canal sections with earthen, concrete and rip-rap bottoms.

Pump Stations. Existing pumping stations were modeled in HEC-RAS using the existing pump curves, as described below. Proposed pumping station pump curves were taken from pump curves of commonly-used centrifugal pumps of appropriate size.

Calibration. Calibration is a process whereby the model is adjusted to better simulate the actual drainage system and a storm event with recorded data. This is usually accomplished by analyzing the performance of the model when an historical rainfall is provided as input. For this model, no historical storm events with recorded data were available. A common method of calibration / validation (when no such data is available) is simulating a 10% recurrence storm and plotting its inundation over the study area. Once that is done, the inundation map is given to the drainage department of the area of study and comments are provided on the extent of the mapping.

For this project, an inundation map of the 10% recurrence simulation was provided to the St. John the Baptist Parish Drainage Department. Comments were provided on several areas that didn't seem to match historical inundation for the 10% storm. Even though a detailed channel network was not available for all areas of the project area, parameters were adjusted so the new inundation more closely matched the historical inundation.

With-Project Model. The levee alignment (Alignment C) was overlaid on the existing conditions sub-basin (storage area) map to determine which sub-basins (storage areas) would be affected by the alignment. The affected sub-basins (storage areas) were then edited to reflect the reduced elevation-volume and gross area. New parameters for the HEC-HMS models were calculated (Table 4). New elevation-volume curves were also calculated and modified in HEC-RAS.

Lateral Structures (weirs) were placed in the model to simulate overflow from canals to and from storage areas.

Gates and pumps were added to the with-project HEC-RAS model. The gates are to promote normal tidal exchange and allow rainwater to move out of the system during normal or low tide conditions. During elevated Lake conditions attributable to hurricane and tropical storm events when the elevation of the lake reaches approximately +1.7 ft. NAVD88, the gates would close and the pumps would evacuate the rain water as it moves through the system. This is expected to occur 8.5 days per year.

The gravity drainage gates and pumps would be placed in the new levee alignment at the following canals:

1. Hope Canal
2. Reserve Relief Canal
3. Ridgefield Canal
4. Montz Canal / Woodland Canal

The gravity drainage gates would be placed in the new levee alignment at the following canals:

1. Mississippi Bayou
2. Perriloux Canal

The storage areas for the proposed model were developed in the same way as those in the existing model. Additional storage areas were created along Alignment C. The levee alignment bisects some storage areas and produces the need to add some new storage areas.

RESULTS AND EVALUATION

As stated in Chapter 5 of the Main Report, hydrologic connectivity would be maintained to the extent practicable through water control structures except during closure for hurricanes or tropical storms. When the system is closed, pumps would operate on average for 1.7 storms per year, which equates to a closure of structures on average 8.5 days per year. This expected rate of closure would be the same regardless of the actual rate of SLR as closure of the system is tied to tropical storm events and the elevation trigger would be adjusted as sea level rises. The risk reduction system is only authorized to address storm surge caused by hurricane and tropical storm events. It is not authorized to mitigate for or reduce impacts caused by higher day-to-day water levels brought about by increases in sea level rise. Any operational changes implemented to address changing SLR conditions or for any other non-project-related purpose would be considered a separate project purpose requiring separate authorization, new NEPA documentation, and/or permit approvals.

An assessment was conducted to analyze the water levels in the surrounding lakes. A hydraulic analysis was performed using HEC-RAS and synthetic frequency rainfall. An initial condition run was established and simulated. The objective of the initial condition simulation is to establish the interior stages to an elevation equal to the actual elevations after high lake elevations for 5 to 7 days. The elevations related to the last profile in the initial conditions simulation are used to begin the synthetic frequency rainfall simulations. This method ensures the model starts with the same interior basin stages that would occur before the gates are closed.

In this section of the Engineering Appendix, the 10% recurrence interval rainfall event (10-Year) for the existing condition (year 2013) and future development condition (Year 2070) are compared. Note - no future land development was considered for the future development condition in the hydrology simulation (HEC-HMS). The only difference is the addition of relative sea level rise (SLR) at the downstream boundaries of the model. The SLR values were added directly to the original downstream boundary.

Table 4 below is the comparison of storage area stages for without-project (Year 2013) and the with-project (Year 2013).

	Without-Project				**With-Project**			
SA	**RT1yr**	**RT5yr**	**RT10yr**	**RT25yr**	**RT1yr**	**RT5yr**	**RT10yr**	**RT25yr**
SA18	2.05	2.20	2.31	2.44	2.05	2.20	2.31	2.44
SA9	3.23	4.24	4.45	4.73	3.23	4.24	4.45	4.73
SA1	5.09	5.81	6.14	6.49	5.09	5.81	6.11	6.52
SA2	6.00	6.83	7.23	7.69	6.02	6.85	7.25	7.70
SA3	13.57	14.00	14.27	14.64	13.58	14.01	14.28	14.65
SA4	11.18	11.67	11.98	12.41	11.19	11.68	12.00	12.42
SA5	11.28	12.00	12.36	12.54	11.31	12.03	12.39	12.56
SA6	12.06	12.63	12.97	13.28	12.06	12.63	12.99	13.28
SA7	4.95	5.87	6.36	6.94	4.97	5.89	6.38	6.96
SA8	6.28	7.26	7.67	7.93	6.30	7.28	7.69	7.94
SA10	3.59	3.81	3.92	4.07	3.62	3.83	3.98	4.12
SA11	6.75	6.96	7.11	7.58	6.76	6.97	7.13	7.60
SA12	5.78	6.72	7.11	7.58	5.81	6.75	7.13	7.60

SA13	4.86	5.31	5.53	5.83	4.88	5.33	5.55	5.85
SA14	8.09	8.88	9.11	9.29	8.12	8.91	9.12	9.30
SA15	8.83	9.77	10.05	10.28	8.85	9.79	10.07	10.29
SA16	4.95	5.81	6.24	6.66	4.96	5.83	6.25	6.68
SA17	3.20	4.36	4.94	5.71	3.23	4.38	4.96	5.73
SA25	3.11	4.29	4.88	5.61	3.15	4.30	4.89	5.63
SA22	4.83	5.73	5.99	6.15	4.85	5.75	6.00	6.15
SA21	3.27	3.87	4.36	4.83	3.33	3.89	4.39	4.84
SA19	2.07	2.28	2.42	2.50	2.07	2.28	2.42	2.50
SA20	3.20	3.49	3.62	3.74	3.22	3.51	3.63	3.86
SA43P	2.08	2.38	2.56	2.86	2.08	2.38	2.47	2.81
SA42P	1.86	2.03	2.12	2.30	1.71	1.84	1.92	2.38
SA26P	1.86	2.03	2.12	2.31	1.74	1.87	1.94	2.41
SA28Y	1.86	2.03	2.12	2.31	1.73	1.86	1.94	2.40
SA29C	1.86	2.03	2.12	2.31	1.73	1.86	1.94	2.40
SA30	1.86	2.03	2.12	2.31	1.74	1.87	1.94	2.40
SA44C	1.76	1.89	1.96	2.14	1.74	1.84	1.92	2.38
SA41P	1.86	2.03	2.12	2.30	1.73	1.86	1.94	2.40
SA40P	1.86	2.03	2.12	2.30	1.73	1.86	1.94	2.40
SA31	2.29	2.75	2.98	3.28	2.32	2.73	2.94	3.23
SA32	2.22	2.70	2.94	3.29	2.27	2.66	2.90	3.23
SA41	2.19	2.67	2.90	3.20	2.26	2.63	2.86	3.17
SA35	2.92	3.24	3.36	3.54	2.92	3.24	3.37	3.55
SA38	2.80	2.89	2.93	2.98	2.81	2.90	2.94	2.99
SA37	2.49	2.68	2.77	2.86	2.50	2.69	2.77	2.87
SA36	1.82	2.23	2.62	3.11	1.76	2.18	2.56	2.98
SA27	1.86	2.03	2.12	2.31	1.74	1.87	1.94	2.41
SA30C	1.86	2.03	2.12	2.31	1.74	1.87	1.94	2.40
SA23	5.95	6.72	6.99	7.40	5.98	6.74	7.02	7.42
SA24	4.58	5.77	6.22	6.64	4.59	5.79	6.23	6.65
SA28X	1.86	2.03	2.12	2.31	1.74	1.87	1.94	2.40
SA39	2.08	2.39	2.56	2.86	2.10	2.39	2.47	2.81
SA39C	2.08	2.39	2.56	2.86	2.08	2.38	2.47	2.81
SA34	3.03	3.67	3.96	4.26	3.02	3.67	3.97	4.27
SA33	3.72	4.04	4.17	4.31	3.73	4.05	4.18	4.32
SA31C	2.28	2.73	2.94	3.20	2.31	2.70	2.90	3.14
SA29Y	3.20	3.79	3.91	4.34	3.22	3.81	4.25	4.68

Table 4: Year 2013 Comparison of Stages: With-Project vs. Without-Project

Table 5 below is the comparison of storage area stages for Without-Project (Year 2070 Intermediate SLR) and the With-Project (Year 2070 Intermediate SLR).

	Without-Project				**With-Project**			
SA	**RT1yr**	**RT5yr**	**RT10yr**	**RT25yr**	**RT1yr**	**RT5yr**	**RT10yr**	**RT25yr**
SA18	2.07	2.86	2.86	3.04	2.07	2.86	2.86	3.04

SA9	3.24	4.30	4.50	4.77	3.24	4.30	4.50	4.77
SA1	5.09	5.81	6.14	6.49	5.23	5.81	6.11	6.52
SA2	6.00	6.83	7.23	7.69	6.00	6.85	7.25	7.70
SA3	13.57	14.00	14.27	14.64	13.57	14.01	14.28	14.65
SA4	11.18	11.67	11.98	12.41	11.18	11.68	12.00	12.42
SA5	11.28	12.00	12.36	12.54	11.28	12.03	12.39	12.56
SA6	12.06	12.63	12.98	13.28	12.06	12.63	12.98	13.28
SA7	4.96	5.89	6.37	6.94	4.95	5.89	6.38	6.96
SA8	6.28	7.26	7.67	7.93	6.28	7.28	7.69	7.94
SA10	3.65	4.13	4.16	4.21	3.57	3.83	3.98	4.12
SA11	6.75	6.96	7.12	7.58	6.76	6.97	7.13	7.60
SA12	5.78	6.72	7.12	7.58	5.78	6.75	7.13	7.60
SA13	4.86	5.31	5.53	5.83	4.86	5.33	5.55	5.85
SA14	8.09	8.88	9.11	9.29	8.09	8.91	9.12	9.30
SA15	8.84	9.78	10.05	10.28	8.83	9.79	10.07	10.29
SA16	4.95	5.83	6.25	6.67	4.95	5.83	6.25	6.68
SA17	3.25	4.39	4.96	5.72	3.29	4.39	4.97	5.73
SA25	3.16	4.32	4.90	5.62	3.19	4.32	4.91	5.64
SA22	4.84	5.78	6.02	6.18	4.83	5.75	6.00	6.15
SA21	3.80	4.69	4.93	5.30	3.23	3.89	4.39	4.84
SA19	3.46	4.08	4.10	4.11	1.88	2.81	3.28	3.84
SA20	3.45	4.08	4.10	4.12	3.20	3.51	3.63	3.84
SA43P	2.19	2.51	2.68	2.94	2.22	2.50	2.67	2.92
SA42P	3.44	3.95	3.99	4.02	0.87	1.27	1.51	1.76
SA26P	3.44	3.96	4.00	4.02	1.31	1.66	1.76	1.89
SA28Y	3.44	3.96	4.00	4.03	1.12	1.42	1.57	1.83
SA29C	3.45	3.96	4.01	4.03	1.50	1.70	1.78	1.88
SA30	3.44	3.96	4.00	4.03	1.47	1.74	1.85	2.00
SA44C	2.52	3.11	3.18	3.29	0.87	1.27	1.51	1.76
SA41P	3.43	3.95	4.00	4.02	0.87	1.29	1.55	1.83
SA40P	3.44	3.96	4.00	4.02	0.87	1.29	1.55	1.83
SA31	3.44	3.96	4.01	4.15	1.89	2.51	2.80	3.10
SA32	3.05	3.50	3.66	3.84	2.01	2.57	2.84	3.18
SA41	3.02	3.43	3.55	3.71	1.72	2.53	2.80	3.11
SA35	2.93	3.31	3.46	3.68	2.92	3.24	3.37	3.55
SA38	2.80	2.89	2.93	2.98	2.80	2.90	2.94	2.99
SA37	2.49	2.68	2.77	2.94	2.49	2.69	2.77	2.92
SA36	2.62	3.28	3.44	3.65	1.80	2.08	2.51	2.95
SA27	3.44	3.96	4.00	4.02	1.18	1.44	1.55	1.83
SA30C	3.45	3.95	4.01	4.03	1.46	1.73	1.84	1.98
SA23	5.98	6.75	7.03	7.43	6.00	6.75	7.03	7.43
SA24	4.72	5.79	6.23	6.65	4.55	5.78	6.23	6.65
SA28X	3.44	3.96	4.00	4.02	0.80	1.38	1.55	1.83
SA39	2.20	2.52	2.69	2.94	2.22	2.51	2.67	2.93
SA39C	2.20	2.52	2.68	2.94	2.22	2.50	2.67	2.92

SA34	3.05	4.02	4.20	4.37	3.02	3.67	3.97	4.27
SA33	3.72	4.11	4.24	4.38	3.72	4.05	4.18	4.32
SA31C	3.44	3.96	4.01	4.05	1.89	2.50	2.78	3.05
SA29Y	3.32	4.26	4.52	4.82	2.75	3.81	4.25	4.68

Table 5: Year 2070 Intermediate SLR Comparison of stages: With-Project vs. Without-Project

By carefully reviewing the results in the tables, the largest reduction occurs when SLR is incorporated into the analysis. Without the levee for risk reduction during hurricane and tropical storm events, elevated lake levels infiltrate the unprotected area of St. Charles and St. John the Baptist Parishes and cause flooding.

Because of the lack of stream detail in the model, the areas away from the new pumping stations are unable to drain effectively to the stations and the analysis shows no elevated stages. A more detailed analysis that includes new channel sections and additional channel geometry from surveys, would likely show reduced stages for the with-project condition.

Exterior Storm Surge Modeling

This portion of the report documents some of the post-processing steps that were performed to determine stage-frequency and associated wave conditions from raw ADCIRC data. A brief summary of the different ADCIRC meshes used in the analysis is described first. Then, some of the surge results are examined in order to explain how the stage-frequency and associated wave values are determined from raw ADCIRC output. It should be noted that an ADCIRC modeling report was completed 22 April 2011. The ADCIRC model used was subjected to an Agency Technical Review (ATR), which was completed 28 September 2011.

Table 6 contains a summary of the ADCIRC simulations performed for the analysis. A total of 152 storms were included in the analysis for the 2011 base condition, on a version of the SL15 mesh that includes HSDRRS features such as the IHNC barrier and the Seabrook closure. After Hurricane Katrina, it was decided (in 2006) to pursue a common technical framework for use by all Federal Agencies that are involved with assessing hurricane-related threats to coastal communities; this includes storm selection and statistical performance. A detailed explanation of the selection of hypothetical storms, probabilities and statistical performance is in a document entitled “White Paper on Estimating Hurricane Inundation Probabilities for Storm Selection and Statistics Reference” (dated 10 June 2007). The mesh also includes added resolution in the project area. Figure 2 displays a version of SL15 which does not include the added resolution for the project area. Figure 3 displays the mesh with added resolution. The areas that appear black are areas that include high resolution. Future condition meshes were created for the “No Action” or “Without-Project Condition” and the “With-Project Condition”. The Year 2020 meshes include a modest SLR value of 0.3ft. In the Year 2020 mesh, the nodal attributes including bottom friction and canopy cover are not modified to reflect land loss that occurs with SLR. For Year 2020, it is assumed that the landscape will not change drastically enough to warrant modifying bottom friction or canopy coefficients. For the Year 2070 meshes, the nodal attributes are modified to reflect a future condition that includes loss of bottom friction and canopy. The Recommended Plan is Alignment C.

Table 6 Summary of ADCIRC Simulations

NO ACTION ADCIRC RUNS	SLR (ft)

No Action Base Condition 2011	0.00
No Action Future Condition 2020 Intermediate SLR	0.30
No Action Future Condition 2070 Low SLR	1.80
No Action Future Condition 2070 Intermediate SLR	2.30
No Action Future Condition 2070 High SLR	3.00
WITH-PROJECT ADCIRC RUNS	SLR (ft)
Alignment C Future Condition 2020 Intermediate SLR	0.30
Alignment C Future Condition 2070 Low SLR	1.80
Alignment C Future Condition 2070 Intermediate SLR	2.30
Alignment C Future Condition 2070 High SLR	3.00

There are differences between the SLR curves that were used for this project and the SLR curves on the USACE Sea-Level Calculator for Non-NOAA Long-Term Tide Gauges Web Page. For this project, the latest ER (ER 1100-2-8162, dated 31 December 2013) as well as local gages in the project area were used. Extensive time was spent in analyzing the gage data and subsidence, while maintaining as much accuracy as possible. SLR is the effect of eustatic sea level rise and subsidence. The rate of eustatic sea level rise may be the same, generally speaking, but the rate of subsidence in Louisiana varies from one place to another (and it is not a linear relationship). Thus, the SLR curves used for this report were appropriate for the project area.

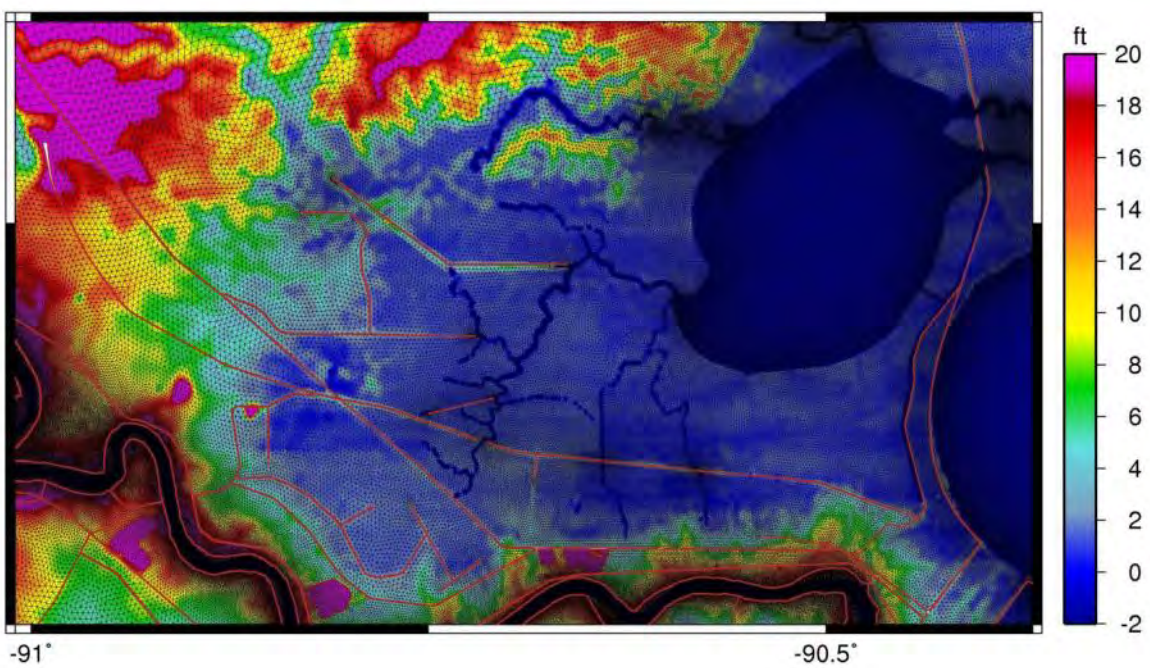


Figure 2 Mesh Elevations and Raised Feature Alignments in the IHNC Study ADCIRC Mesh. Contours are in feet relative to NAVD88 (2004.65 Epoch). Black lines represent element edges and display mesh resolution.

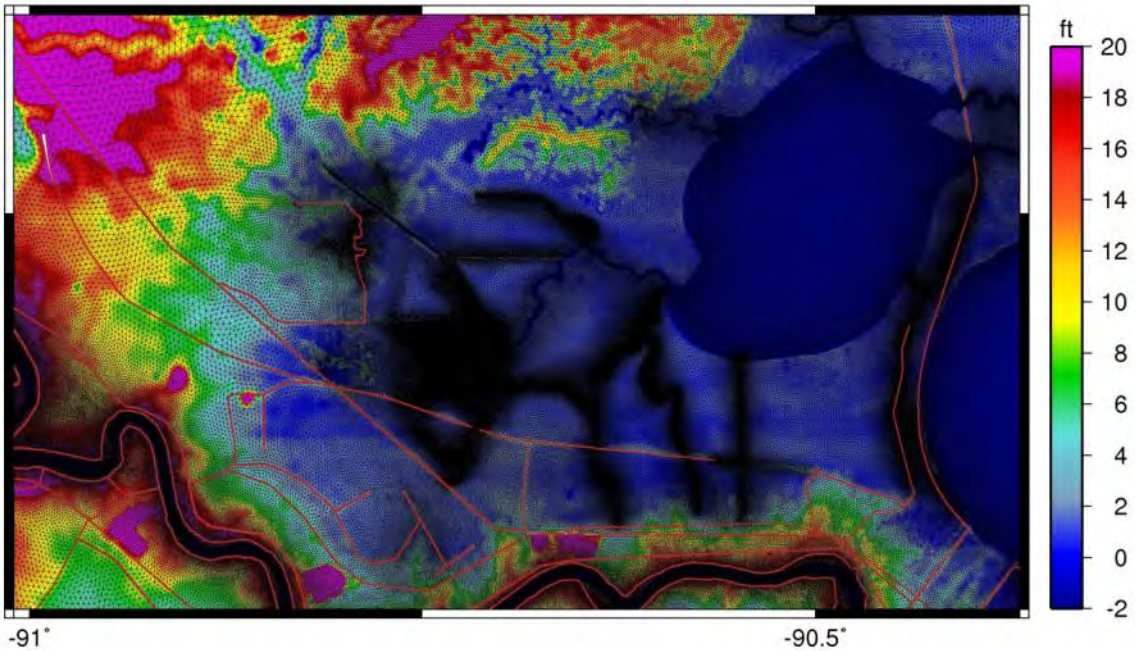


Figure 3 Mesh Elevations and Raised Feature Alignments in the ADCIRC Mesh. Contours are in feet relative to NAVD88 (2004.65 Epoch). Black lines represent element edges and display mesh resolution.

Figure 4 compares peak surge results from the 2011 base condition to the "IHNC 152" base condition. The "IHNC 152" was a suite of 152 simulations used to determine design conditions for the IHNC surge barrier. The IHNC grid, as pictured in Figure 2, does not contain high resolution in the project area. If the peak surge results are compared storm by storm from this project and the IHNC simulation, it can be determined what the effect of the added resolution on stage-frequency is in the project area. The left portion of Figure 4 displays the location of the output point represented as a green dot. This location was selected at the St. Charles Parish portion on HSDRRS, which is represented by a light purple line. The MRL is represented by the red line and Alignment C is represented as a blue line. The right portion of the figure is a regression analysis between the IHNC 152 and the project Base Condition. At the St. Charles Parish location, the surge results are nearly equal for both sets of simulations. Both suites model the same 152 storms, which allows processing in the JPM-OS statistical code. The 50yr, 100yr, 200yr and 500yr returns are plotted for both analyses in blue. For example, the 100yr surge for the IHNC set is 11.8 ft. NAVD88, while the 100yr surge for the project set is 12.0 ft. NAVD88. In summary, at this location, which is located away from the added resolution, the effect of resolution on statistical output results in a 0.1 ft. increase at the 50yr level, a 0.2 ft. increase at the 100yr level, a 0.2 ft. increase at the 200yr level and a 0.3 ft. increase at the 500yr level. It is important to note that the IHNC 152 surge analysis results in the St. Charles Parish area were modified prior to final design. Therefore, the IHNC 152 stage-frequency data presented in Figure 3 is different than what was actually used in HSDRRS design.

Figure 5 compares peak surge results from the 2011 base condition to the "IHNC 152" base condition at Reach 5 of the Alignment C levee. At this output point, the effect of resolution on statistical output results in a 0.3 ft. increase at the 50yr level, a 0.2 ft. increase at the 100yr level, a 0.3 ft. increase at the 200yr level and a 0.4 ft. increase at the 500yr level. Stage-frequency information was developed for the 2011 base condition using the same JPM-OS code as used for the HSDRRS design analysis.

With the 2011 base condition stage-frequency established, the stage-frequency for the 4 SLR conditions, including with- and without-project are processed using a regression analysis. Figure 6 displays a regression analysis between peak surge values of the 2011 base condition and the peak surge values from the Year 2020 Alignment C surge values. In this case, 52 storms are available for the regression. The trend line, as plotted in green, is used to estimate 50yr, 100yr, 200yr and 500yr surge values for the Year 2020 Alignment C condition. At this location, the 100yr for the Year 2020 Alignment C condition is estimated to be 12.2 ft. NAVD88. Figure 7 displays a regression analysis between the Year 2020 Alignment C condition, and the Year 2020 base condition. The trend line in Figure 7 is used to estimate the stage-frequency for the Year 2020 base condition. At this location, the Year 2020 base condition 100yr surge is estimated to be 10.6 ft. NAVD88.

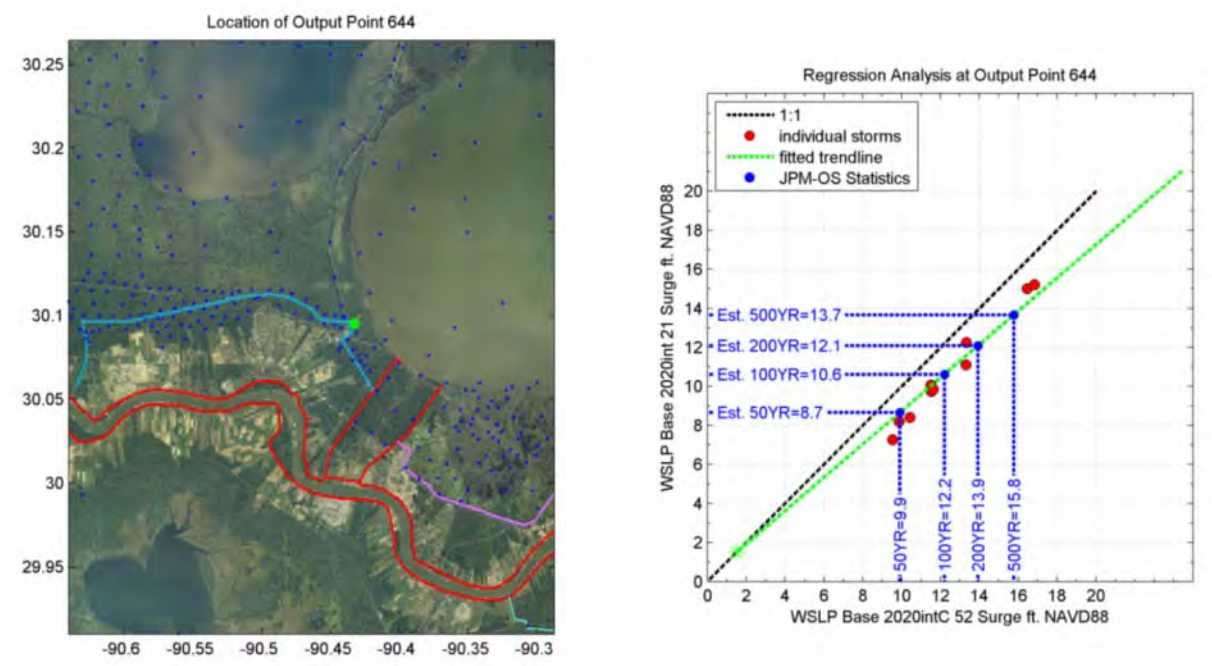


Figure 4 Comparison of IHNC 152 peak storm surge values and the Project 152 Base 2011 peak storm surge values at the St. Charles Parish HSDRRS Levee

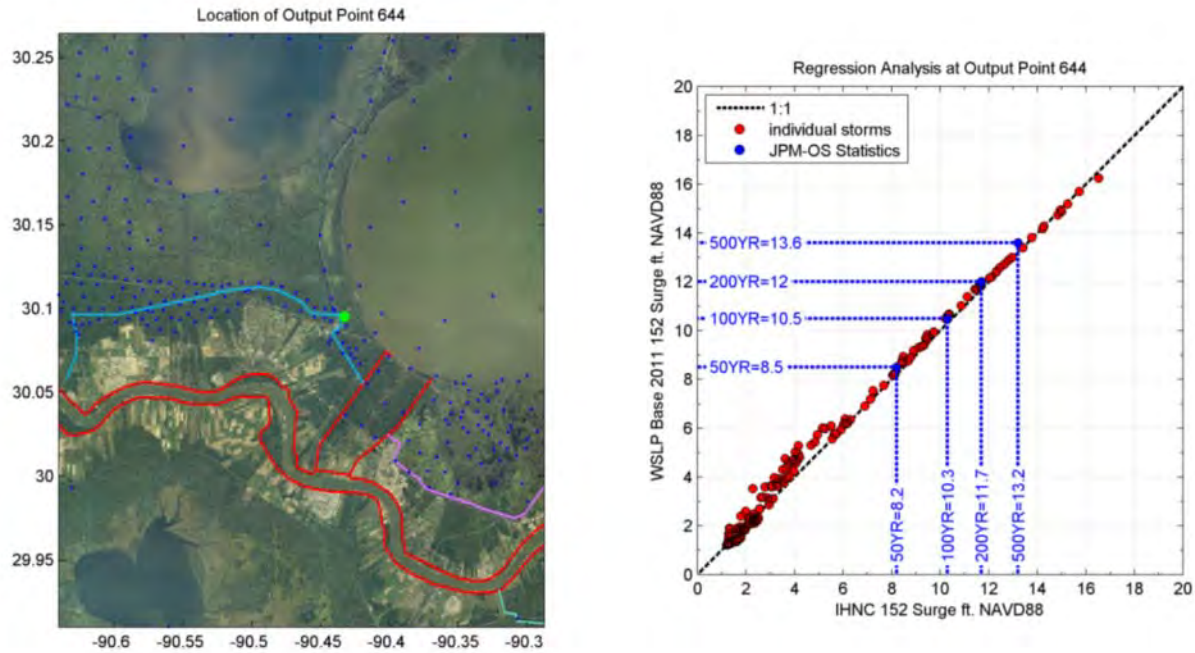


Figure 5 Comparison of IHNC 152 peak storm surge values and Project 152 Base 2011 peak storm surge values at Reach 5 of the project levee

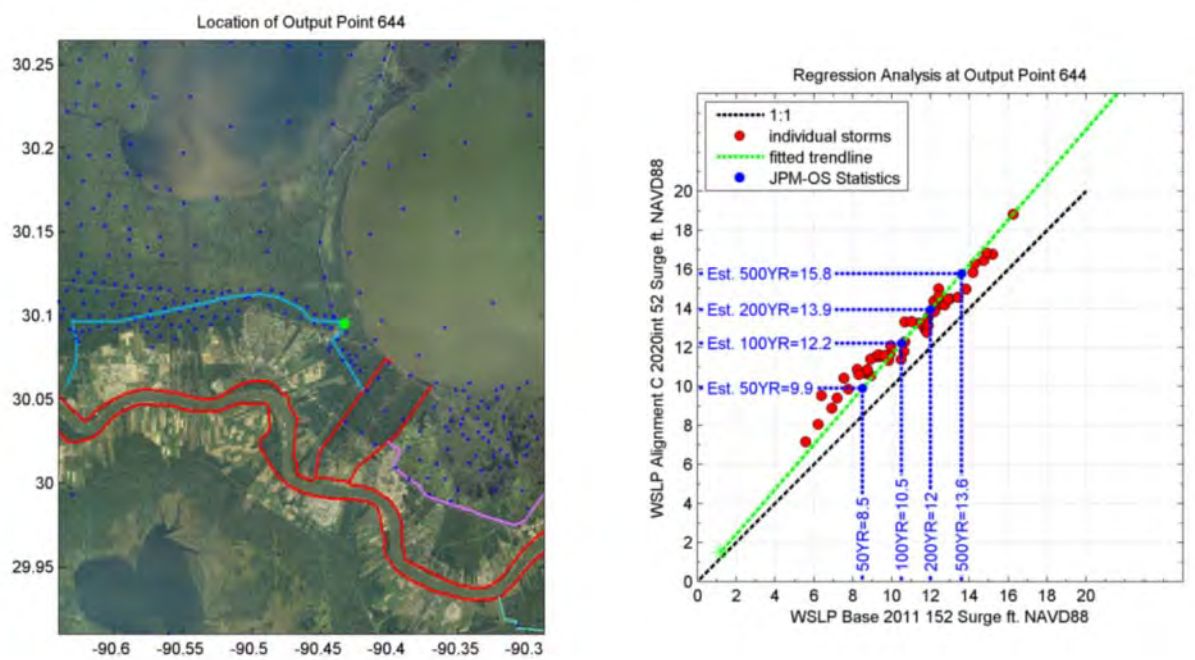


Figure 6 Comparison of Project 152 Base 2011 storm surge values and Project 52 Alignment C 2020 peak storm surge values at Reach 5 of the project levee

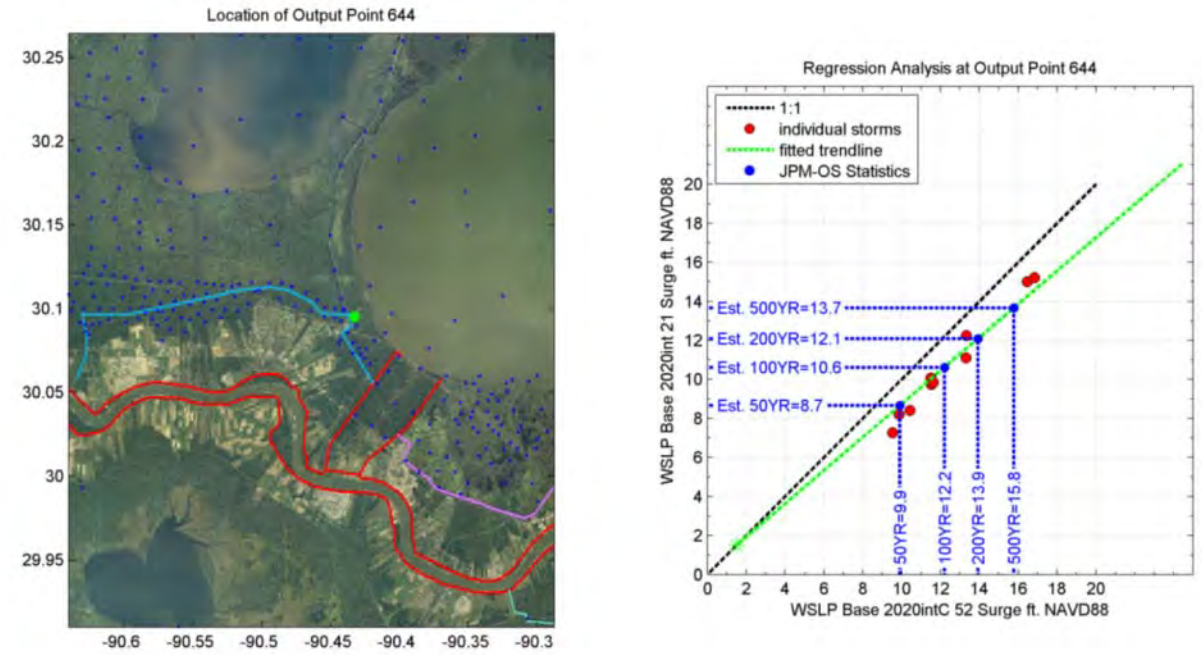


Figure 7 Comparison of Project 52 Alignment C 2020 storm surge values and Project 21 Base 2020 peak storm surge values at Reach 5 of the project levee

Figure 8 displays a regression between peak surge values from the 2011 Base Condition and the Year 2070 low SLR Alignment C condition. The trend line allows estimation of the stage-frequency data for the Year 2070 low SLR Alignment C condition. For example, the 100yr elevation is estimated to be 13.8 ft. NAVD88, based on the trend line. Figure 9 displays a regression plot between peak surge from the Year 2070 low SLR Alignment C condition and the Year 2070 low SLR project base condition. This regression trend line allows estimation of stage-frequency for the Year 2070 low SLR project base condition. For example, the 100yr elevation is estimated to be 12.7 ft. NAVD88.

The same regression analysis is applied for the Year 2070 intermediate SLR condition and the Year 2070 high SLR condition. Figure 10 and Figure 11 display the regression analysis for the Year 2070 intermediate SLR condition. Figure 12 and Figure 13 display the regression analysis for the Year 2070 high SLR condition.

Table 7 displays the final developed stage-frequency data for the project analysis for Years 2020 and 2070 conditions. The table contains stage-frequency data for all 7 design reaches.

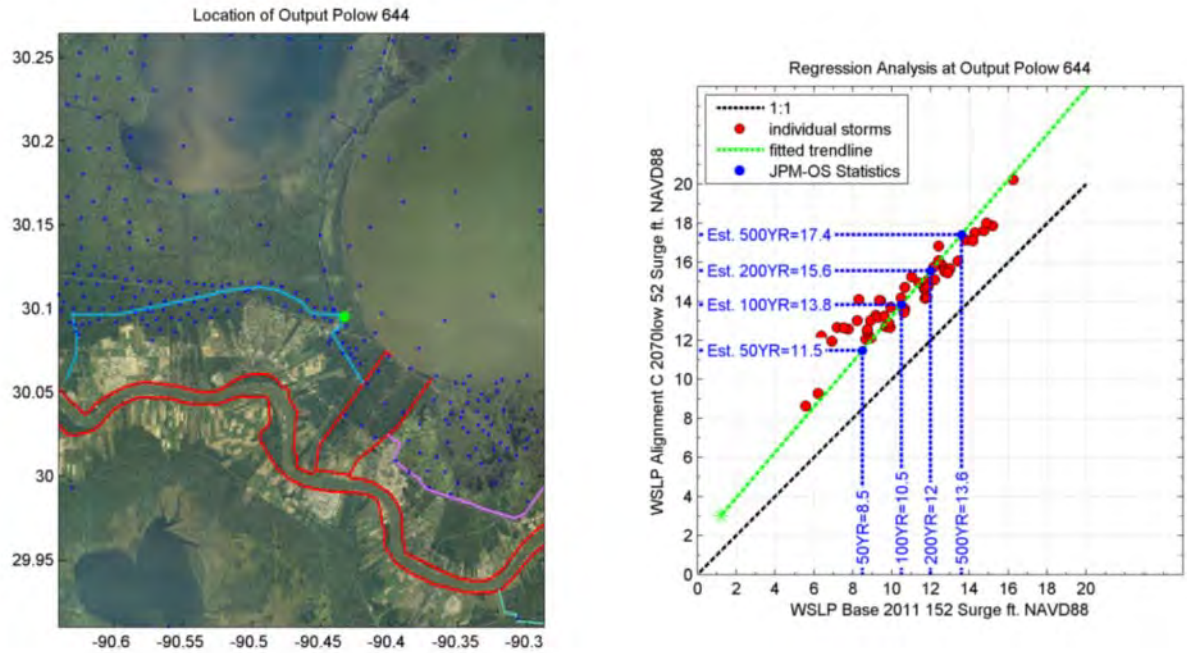


Figure 8 Comparison of Project 152 Base 2011 storm surge values and 52 Alignment C 2070 Low SLR peak storm surge values at Reach 5 of the project levee

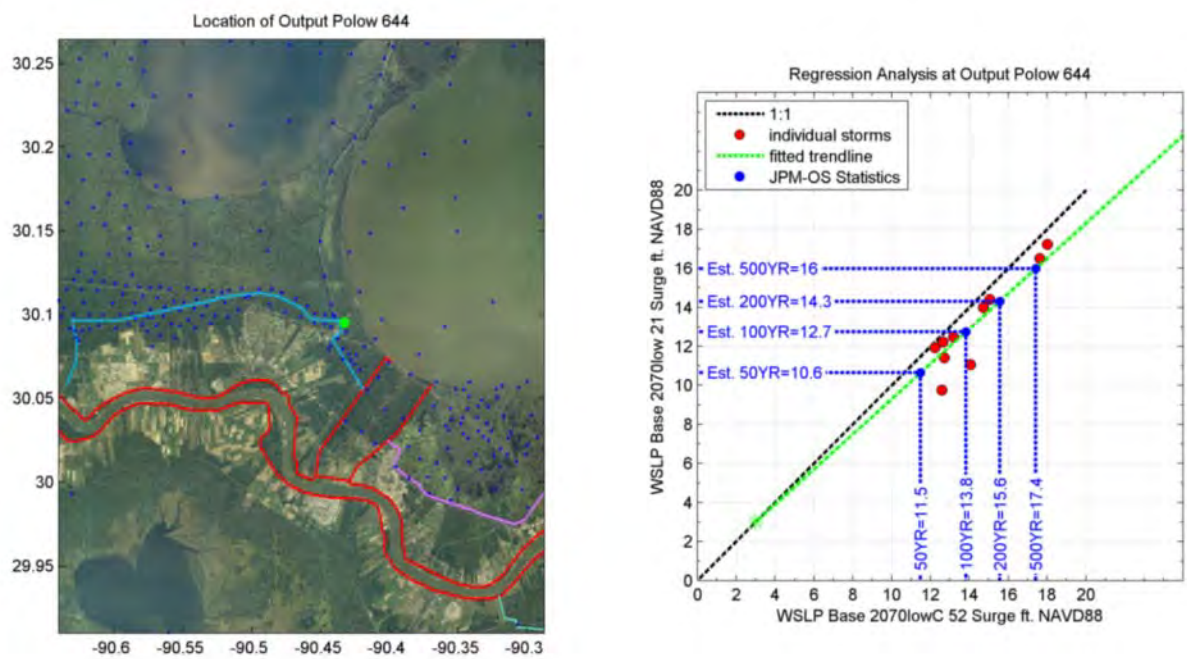


Figure 9 Comparison of 52 Alignment C 2070 Low SLR storm surge values and Project 21 Base 2070 Low SLR peak storm surge values at Reach 5 of the project levee

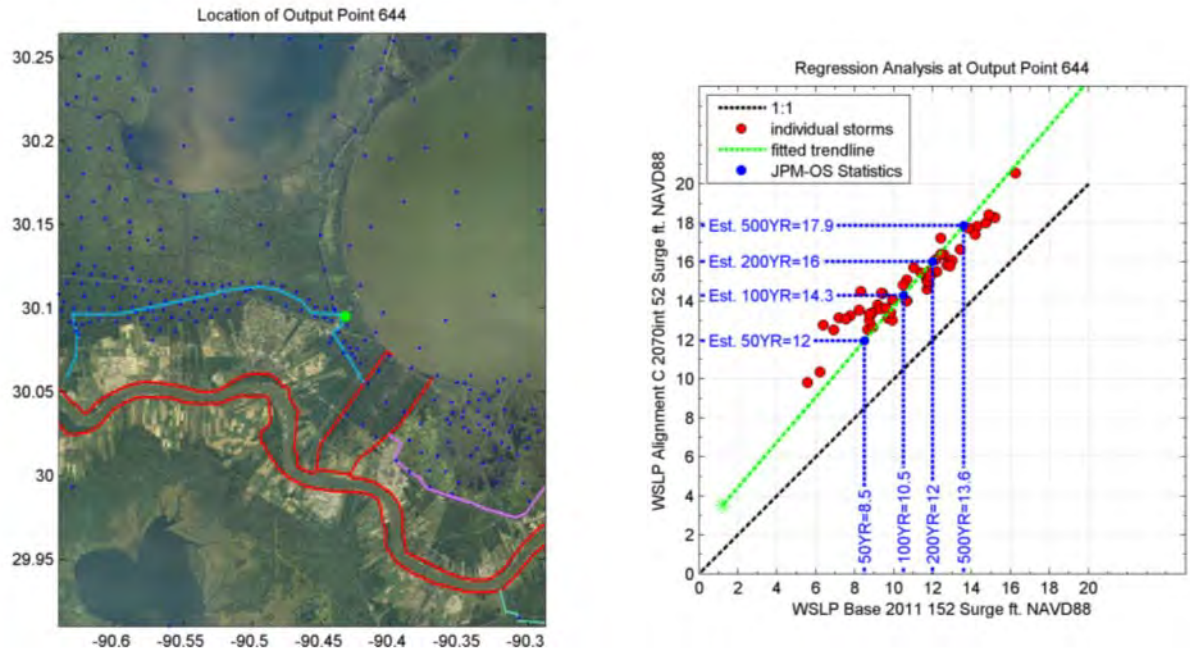


Figure 10 Comparison of 152 Base 2011 storm surge values and 52 Alignment C 2070 Intermediate SLR peak storm surge values at Reach 5 of the project levee

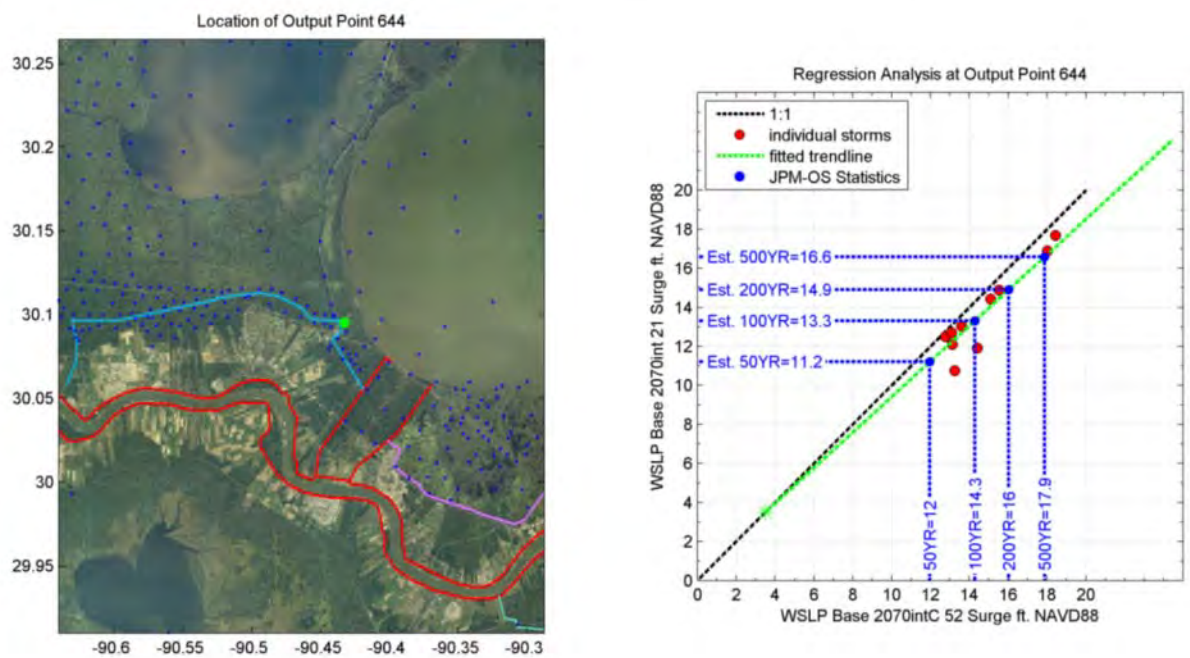


Figure 11 Comparison of 52 Alignment C 2070 Intermediate SLR storm surge values and 21 Base 2070 Intermediate SLR peak storm surge values at Reach 5 of the project levee

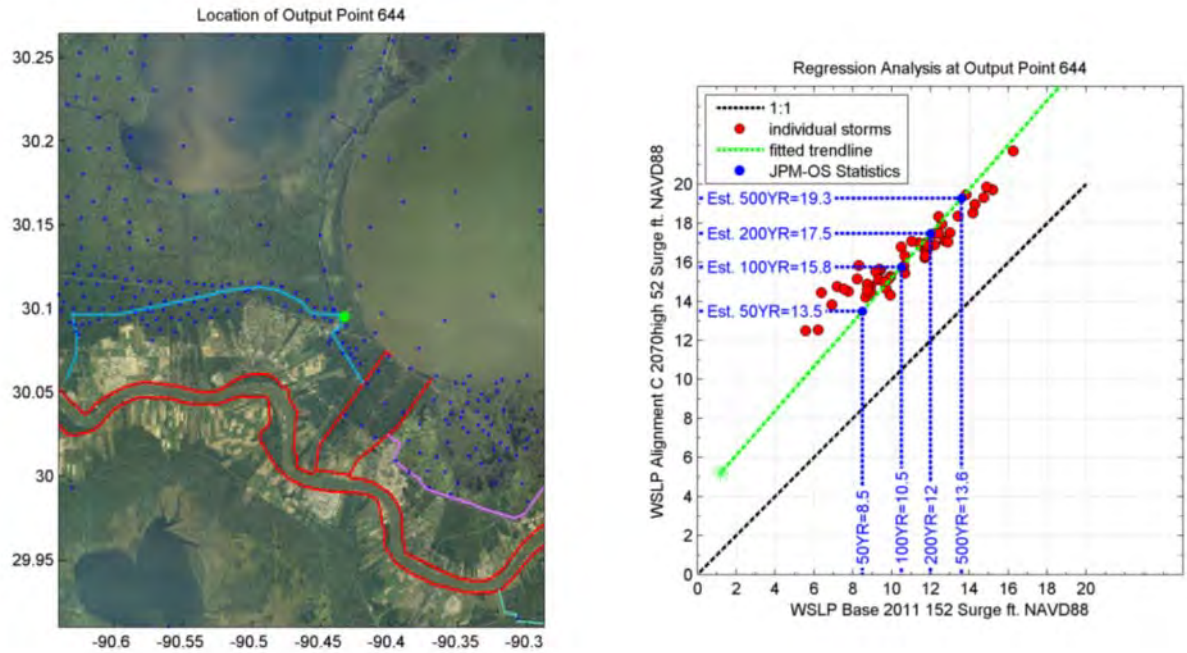


Figure 12 Comparison of 152 Base 2011 storm surge values and 52 Alignment C 2070 High SLR peak storm surge values at Reach 5 of the project levee

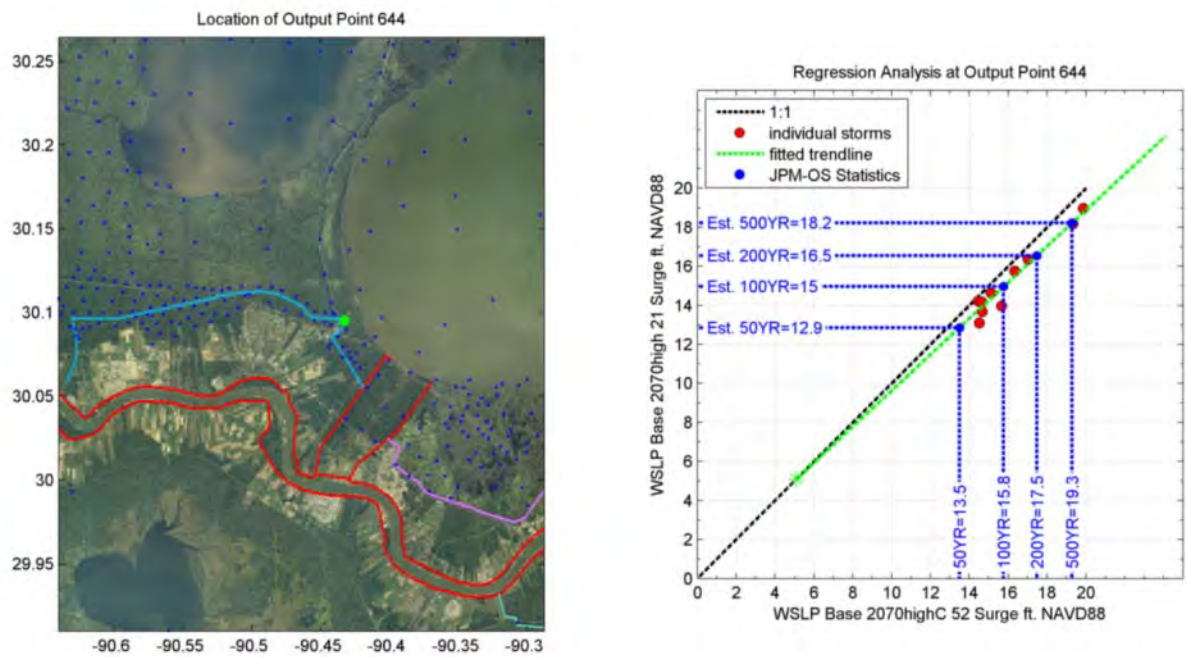


Figure 13 Comparison of 52 Alignment C 2070 High SLR storm surge values and 21 Base 2070 High SLR peak storm surge values at Reach 5 of the project levee

Table 7 Final stage frequency estimates for the WSLP levee design

			Without Project Surge Elevation (ft. NAVD88)				With Project / Alignment C Surge Elevation (ft. NAVD88)				Difference (ft. / %)							
Condition	**Reach ID**	**ADCIRC Output Point**	50YR	**100YR**	200YR	500YR	50YR	**100YR**	200YR	500YR	50YR		**100YR**		200YR		500YR	
2020 int	1	534	4.5	**5.7**	6.6	7.8	4.5	**5.7**	6.6	7.9	0.0	1%	**0.0**	**1%**	0.0	1%	0.1	1%
2020 int	2	439	5.5	**6.7**	7.8	9.1	5.9	**7.2**	8.4	9.9	0.4	7%	**0.5**	**7%**	0.6	11%	0.8	9%
2020 int	3	337	6.8	**8.1**	9.1	10.1	7.1	**8.5**	9.5	10.6	0.3	5%	**0.4**	**4%**	0.5	7%	0.5	5%
2020 int	4	365	8.0	**9.6**	10.8	12.1	9.1	**10.9**	12.3	13.8	1.1	13%	**1.3**	**12%**	1.5	17%	1.7	14%
2020 int	5	644	8.7	**10.6**	12.1	13.7	9.9	**12.2**	13.9	15.8	1.2	14%	**1.6**	**13%**	1.8	19%	2.1	15%
2020 int	6	117	10.4	**12.1**	13.4	14.6	10.5	**12.2**	13.5	14.7	0.1	1%	**0.1**	**1%**	0.1	1%	0.1	1%
2020 int	7	132	10.2	**11.9**	13.2	14.5	10.3	**12.0**	13.3	14.6	0.1	1%	**0.1**	**1%**	0.1	1%	0.1	1%
2070 low	1	534	8.3	**10.3**	11.9	14.1	8.4	**10.4**	12.1	14.3	0.1	1%	**0.1**	**1%**	0.2	2%	0.2	2%
2070 low	2	439	9.3	**11.2**	12.9	14.9	9.7	**11.7**	13.5	15.7	0.4	4%	**0.5**	**4%**	0.6	7%	0.8	6%
2070 low	3	337	10.0	**11.8**	13.1	14.5	10.4	**12.2**	13.6	15.0	0.3	3%	**0.4**	**3%**	0.5	5%	0.5	4%
2070 low	4	365	9.3	**10.8**	12.0	13.2	11.0	**12.9**	14.4	16.0	1.7	18%	**2.1**	**18%**	2.4	22%	2.8	19%
2070 low	5	644	10.7	**12.7**	14.3	16.0	11.5	**13.8**	15.6	17.4	0.8	8%	**1.1**	**8%**	1.3	11%	1.4	9%
2070 low	6	117	12.6	**14.4**	15.8	17.1	12.6	**14.4**	15.8	17.1	0.0	0%	**0.0**	**0%**	0.0	0%	0.0	0%
2070 low	7	132	13.2	**15.2**	16.7	18.2	13.2	**15.2**	16.7	18.2	0.0	0%	**0.0**	**0%**	0.0	0%	0.0	0%
2070 int	1	534	9.0	**11.1**	12.9	15.1	9.1	**11.2**	12.9	15.2	0.0	0%	**0.0**	**0%**	0.1	1%	0.1	1%
2070 int	2	439	10.0	**12.0**	13.8	15.9	10.4	**12.5**	14.4	16.6	0.4	3%	**0.5**	**3%**	0.5	5%	0.7	5%
2070 int	3	337	10.6	**12.4**	13.8	15.2	11.0	**12.9**	14.3	15.8	0.4	3%	**0.5**	**3%**	0.5	5%	0.6	4%
2070 int	4	365	11.1	**13.0**	14.4	15.9	11.5	**13.4**	14.9	16.5	0.4	3%	**0.4**	**3%**	0.5	4%	0.6	4%
2070 int	5	644	11.2	**13.3**	14.9	16.6	12.0	**14.3**	16.0	17.9	0.8	7%	**1.0**	**7%**	1.1	9%	1.3	8%
2070 int	6	117	12.9	**14.7**	16.1	17.4	13.0	**14.9**	16.2	17.5	0.1	1%	**0.1**	**1%**	0.1	1%	0.2	1%
2070 int	7	132	13.6	**15.5**	17.0	18.5	13.6	**15.6**	17.1	18.6	0.1	1%	**0.1**	**1%**	0.1	1%	0.1	1%
2070 high	1	534	11.3	**13.6**	15.5	18.0	11.2	**13.5**	15.4	17.9	-0.1	-1%	**-0.1**	**-1%**	-0.1	-1%	-0.1	-1%
2070 high	2	439	12.2	**14.4**	16.3	18.6	12.5	**14.7**	16.6	19.0	0.2	2%	**0.3**	**2%**	0.4	3%	0.4	3%
2070 high	3	337	12.7	**14.6**	16.0	17.5	13.0	**14.9**	16.4	17.9	0.3	2%	**0.4**	**2%**	0.4	3%	0.5	3%
2070 high	4	365	12.8	**14.7**	16.1	17.6	13.0	**15.0**	16.4	18.0	0.2	2%	**0.3**	**2%**	0.3	2%	0.4	2%
2070 high	5	644	12.9	**15.0**	16.5	18.2	13.5	**15.8**	17.5	19.3	0.6	5%	**0.8**	**5%**	0.9	7%	1.1	6%
2070 high	6	117	14.3	**16.1**	17.4	18.6	14.5	**16.3**	17.6	18.9	0.2	1%	**0.2**	**1%**	0.2	1%	0.2	1%
2070 high	7	132	14.9	**16.8**	18.2	19.7	15.0	**16.9**	18.4	19.9	0.1	1%	**0.1**	**1%**	0.2	1%	0.2	1%

Wave Conditions

Figure 14 displays peak significant wave heights from the 2011 Base Condition and the Year 2020 Alignment C condition. The raw STWAVE significant wave heights at point 644 (also known as Reach 5) are unrealistically high given the conditions surrounding the project area. STWAVE does not incorporate the effects of this vegetation. In the model, it was apparent that larger waves that form in Lake Pontchartrain are allowed to propagate to the levee. In reality, this propagation will not occur because the vegetation is simply too thick and too tall to allow it.

Figure 15 displays an aerial image of the project area. Currently, approximately one mile of dense canopy exists between Lake Pontchartrain and the most exposed portion of the project levee. This canopy is not accounted for in the Steady State Spectral Wave (STWAVE) model, allowing unrealistic larger waves to occur in the modeling.

Based on engineering judgment, the significant wave height and peak wave period used for the levee design are the minimum recommended wave height/wave period for coastal structure. For existing conditions, the significant wave heights are set to 1.5 ft. and the peak wave periods are set to 2.5 sec. For future conditions, the significant wave heights are set to 2.5 ft. and the peak wave periods are set to 3.0 sec.

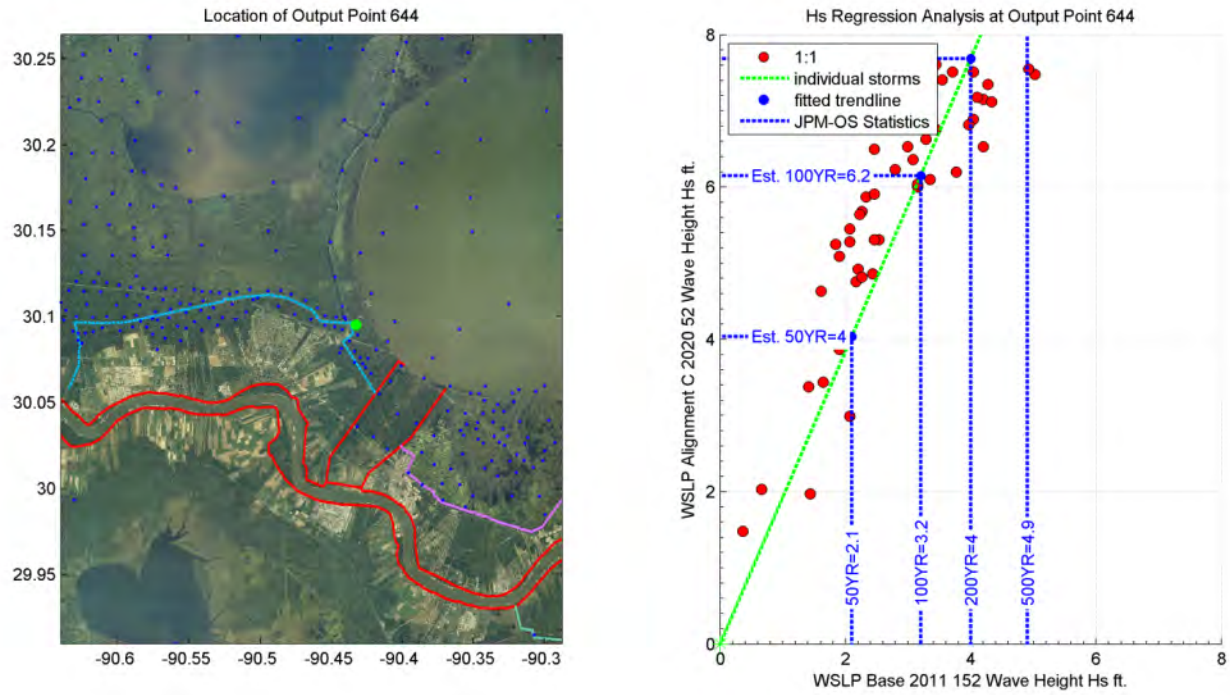


Figure 14 Wave Heights for 2011 Base Condition and Year 2020 Alignment C Condition

Figure 15 Recommended Alignment with Dense Canopy

Levee Design

The following section describes how the final levee design elevations were determined for the project for Year 2020 and Year 2070 conditions for the 50yr, 100yr and 200yr hydraulic boundary conditions.

The hydraulic and geometric parameters in the levee design approach are uncertain. For instance, there are errors in the computed surge elevation near the levees / floodwalls by the ADCIRC / STWAVE models. The coefficients of the empirical overtopping equations are calibrated against laboratory and field experiments and are inherently uncertain. It is believed that the uncertainty in these parameters should be taken into account in the design process to come up with a robust design. This section describes the method used which accounts for uncertainties in water elevations and waves, and computes the overtopping rate with state-of-the-art formulations. The objective of this method is to ensure that overtopping criteria can be met with a certain level of confidence due to the uncertainties.

A common way of dealing with uncertainties is the application of a Monte Carlo analysis. In the Monte Carlo analysis, the overtopping algorithm is repeated to compute the overtopping rate many times. Based on these outputs, a statistical distribution can be derived from the resulting overtopping rates. The parameters that are included in the Monte Carlo analysis are the 1% surge elevation, wave height and wave period. Uncertainties in the geometric parameters are not included; it is assumed that the proposed heights and slopes in the final design document are minimum values that will be constructed.

To determine the overtopping rate in the Monte Carlo analysis, the probabilistic overtopping formulations from Van der Meer are applied for levees (see text box below) and the Franco & Franco formulation for floodwalls. Besides the geometric parameters (levee height and slope), hydraulic input parameters for determination of the overtopping rate in Equations 1 and 2 are the water elevation (ζ), the significant wave height (Hs) and the peak wave period (Tp).

Van der Meer overtopping formulations

The overtopping formulation from Van der Meer reads (TAW, 2002):

$$\frac{q}{\sqrt{gH_{m0}^3}} = \frac{0.067}{\sqrt{\tan\alpha}}\gamma_b\xi_0 \exp\left(-4.75\frac{R_c}{H_{m0}}\frac{1}{\xi_0\gamma_b\gamma_f\gamma_\beta\gamma_v}\right)$$

$$with \quad \max imum: \quad \frac{q}{\sqrt{gH_{m0}^3}} = 0.2\exp\left(-2.6\frac{R_c}{H_{m0}}\frac{1}{\gamma_f\gamma_\beta}\right) \qquad (1)$$

With:

q : average overtopping rate [cfs/ft]

g : gravitational acceleration [ft/s2]

Hm0 : wave height at toe of the structure [ft]

ξ0: surf similarity parameter [-]

α : slope [-]

Rc : freeboard [ft]

γ : coefficient for presence of berm (b), friction (f), wave incidence (β), vertical wall (v)

The surf similarity parameter ξ0 is defined herein as $\xi_0 = \tan\alpha / \sqrt{s_0}$ with α the angle of slope and s_0 the wave steepness. The wave steepness follows from $s0 = 2\pi H_{m0} /(g\, Tm_{-10}^2)$. The coefficients -4.75 and -2.6 in Equation 1 are the mean values. The standard deviations of these coefficients are equal to 0.5 and 0.35, respectively and these errors are normally distributed (TAW, 2002). The reader is referred to TAW (2002) for definitions of the various coefficients for presence of berm, friction, wave incidence, vertical wall.

Equation 1 is valid for $\xi_0 < 5$ and slopes steeper than 1:8. For values of $\xi_0 > 7$ the following equation is proposed for the overtopping rate:

$$\frac{q}{\sqrt{gH_{m0}^3}} = 10^{-0.92}\exp\left(-\frac{R_c}{\gamma_f\gamma_\beta H_{m0}(0.33+0.022\xi_0)}\right) \qquad (2)$$

The overtopping rates for the range $5 < \xi_0 < 7$ are obtained by linear interpolation of Equation 1 and 2 using the logarithmic value of the overtopping rates. For slopes between 1:8 and 1:15, the solution should be found by iteration. If the slope is less than 1:15, it should be considered as a berm or a foreshore depending on the length of the section compared to the deep water wavelength. The coefficients -0.92 is the mean value. The standard deviation of this coefficient is equal to 0.24 and the error is normally distributed (TAW, 2002).

Figure 16 graphically shows the overtopping for a levee and floodwall situation including the most relevant parameters.

In the design process, the best estimate 1% values is used for these parameters from the JPM-OS method (White Paper, 2007); uncertainty in these values exists. Resio (2007) has provided a method to derive the standard deviation in the 1% surge elevation. Standard deviation values of 10% of the average significant wave height and 20% of the peak period were used (Smith, 2006, pers. comm.). In absence of data, all uncertainties are assumed to be normally distributed.

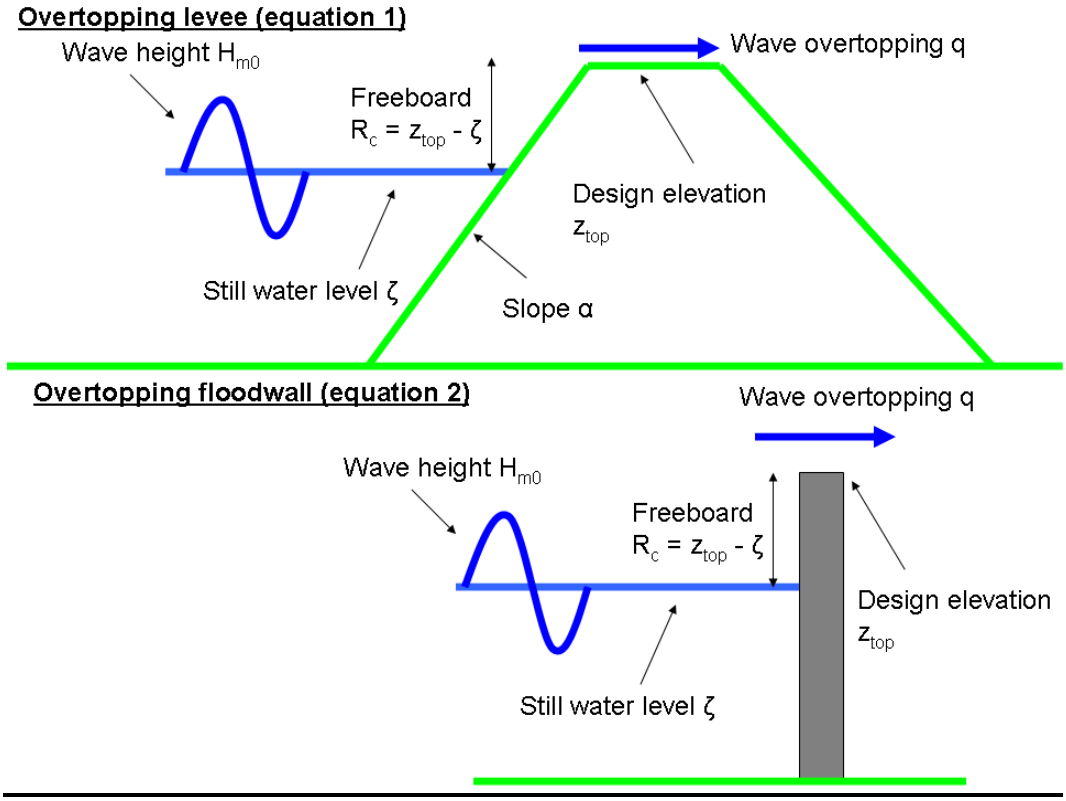


Figure 16 Definitions for Overtopping for Levee and Floodwall

The Monte Carlo Analysis is executed as follows:

1. Draw a random number between 0 and 1 to set the exceedance probability (p).
2. Compute the water elevation from a normal distribution using the mean 1% surge elevation and standard deviation as parameters and with an exceedance probability (p).
3. Draw a random number between 0 and 1 to set the exceedance probability (p).
4. Compute the wave height and wave period from a normal distribution using the mean 1% wave height/wave period and the associated standard deviation and with an exceedance probability (p).
5. Repeat steps 3. and 4. above for the three overtopping coefficients independently.
6. Compute the overtopping rate for these hydraulic parameters and overtopping coefficients determined in steps 2., 4. and 5. above using the Van der Meer overtopping formulations for levees or the Franco & Franco equation for floodwalls (see Equations 1 and 2 in the textbox).
7. Repeat Steps 1. through 5. above a large number of times. (N)
8. Compute the 50% and 90% confidence limit of the overtopping rate. (i.e., q_{50} and q_{90})

The procedure is implemented in the numerical software package MATLAB because it is a computationally intensive procedure. MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis and numeric computation.

Results

Figure 17 displays an example of MATLAB Monte Carlo-based output for the 50yr design of segment 1 for Year 2020 conditions with a 1:4 levee slope. The final 50yr design elevation at 7.0 ft. NAVD88 was selected to limit the overtopping rates below 0.01 cfs/ft. with 50% assurance, and limit the overtopping rate below 0.10 cfs/ft. with 90% assurance. For a robust design, the Monte Carlo-based design methodology accounts for the uncertainty of the hydraulic boundary conditions, and the uncertainty in the Van der Meer overtopping equations. Table 8 contains the final design elevations for the 50yr, 100yr and 500yr conditions for all 4 SLR scenarios. Design elevations are determined for both 1:3 and 1:4 levee slopes. Figure 18 displays the 7 design reaches for the project.

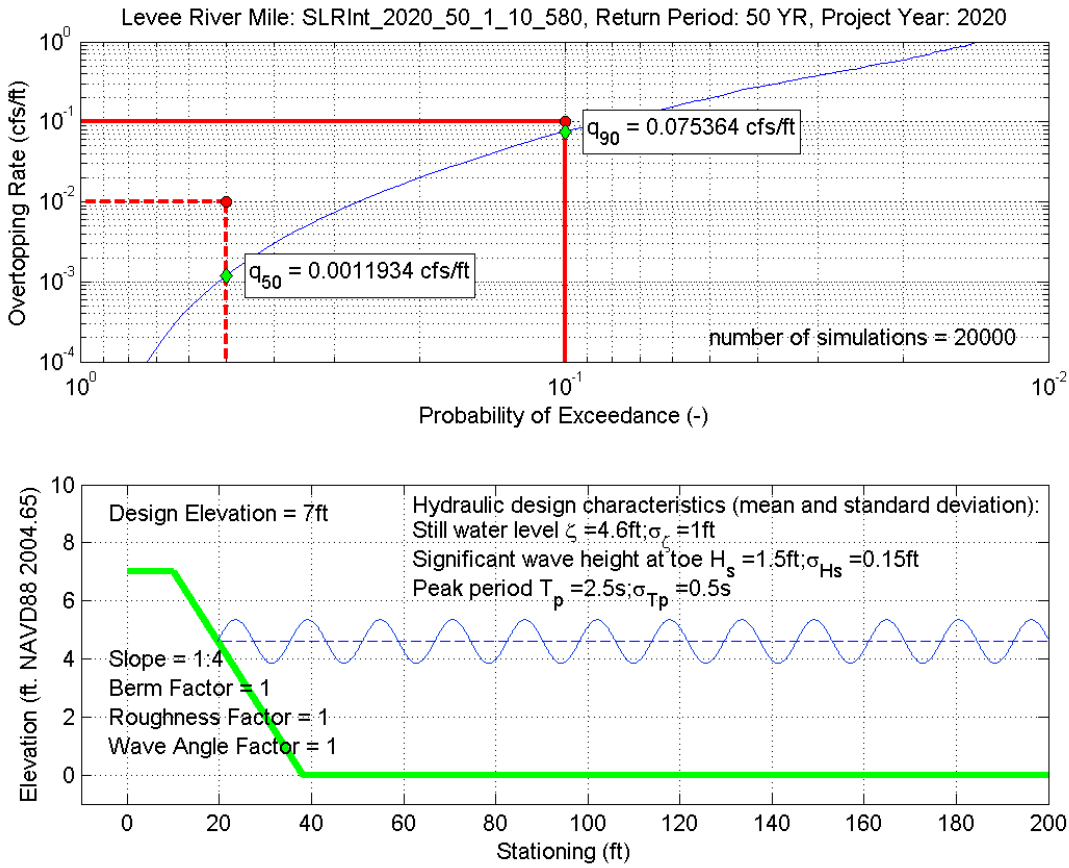


Figure 17 Monte Carlo-Based Hydraulic Design Output for Reach 1, 50yr, Year 2020

Table 8 Final Design Elevations (All elevations are in ft. NAVD88)

Levee Section	Reach	ID	Design Year	50YR Levee Elevation with 1:3 slope	100YR Levee Elevation with 1:3 slope	200YR Levee Elevation with 1:3 slope	50YR Levee Elevation with 1:4 slope	100YR Levee Elevation with 1:4 slope	200YR Levee Elevation with 1:4 slope
2020int_50_1_534	1	534	2020 int	7	8.5	10	6.5	8	9.5
2020int_50_2_439	2	439	2020 int	8.5	10	11.5	8	9.5	11
2020int_50_3_337	3	337	2020 int	9.5	11.5	12.5	9.5	11	12.5
2020int_50_4_365	4	365	2020 int	11.5	14	15.5	11.5	13.5	15
2020int_50_5_644	5	644	2020 int	12.5	15	17	12	14.5	16.5
2020int_50_6_117	6	117	2020 int	13	15	16.5	12.5	14.5	16.5
2020int_50_7_132	7	132	2020 int	13	15	16.5	12.5	14.5	16
2070low_50_1_534	1	534	2070 low	12.5	15	17	12	14	16
2070low_50_2_439	2	439	2070 low	14	16	18	13	15.5	17.5
2070low_50_3_337	3	337	2070 low	14.5	16.5	18.5	14	16	17.5
2070low_50_4_365	4	365	2070 low	15.5	17.5	19	14.5	16.5	18.5
2070low_50_5_644	5	644	2070 low	16	18.5	20.5	15	17.5	19.5
2070low_50_6_117	6	117	2070 low	17	19	20.5	16	18	19.5
2070low_50_7_132	7	132	2070 low	17.5	19.5	21.5	16.5	19	20.5
2070int_50_1_534	1	534	2070 int	13.5	16	17.5	12.5	15	17
2070int_50_2_439	2	439	2070 int	14.5	17	19	14	16	18.5
2070int_50_3_337	3	337	2070 int	15.5	17.5	19	14.5	16.5	18.5
2070int_50_4_365	4	365	2070 int	16	18	19.5	15	17	19
2070int_50_5_644	5	644	2070 int	16.5	19	21	15.5	18	20
2070int_50_6_117	6	117	2070 int	17.5	19.5	21	16.5	18.5	20
2070int_50_7_132	7	132	2070 int	18	20	22	17	19.5	21
2070high_50_1_534	1	534	2070 high	15	18	20.5	14	17	19.5
2070high_50_2_439	2	439	2070 high	16	19	22	15.5	18.5	21
2070high_50_3_337	3	337	2070 high	17	19.5	21.5	16	18.5	21
2070high_50_4_365	4	365	2070 high	17	19.5	21.5	16	18.5	20.5
2070high_50_5_644	5	644	2070 high	17.5	20.5	22.5	16.5	19.5	21.5
2070high_50_6_117	6	117	2070 high	18.5	21	22.5	17.5	20	22
2070high_50_7_132	7	132	2070 high	19	21.5	23.5	18	20.5	22.5

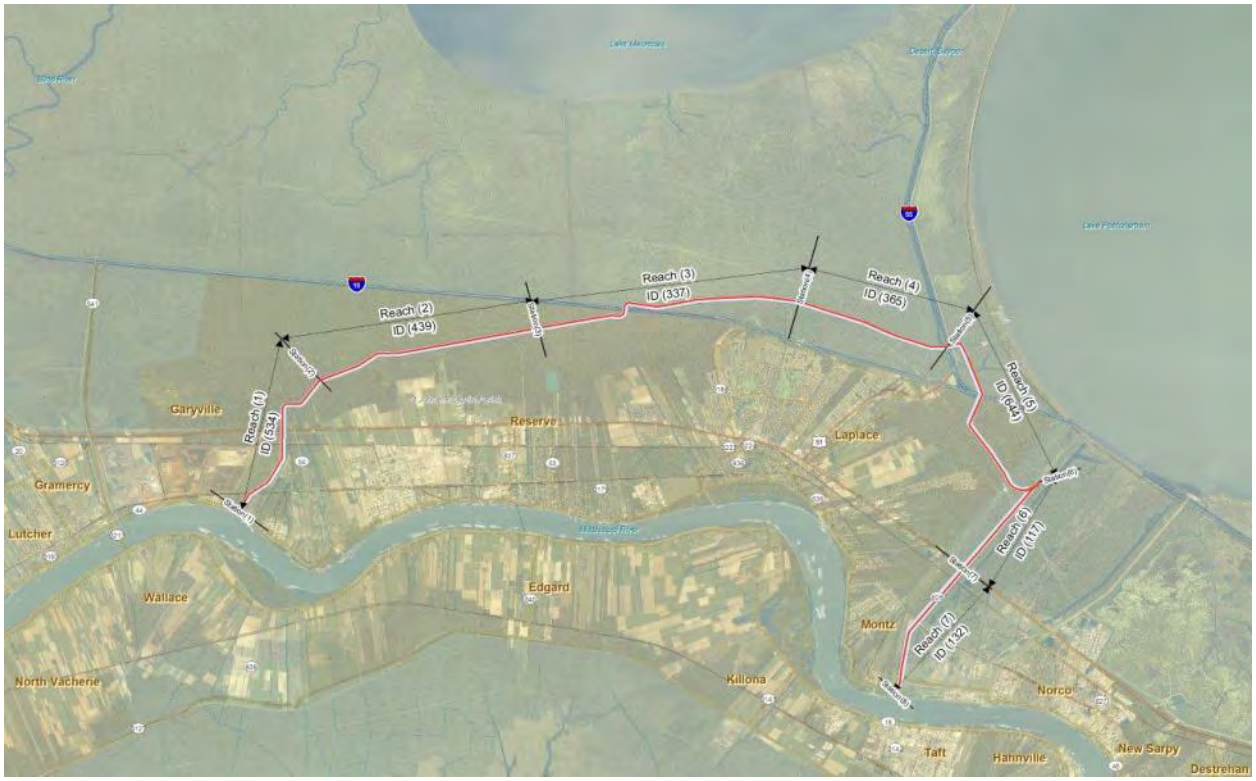


Figure 18 Project Levee Reaches

Sub-planning Stage Frequency

In the coastal area, the risk of flooding is dominated by storm surge. Inland areas might be more prone to flooding by heavy rainfall. In the analysis, both hazards have been evaluated. In order to conduct the economic analysis, the 2-, 5-, 10-, 25-, 50-,100-, 200- and 500-year stages have been developed for each of the sub-planning units in the study area.

The storm surge modeling does not include the effects of rainfall. The storm surge modeling is not capable of producing stages for higher frequency events such as the 2-, 5-, 10- and 25-year events. The suite of storms selected for the modeling is selected to produce stage frequencies for 50-year events and above. Therefore, for higher frequency events, it is preferable to use gage data for developing the stage-frequency. However, no long term gage data is available for the project area.

For the project area sub-planning units, the stage-frequency data developed through the hydrologic modeling were combined with the stage-frequency data developed through the surge modeling so as to develop complete stage-frequency data for the economic analysis.

Tables that contain the combined stage-frequency curves for the 2-, 5-, 10-, 25-, 50-, 100-, 200- and 500-year events for each sub-planning unit (for with- and without-project) were provided for economic analysis.

Induced Flooding

Stage-frequency data were developed for each of the sub-basins in the economic analysis. Figure 19 displays the 100-year stillwater elevations for the Base Year 2020 condition. The values at these locations include the effects of rainfall and surge as discussed in the previous section. Figure 20 displays the 100-year stillwater elevations for the with-project Year 2020 condition. Figure 21 displays the difference in the 100-year stillwater elevations between the with- and without-project condition for Year 2020. A positive number represents an increase due to the Alignment C condition. Figure 22 displays the difference in the 100-year stillwater elevations between the with- and without-project condition for Year 2070 with intermediate SLR.

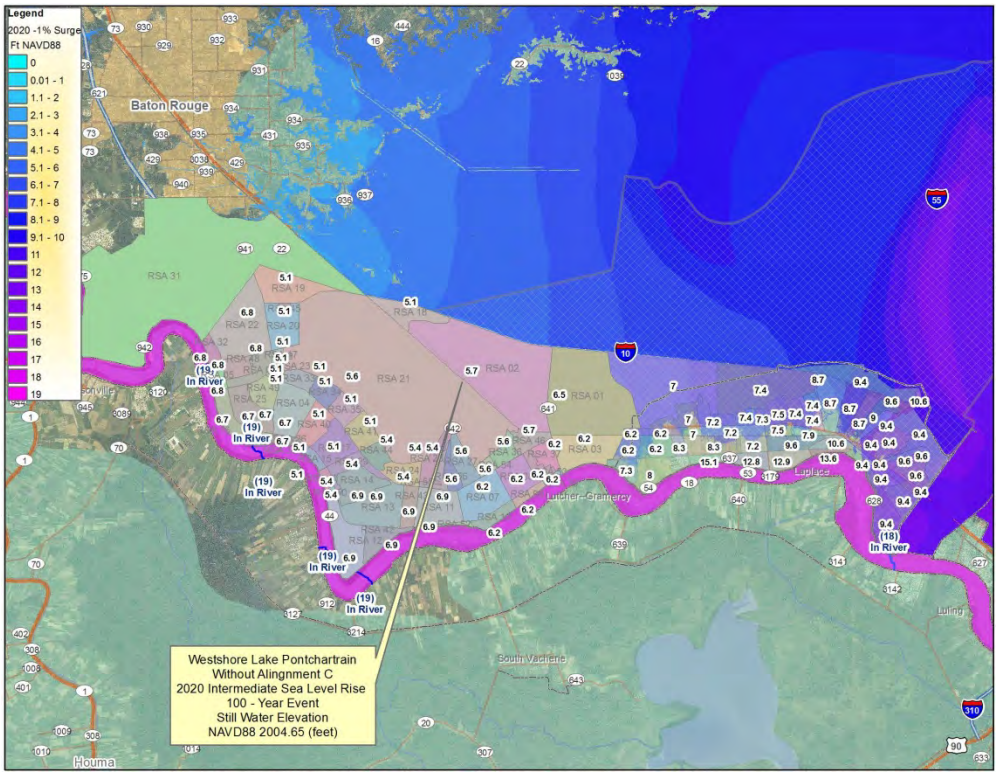


Figure 19 100-Year Stillwater Elevations for Year 2020-Intermediate SLR Condition – Without-Project

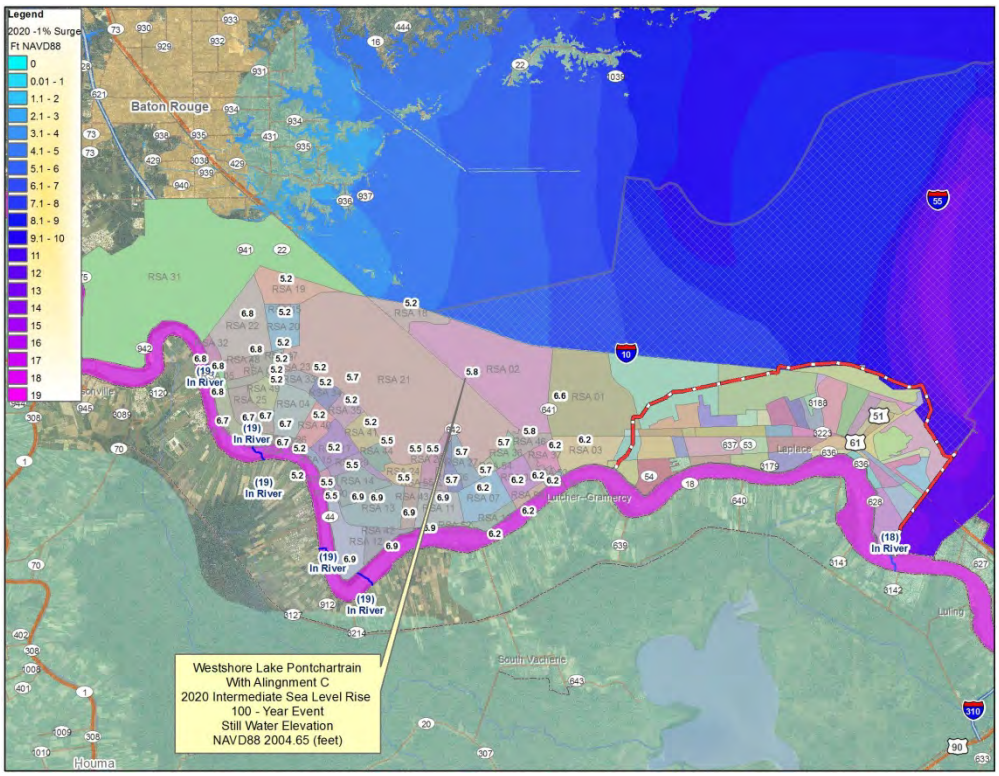


Figure 20 100-Year Stillwater Elevations for Year 2020-Intermediate SLR Condition – With Alignment C

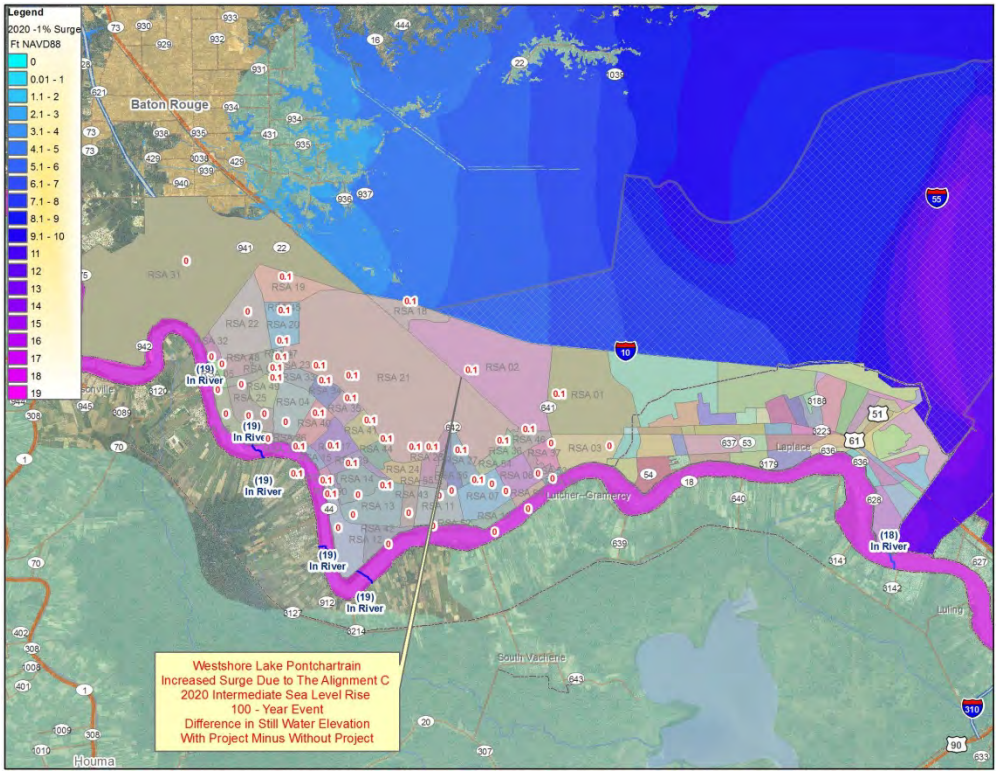


Figure 21 Difference Between With- and Without-Project for Year 2020-Intermediate SLR conditions

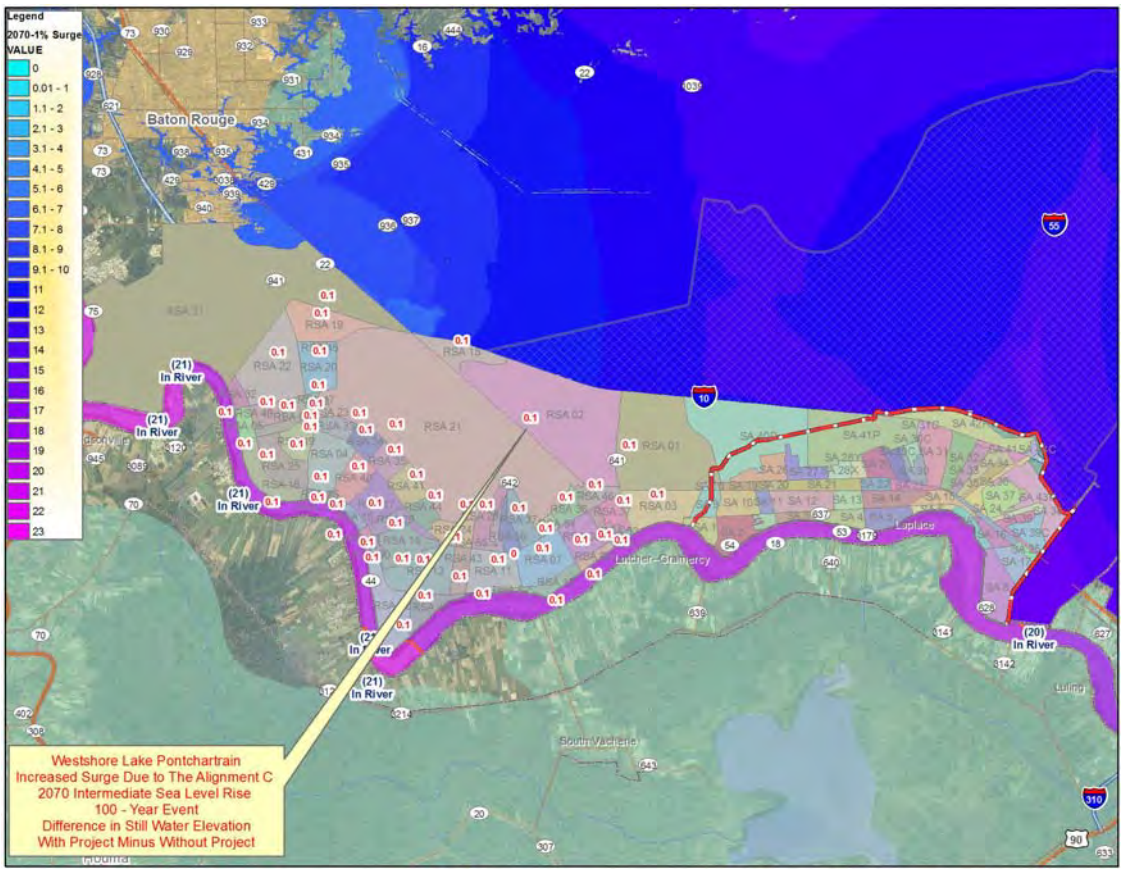


Figure 22 Difference Between With- and Without-Project for Year 2070-Intermediate SLR conditions

Geotechnical

Background and Furnished Information. As described at the beginning of this Appendix, the three levee alignments (A, C and D) were evaluated as part of the screening level effort. Levee cross section templates were developed based upon the proposed levee elevations and the geologic soil reaches. The analyses were based on Proposed Levee Elevations applicable to multiple alignments and for 11 soil reaches. Levee settlement estimates, recommended levee overbuild elevations and the number of projected levee lifts for Proposed Levee Elevations at Years 2020 and 2070 were also developed.

With Alignment C designated as the Recommended Plan, revised hydraulic design criteria were developed to meet increased intermediate sea level rise (SLR) elevations which resulted in increasing the Year 2020 and Year 2070 Proposed Levee Elevations to elevations greater than those used for screening analyses. A summary of the revised hydraulic design criteria for applicable soil reaches in Alignment C is shown in Table 9. These levels consider the previous-analyzed levee considering 1V:3H side slopes and no wave berms.

TABLE 9: REVISED ALIGNMENT C HYDRAULIC DESIGN CRITERIA

SOIL DESIGN REACH	ELEVATION (NAVD88)	
	REVISED Proposed Levee Elevation (2020)	REVISED Proposed Levee Elevation (2070)
1	8.5 / 10	16 / 17
2	10	17
4	11.5	17.5
7	11.5	17.5
8	14 / 15	18 / 19

Application of Soil Design Reaches. As noted in Table 9 above, five of the 11 soil design reaches have been identified as being applicable to Alignment C and the current hydraulic design levels. Selection of the application of these reaches were based on the original soil reach locations, the levee sections developed for the screening study, levee lift construction recommendations, original design elevations and current design elevations. These soil design reaches were then correlated to the 22 design sections previously developed (based upon the original 8 proposed levee elevation reaches, the 7 stillwater elevation reaches and the 10 geologic reaches) for this levee alignment and designated as C-1 through C-22.

Revised Analyses and Modified Recommendations. The revised hydraulic design criteria increased the Proposed Levee Elevations in Year 2020 and Year 2070; prior analyses were reviewed and additional analyses performed to assess where modifications to previous recommendations were necessary.

Considering limited changes in Proposed Levee Elevations previously analyzed and original computed factors of safety, it was recommended that the templates developed for soil reaches 1, 2, 4 and 7 be utilized to evaluate the new design grades. Soil Reach 8 for the Year 2020 Proposed Levee Elevation of El. +14 was also still applicable. The stability berm geometries and geosynthetic fabric lengths shown in previous analyses do not require further modifications and the recommended overbuild remains as 1.5 feet for these Year 2020 sections.

In Soil Reach 8 where the Year 2020 Proposed Levee Elevation is at El. +15, additional analyses were performed to evaluate the higher proposed grades. Increased stability berm dimensions and increased geosynthetic reinforcement fabric length were recommended in order to achieve the minimum required factors of safety. The revised dimensions and geometry should be applied to Alignment C for stations previously identified as C-1 through C-5.

As noted previously, stability analyses were not conducted for the Year 2070 Proposed Levee Elevations. Rather, sufficient gain-in-strength was assumed to occur over the life of the levee and as subsequent lifts are placed. In general, the change in grade between the new Year 2020 Proposed Levee Elevations and new Year 2070 Proposed Levee Elevations varies between 5 and 8 feet. The original change in grade averaged about 5 feet for the previous analyses. It should be noted that the 8-ft. grade change occurs where the highest factors of safety are computed for the Year 2020 Proposed Levee Elevations.

In general, the lift schedule described in the screening analysis should be followed, but the thickness of the lifts at Years 2030, 2045 and 2060 will be increased where the net grade change is increased.

Additional Considerations. As previously noted, the limited geotechnical data for this screening study required the development of assumed time-rate of settlement parameters for estimates of lift thickness and lift construction recommendations. However, even these assumptions would not address the stress history and time-rate away from the boring locations. Because Alignment C is located within a previously undeveloped area, additional lifts or increased lift thickness may be required.

Datum and Topography

As discussed in the **Datum and Topography** section of the **Screening Phase (Background) Information** section of this Appendix, all elevations used in the design were NAVD88-2004.65 datum. Any elevation data not in the NAVD88-2004.65 datum was adjusted prior to use.

Civil / Structural Design

The same set of standard details developed during the screening analysis to provide a schematic elevation view of the typical pump station T-Wall, Interstate T-Wall, Roadway/Railroad Floodgate T-Wall and Pipeline T-Wall were utilized for the Recommended Plan.

The revised design levee elevations for Alignment C were reduced from eight during the screening analysis to five in the recommended plan analysis. It was decided to maintain the same 22 levee design section limits in order to correlate and compare the screening and the recommended plan design sections. The design sections were adjusted based upon the revised geotechnical levee template, the proposed connector canal, and the proposed frontal ditch. A frontal ditch was added to the levee footprint to minimize wetland impacts. Typical Section drawings of the alignment can be found in Annex 3 of this Appendix.

As was done during the screening analysis, special attention was made to locate the right-of-way limits for the proposed levee sections to coincide with the existing rights-of-way from highways, pipelines, etc. to avoid remainder parcels that were nonfunctional to the original owner. This was accomplished since the growth of the levee template and frontal ditch was toward the unprotected side of the project and the highway and pipeline rights-of-way are on the protected side of the project.

Access Routes and Staging Areas. Potential access routes and staging areas have been identified during the feasibility-level design of the recommended plan alignment. Potential access roadways were identified by using aerial imagery to identify existing features along Alignment C. The aerial imagery utilized for the evaluation consisted of Google Earth imagery dated 05 March 2013 and 2004 Digital Orthophoto Quarter Quadrant (DOQQ) imagery available from the Louisiana State University Atlas Database website (http://atlas.lsu.edu). The Google Earth imagery was used to identify potential access points and the 2004 DOQQ was used to document the potential access points on the drawings.

Alignment C is primarily through wetland areas and adjacent to a major pipeline corridor. While the existing pipeline corridor has already been clear cut and mitigated, the corridor was excluded based upon construction loading being detrimental to existing pipelines.

The next approach was to identify potential access via direct access points, existing access points and new access points in that order of selection hierarchy. Since the proposed alignment crosses existing public roadways such as U.S. Highways 51 and 61, Louisiana Highway 44, Frenier Road and Oak Park Boulevard, direct access to the levee right-of-way could be obtained for construction. Existing access consisting of aggregate and dirt roads were identified along the alignment. There were twelve aggregate and dirt roads identified along the alignment with one being located within Louisiana State lands and the remainder being within what is assumed to be private lands. Actual ownership was not determined but assessed and evaluated from existing large tract ownership maps available to the project design team. Potential new access points consisted of potential new roadways through the wetlands to the levee right-of-way. Typically, these were potential new road extensions of existing aggregate or dirt roadways. There were three potential new access road (extensions) identified from the aerial imagery. This process identified twenty potential access roads for construction of the project.

The twenty potential access roads identified are in excess of what is needed for construction of an 18-mile levee. Some of the potential access roads were selected to form a recommended list of potential access roads based upon the selection criteria described above and the potential haul distances between the access points. The recommended list includes three direct accesses, six existing accesses and three new accesses for a total of twelve access points. A one-acre staging area was allocated for all twelve access points for haul ticket collection and truck wash-down. During the P.E.D. phase of the project, these routes and staging areas will be finalized.

Borrow Sources. Borrow material for this project would come from the Bonnet Carré Spillway. The project design team has reviewed the potential for obtaining all of the required borrow for this project from the spillway. They believe the spillway has adequate clay material available for this project. An alternative borrow pit investigation has not been conducted at this time.

Quantities. Quantities were computed for clearing and grubbing, geotextile, earthwork, aggregate roadway, turf establishment, T-Walls, drainage gates, roadway gates, railroad gates, pump stations and pipeline relocations in the same manner as during the screening evaluation. The quantities for clearing and grubbing, geotextile, earthwork and turf establishment increased based upon the revised levee elevation and template changes. New quantities for access roads and staging areas were computed including clearing, grubbing and aggregate roadway. The revised and new quantities have been included in the MII Cost Estimate.

Relocations

The assumption for Alignment C was that a pipeline floodwall would be required wherever a pipeline crossed the levee footprint. The pipeline would cross through a cutoff wall under the pipeline floodwall. It was decided that the existing carrier line would remain in operation while a bypass line would be constructed through a sleeve in the T-wall cutoff piles. When the bypass would be completed and in place, the switch over-tie in with the existing line then would follow along with the removal of the abandoned pipeline. These assumptions are consistent with the screening level assumptions. For the recommended plan, it was assumed the pipeline would be relocated for the full right-of-way width of the proposed levee to accommodate the proposed protected side canal and the unprotected side ditch. A pipeline relocation length of 600 feet was used versus the widest right-of-way of 541 feet. The costs for relocations have been included in the MII Cost Estimate.

Cost Estimates

The project cost estimate was developed in the MCACES MII cost estimating software and used the standard approaches for a feasibility estimate structure regarding labor, equipment, materials, crews, unit prices, quotes, sub- and prime contractor increases above costs. This philosophy was used wherever practical within the time constraints. It was supplemented with estimating information from other sources where necessary such as quotes, bid data and A/E estimates. The estimate is structured to reflect the project construction tasks performed. The estimate has been subdivided by USACE feature codes and by the 22 levee design reaches (levee and floodwalls), 36 pipeline relocations and 4 pump stations. The cost estimate included consideration of labor rates, materials, equipment, fuel, crew production, relocation, mob/demobilization, field and office overhead, taxes, bonds, engineering, contingencies and escalation. A construction schedule was developed to provide 100-year protection from project design year of 2020 through the project life span of 50 years to Year 2070. Annex 1 to this Appendix contains the Cost Engineering Report, the MII Cost Estimate, the Project Construction Schedule and the Summary Cost Schedule Risk Analysis (CSRA). Annex 2 to this Appendix contains the Detailed CSRA.

References

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ER 1110-1-8159, Engineering and Design, DrChecks, 10 May 2001.

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ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, 31 December 2013.

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CECW-CE, Engineering and Construction Bulletin, No. 2004-13, Issued 30 Aug 2004.

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USACE New Orleans District Guide for Minimum Survey Standards for Performing Topographic, Hydrographic, and Static GPS Control Surveys (Edition 2.1).

Louisiana State Plane Coordinate System South Zone (1702) using North American Datum of 1983 (NAD83) for horizontal datum.

North American Vertical Datum of 1988 Epoch 2004.65 (NAVD88-2004.65) for vertical datum.

ER 1110-1-12, Engineering and Design, Quality Management, dated September 30, 2005.

JPM-OS method (White Paper on Estimating Hurricane Inundation Probabilities for Storm Selection and Statistics Reference (dated 10 June 2007)

Resio (2007)

Smith, 2006, pers. comm.

SCREENING PHASE (BACKGROUND) INFORMATION

The following information below was used in the plan formulation process to identify the tentatively selected plan (TSP) described in the Draft Report. The Draft Report was presented to the public on August 23, 2013. The information below is the same information presented in the Draft Report and does not reflect changes to the TSP recommendation that occurred after the publication of the Draft Report. The information is included to inform the reader of the planning process as it had been conducted up to publication of the Draft Report. After the release of the Draft Report, the team refined the design of the TSP with additional engineering and environmental investigations. This information is presented in the sections above. Based on feasibility level of design and based on comments received following publication of the Draft Report, portions of the TSP was modified. For the full details of the additional planning efforts a brief description of those modifications please see section 3.9 and section of the main report.

Figure 23 displays the 3 alternative alignments that were presented to the public in the August 2013 Draft Report

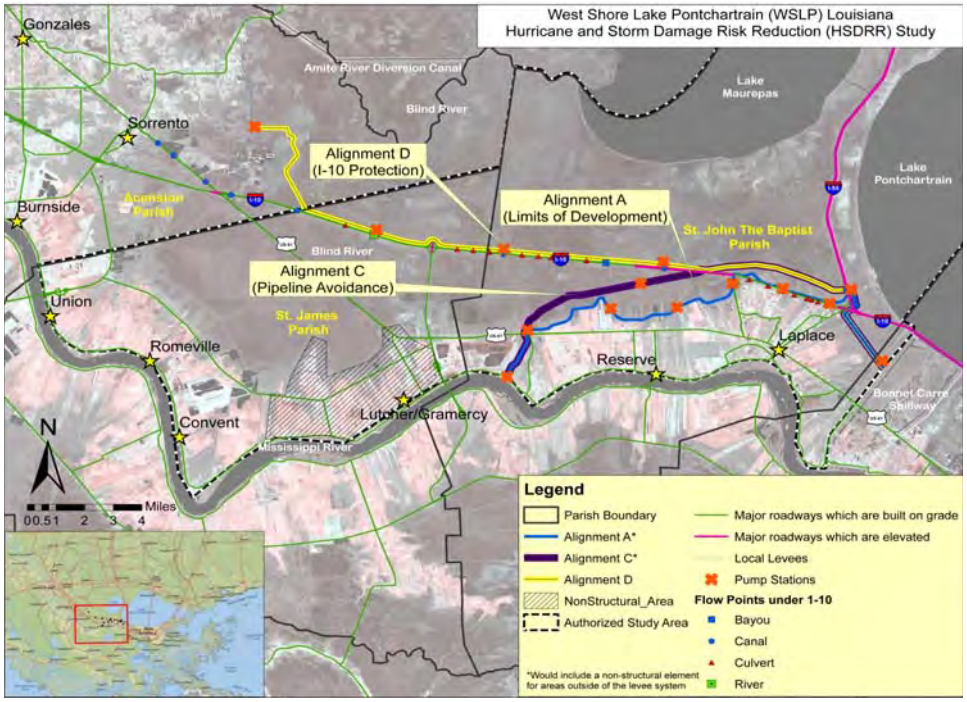

Figure 23: The Three Alternative Alignments

Alternative A

Alternative A starts at the Upper Guide Levee of the Bonnet Carre Spillway in St. Charles Parish, LA (north of the transmission and pipeline corridors), extends west around the I-10/I-55 interstate interchange and ends at the Mississippi River Levee just west of the Hope Canal in St. John the Baptist Parish, LA, a distance of 20.41 miles. The earthen levee generally follows

the wet/dry interface. The following information is based on modeling for a 100-year level of risk reduction in the Baseline Year of 2020 for a period of evaluation of 50 years.

The top of levee elevation (net elevation) for this alignment ranges from El. 13.5 NAVD88 on the eastern reaches of the levee near the Bonnet Carre Spillway and gradually tapering to El. 7.0 NAVD88 as the levee moves west across the project .

Floodwalls

Ten Floodwalls (T-type walls), comprising a total of 4,774 linear feet, range from 10 ft. to 19 ft. in height; the top of wall design elevation is El. 17.0 NAVD88. The floodwalls, for the most part, are located where the alignment runs under I-10 and the I-10/I-55 interchange.

Floodgates

Nine Floodgates, comprising a total of 1,218 linear feet, range from 10 ft. to 19 ft. in height; the top of gate design elevation is El. 17.0 NAVD88. The floodgates, for the most part, are located along the alignment, usually where canals and roads are. Additionally, two 25-ft. wide railroad swing gates (each 11 ft. high) are included for those instances where the levee crosses the railroad.

Drainage Structures

Gravity Drainage Structures (with sluice gates), comprising a total of 240 linear feet, range from 20 ft. to 29 ft. in width. These are located near proposed pumping stations.

Pumping Stations

There are 8 pumping stations located along the alignment. The different sizes (which assumes there is no storage capacity available) are as follows:

2 at 240 cfs each

1 at 328 cfs

1 at 400 cfs

2 at 460 cfs each

1 at 656 cfs

1 at 787 cfs

Pumping stations are located at the various canals that cross the alignment, such as the Hope, Mississippi Bayou, Reserve Relief, Ridgefield, Vicknair and Montz Canals. It is generally expected that the gates would be closed, and the pumps would be operated during tropical/hurricane storm surge events. Pumping would continue until the water level returns to existing natural water level conditions (currently estimated to be El. 2.0 NGVD), at which time the operation of the pumps would be discontinued and the gates would be opened.

Pipeline Relocations

There are numerous pipeline relocations involved in this alignment. The diameters of the various pipelines are as follows:

6 in. and less	18 pipelines
12 in. and less (but greater than 6 in.)	40 pipelines
24 in. and less (but greater than 18 in.)	11 pipelines
Greater than 24 in.	1 pipeline

Alternative D

Alternative D starts at the Upper Guide Levee of the Bonnet Carre Spillway in St. Charles Parish, LA (north of the transmission and pipeline corridors), extends west around the I-10/I-55 interstate interchange, continues west along I-10 and ends at the Marvin Braud Pumping Station, in the vicinity of Sorrento (within the McElroy Swamp) in Ascension Parish, LA, a distance of 28.28 miles. The following information is based on modeling for a 100-year level of risk reduction in the Baseline Year of 2020 for a period of evaluation of 50 years and is subject to change based on further evaluation in future phases of the project. The top of levee elevation (net elevation) for this alignment ranges from El. 13.5 NAVD88 on the eastern reaches of the levee near the Bonnet Carre Spillway and gradually tapering to El. 8.0 NAVD88 as the levee moves west across the project area.

Floodwalls

Six Floodwalls (T-type walls), comprising a total of 4,011 linear feet, range from 15 ft. to 19 ft. in height; the top of wall design elevation is El. 17.0 NAVD88. The floodwalls, for the most part, are located where the alignment runs under I-10 and the I-10/I-55 interchange.

Floodgates

Three Floodgates, comprising a total of 306 linear feet, range from 15 ft. to 19 ft. in height; the top of gate design elevation is El. 17.0 NAVD88. The floodgates, for the most part, are located along the alignment, usually where canals and roads are.

Drainage Structures

Gravity Drainage Structures (with sluice gates), comprising a total of 396 linear feet, range from 20 ft. to 29 ft. in width. These are located near proposed pumping stations. For the Bayou Conway area, the required channel size is 24 ft. wide x 12 ft. deep (to convey 1,100 cfs of flow). For the Blind River area, the required channel size is 40 ft. wide x 20 ft. deep (to convey 4,500 cfs of flow).

Pumping Stations

There are 6 pumping stations located along the alignment. The different sizes (which assume there is no storage capacity available) are as follows:

1 at 200 cfs

1 at 400 cfs

1 at 450 cfs

2 at 1,100 cfs each (this includes the Bayou Conway area)

1 at 4,500 cfs (this is for the Blind River area)

Pumping stations are located at the various canals that cross the alignment, such as the Montz, Reserve Relief and Ridgefield Canals, as well as a local canal near approx. Baseline Station 951+00 and the Bayou Conway and Blind River areas. It is generally expected that the gates would be closed, and the pumps would be operated during tropical/hurricane storm surge events. Pumping would continue until the water level returns to existing natural water level conditions (currently estimated to be El. 2.0), at which time the operation of the pumps would be discontinued and the gates would be opened.

Pipeline Relocations

There are numerous pipeline relocations involved in this alignment. The diameters of the various pipelines are as follows:

6 in. and less	7 pipelines
12 in. and less (but greater than 6 in.)	6 pipelines
24 in. and less (but greater than 18 in.)	1 pipeline

There are at least two instances where the pipeline would cross through the floodwall (at approx. Baseline Station 1382+00 and at approx. Baseline Station 1404+00).

Culverts

There are 6 culverts (in addition to the culverts that exist under I-10) that facilitate tidal exchange of water with the wetlands.

Hydraulics and Hydrology

Interior Drainage

The interior drainage analysis for the feasibility study was broken down into two stages:

1) Determine the rough-order-of-magnitude (ROM) capacities of gravity drainage structures and pumps recommended to prevent project induced flooding for each of the proposed alignments (A, C and D).

2) For the tentatively selected plan (TSP), determine the capacities of gravity drainage structures and pumps using a detailed rainfall-runoff analysis.

For the ROM phase of the analysis, pump and gravity drainage recommendations were determined using an XP-SWMM model completed during the reconnaissance phase of the study for Alignments A and C. Figure 24 depicts the storage basin layout for used in the model. These basins correspond to the sizes and capacities listed in Table 10. Alignment D covers the area of Alignment C in addition to the drainage basins of the Blind River and Bayou Conway. Structures and pumps were sized for Blind and Conway using the HEC-HMS and HEC-RAS modeling suite. The recommendations are also listed in Table 10. All design values are based on a 10-yr, 24-hr rainfall.

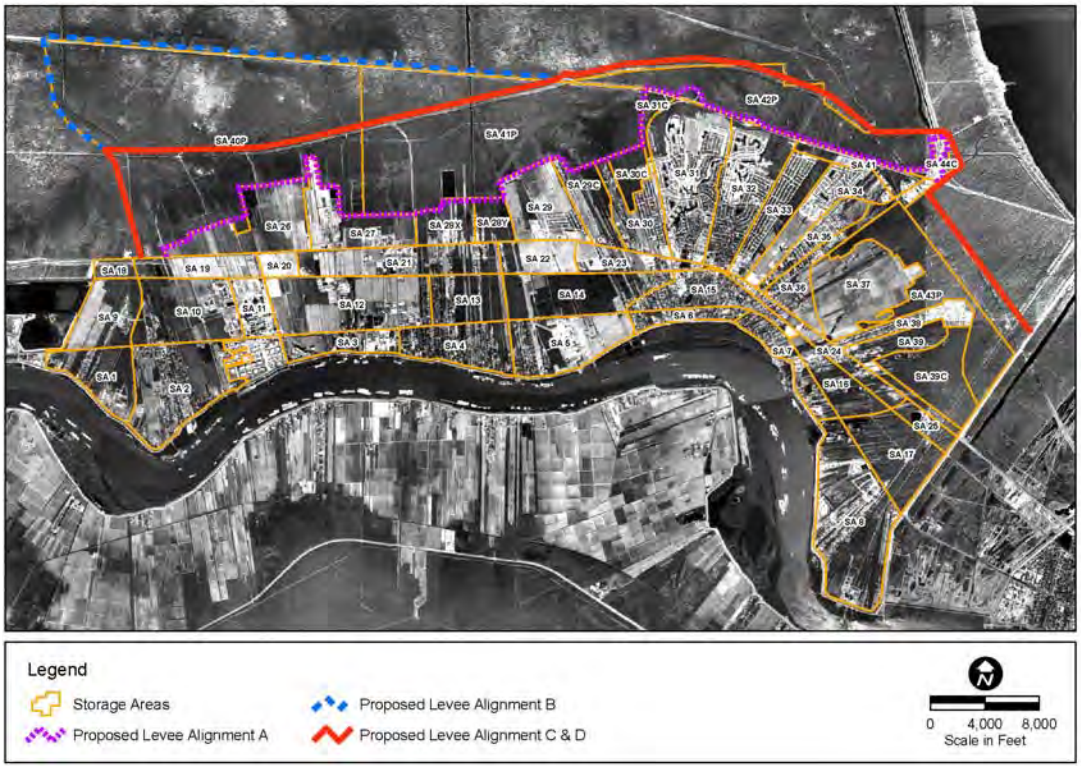

Figure 24: Storage Basin Layout

Table 10: ROM Determinations

Item / Location:	Alignment A	Alignment C and D	Blind River and Bayou Conway (Alignment D only)
Gravity Drain, SA-40P	1 RCBC*, 6' High by 20' Wide	1 RCBC, 6' High by 20' Wide	
Gravity Drain, SA-41P	2 RCBC's, 6' High by 20' Wide	2 RCBC's, 6' High by 20' Wide	
Gravity Drain, SA-42P	2 RCBC's, 6' High by 18' Wide	2 RCBC's, 6' High by 18' Wide	
Gravity Drain, SA-43P	2 RCBC's, 6' High by 18' Wide	2 RCBC's, 6' High by 18' Wide	
Pump Station, SA-40P	480 cfs	450 cfs	
Pump Station, SA-41P	1180 cfs	400 cfs	
Pump Station, SA-42P	920 cfs	200 cfs	
Pump Station, SA-43P	985 cfs	1100 cfs	
Gravity Drain, Blind River			40ft. wide, 20ft. deep rectangular cross section

Gravity Drain, Bayou Conway			24ft. wide, 12 ft. deep rectangular cross section is required
Pump Station, Blind River			1100 cfs
Pump Station, Bayou Conway			4500 cfs

*RCBC - Reinforced Concrete Box Culvert

Tropical/Hurricane Storm Surge Modeling

State-of-the-Art coastal ocean hydrodynamic analysis methods were used to determine the storm surge and wave results. The modeling system for this study was established by fine-tuning existing models used previously for the Joint Storm Surge (JSS) Analysis in Southern Louisiana for the Louisiana Coastal Protection and Restoration (LACPR) project, as well as the recent flood insurance rate map modernization study conducted by the Federal Emergency Management Agency (FEMA) (USACE 2008a; USACE 2007).

The data gathered from Advanced Circulation (ADCIRC) and the Steady State Spectral Wave (STWAVE) modeling were used to generate surge and wave return values ranging from the 50 year return to the 2000 year return in 50 year increments. A set of 152 hurricane condition storm events were used to develop an existing (2011) condition and future conditions for a 2020 intermediate relative sea level rise (SLR) and 2070 low, intermediate, and high SLR as well as alternative alignments intermediate SLR. The Joint Probability Method, with Optimum Sampling (JPM-OS) was applied for each data set to develop stage frequencies. The resulting levee design heights for the screening level effort for each alignment and for each condition (2011, 2020 and 2070) are shown on the following maps (Figures 25 through 33). It should be noted that, for Figures 28 through 33, the notation of "Considering Intermediate Sea Level Rise" on each of these maps refers to Intermediate Relative Sea Level Rise.

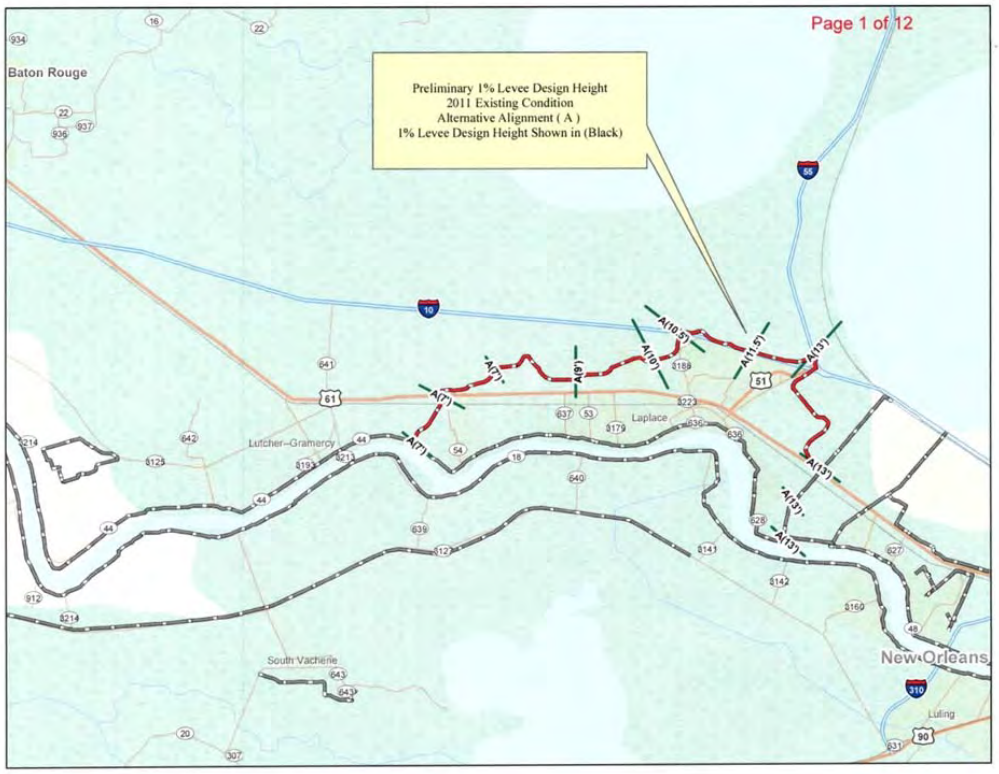

Figure 25: Levee Design Height Existing Conditions Alignment A

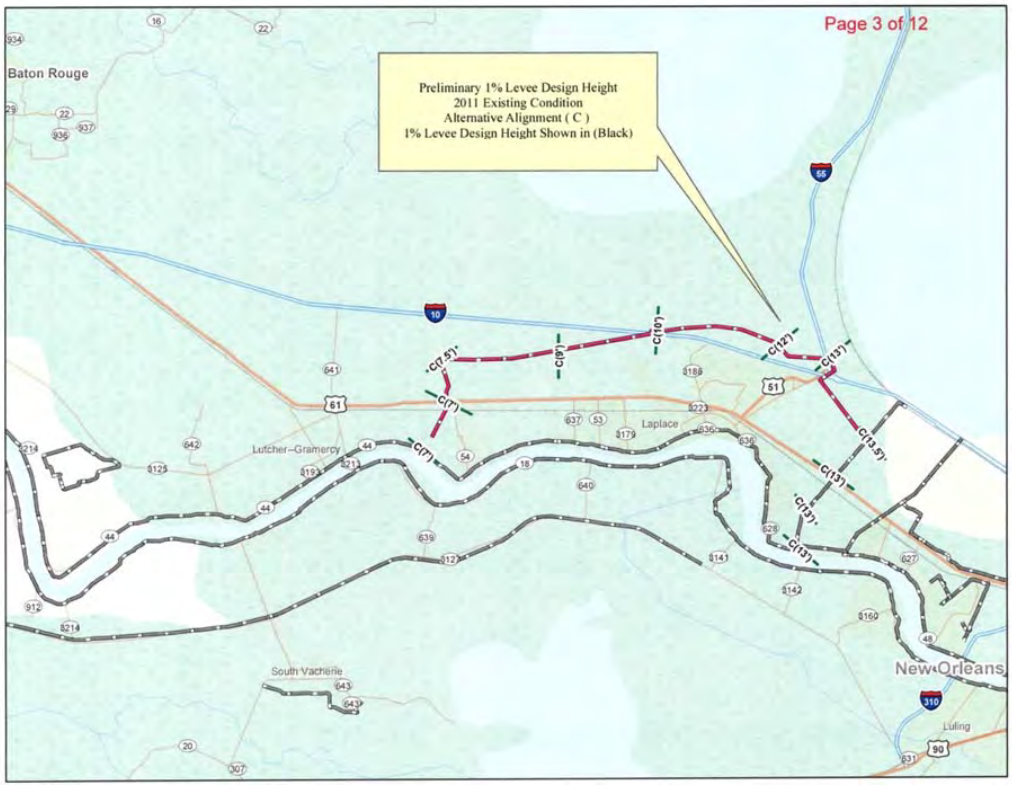

Figure 26: Levee Design Height Existing Conditions Alignment C

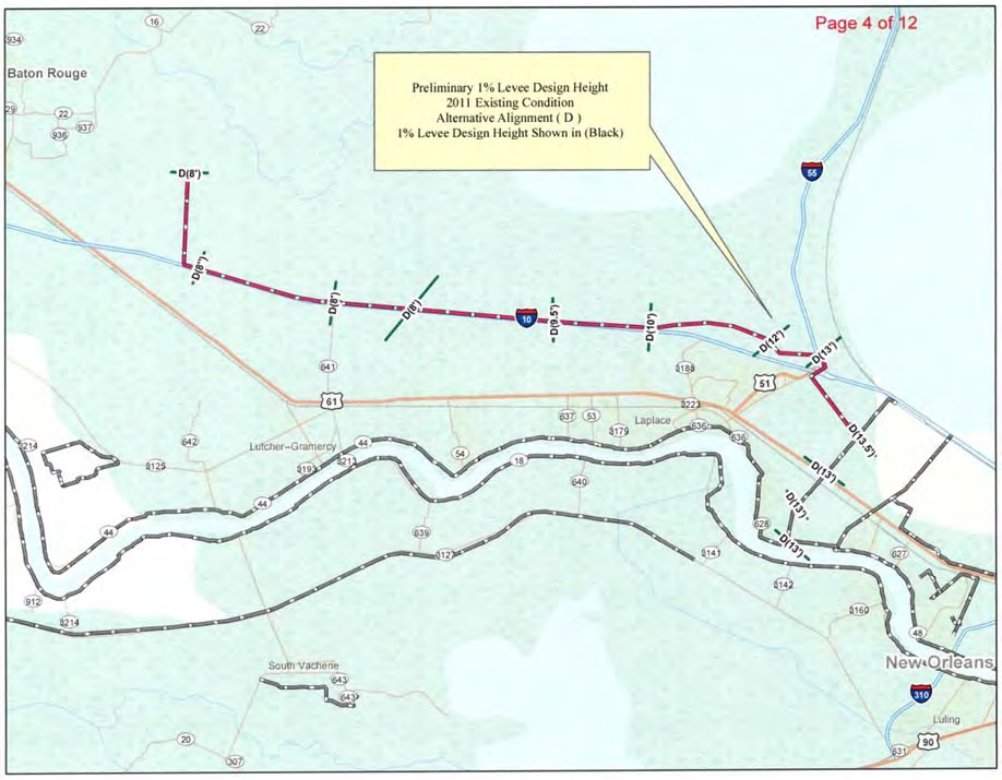

Figure 27: Levee Design Height Existing Conditions Alignment D

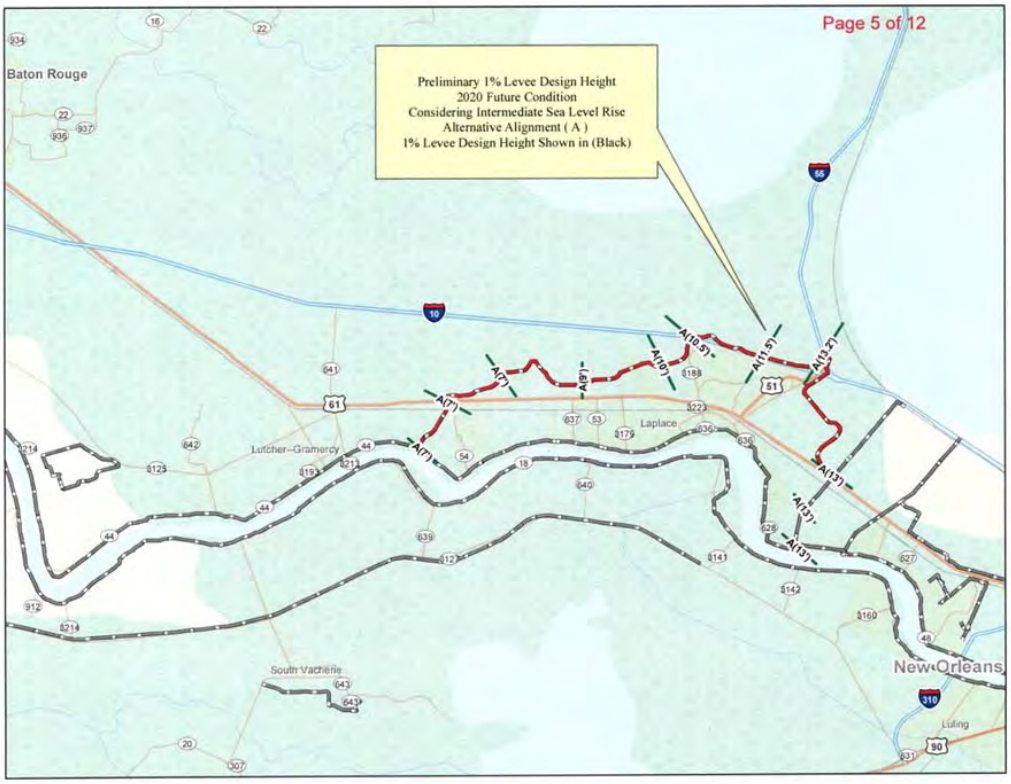

Figure 28: Levee Design Height 2020 Future Condition Alignment A

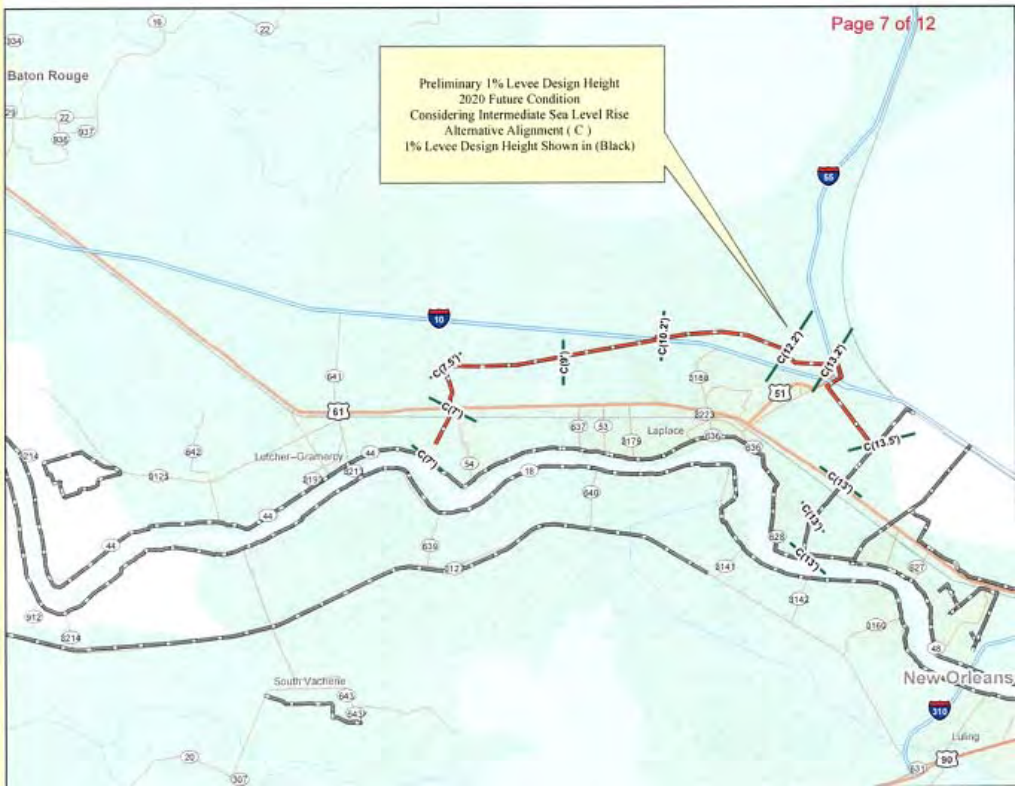

Figure 29: Levee Design Height 2020 Future Condition Alignment C

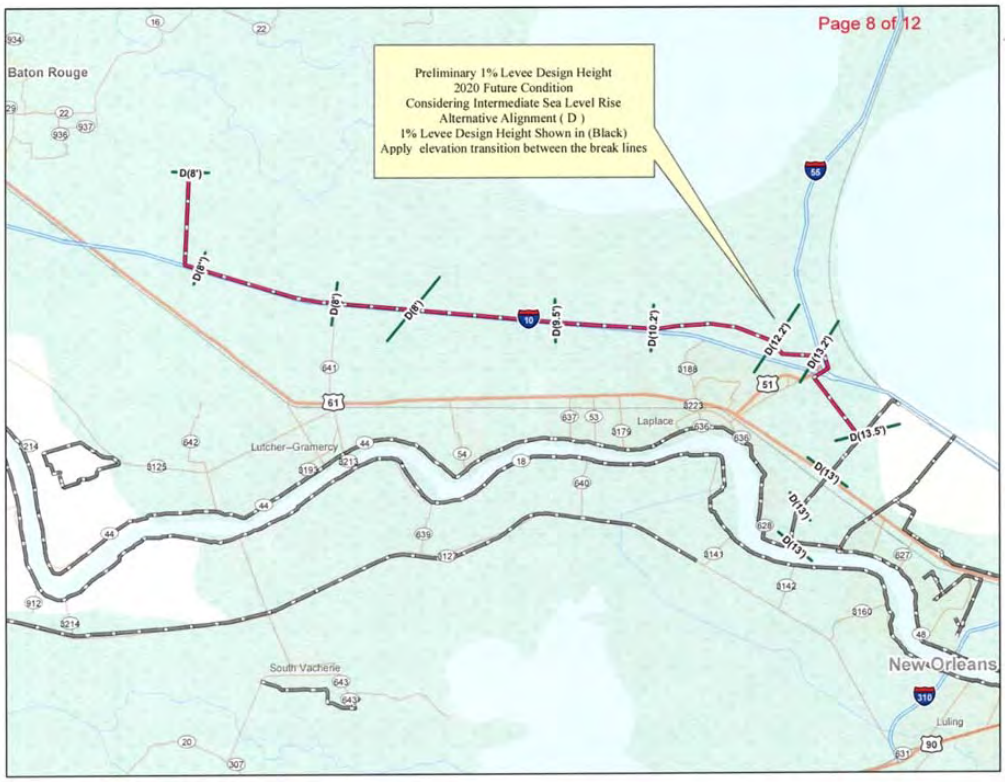

Figure 30: Levee Design Height 2020 Future Condition Alignment D

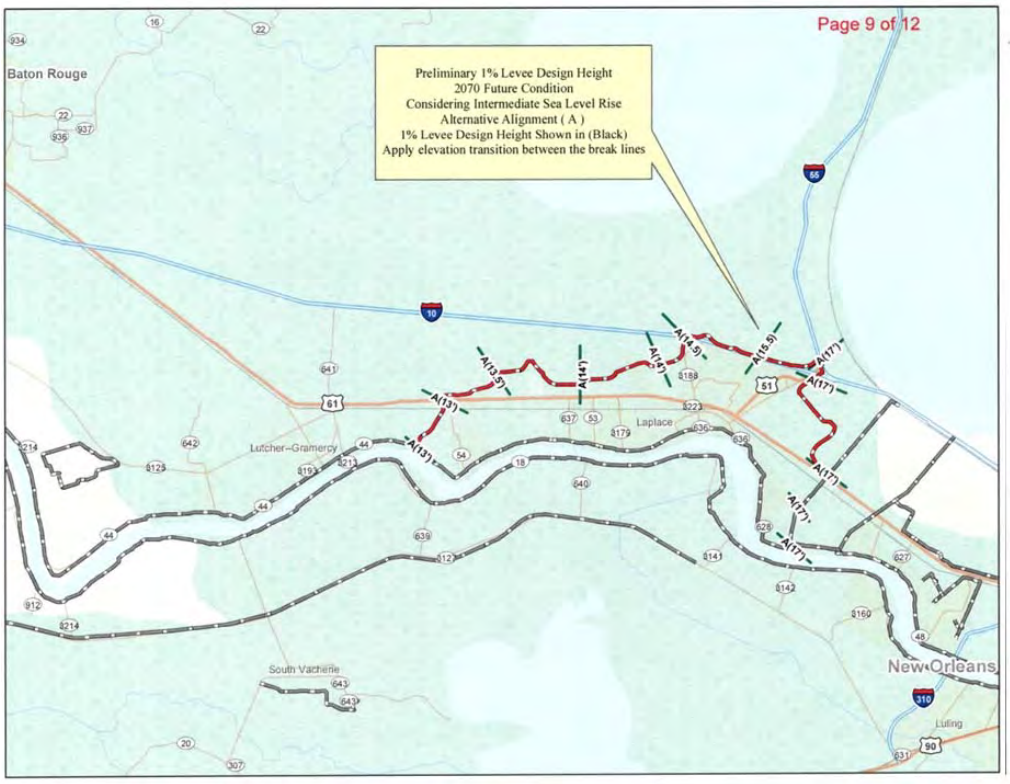

Figure 31: Levee Design Height 2070 Future Condition Alignment A

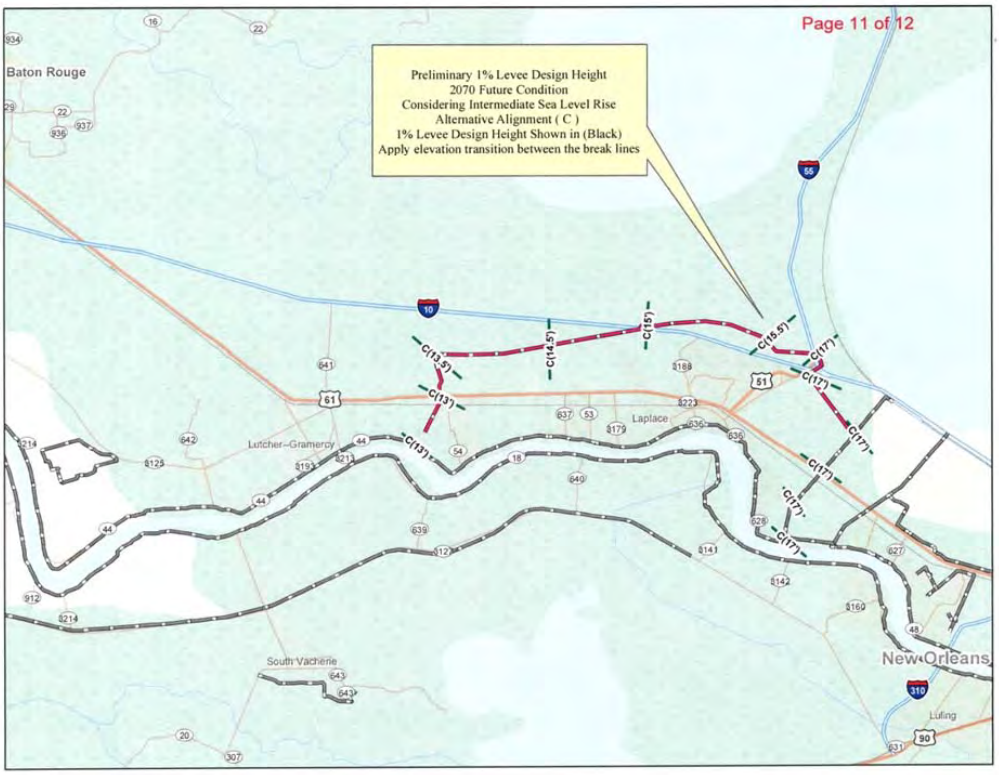

Figure 32: Levee Design Height 2070 Future Condition Alignment C

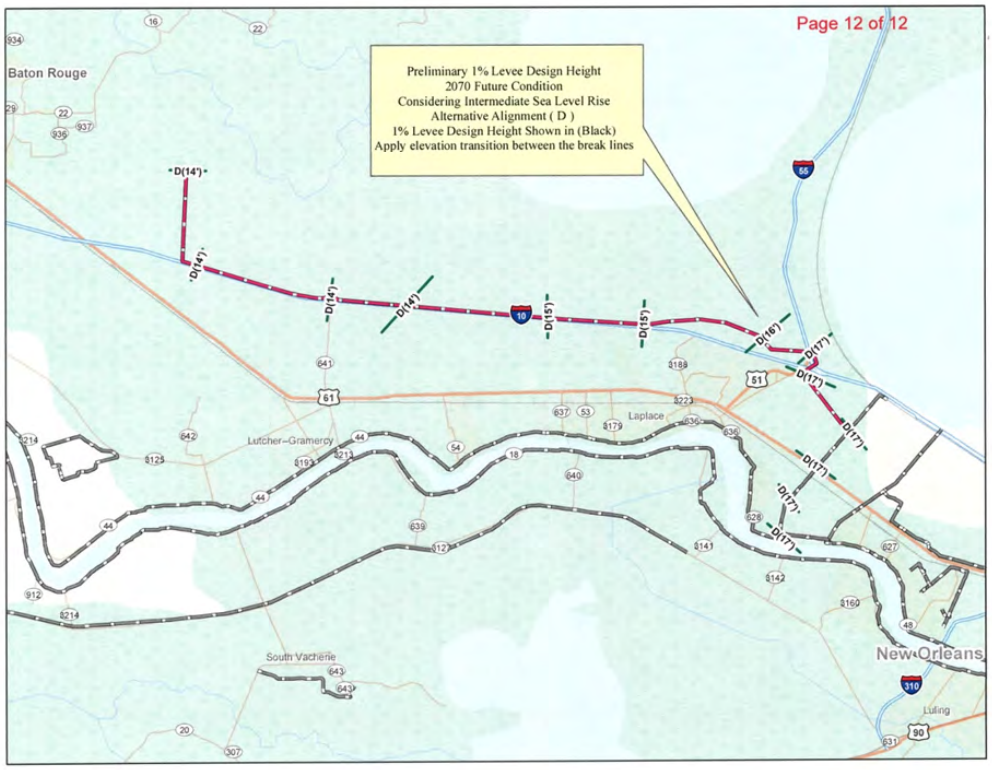

Figure 33: Levee Design Height 2070 Future Condition Alignment D

Potential Sea Level conditions are represented in the modeling system by application of a relative Sea Level Rise (SLR) that is consistent with USACE ER 1100-2-8162 (31 December 2013). Subsidence levels predicted in the study area were incorporated in the ADCIRC initial water level parameter to capture the combined effects of subsidence and local SLR into a single SLR value. For the Year 2020 and Year 2070 simulations, unique SLR values were added to the 2011 initial water surface elevations (WSE) to determine the initial WSE appropriate for each year and SLR rate. In addition to accounting for SLR of future conditions, the Year 2070 scenarios accounted for potential degradation of vegetation in landscapes. SLR changes (as well as salinity intrusion) can cause an associated vegetation degradation and / or loss (this was considered in the ADCIRC modeling). Since these are slow-moving processes, forecasts of 50 years in the future were used, with intermediate SLR conditions. See Figure 34 for SLR estimates for Years 2011 through 2080.

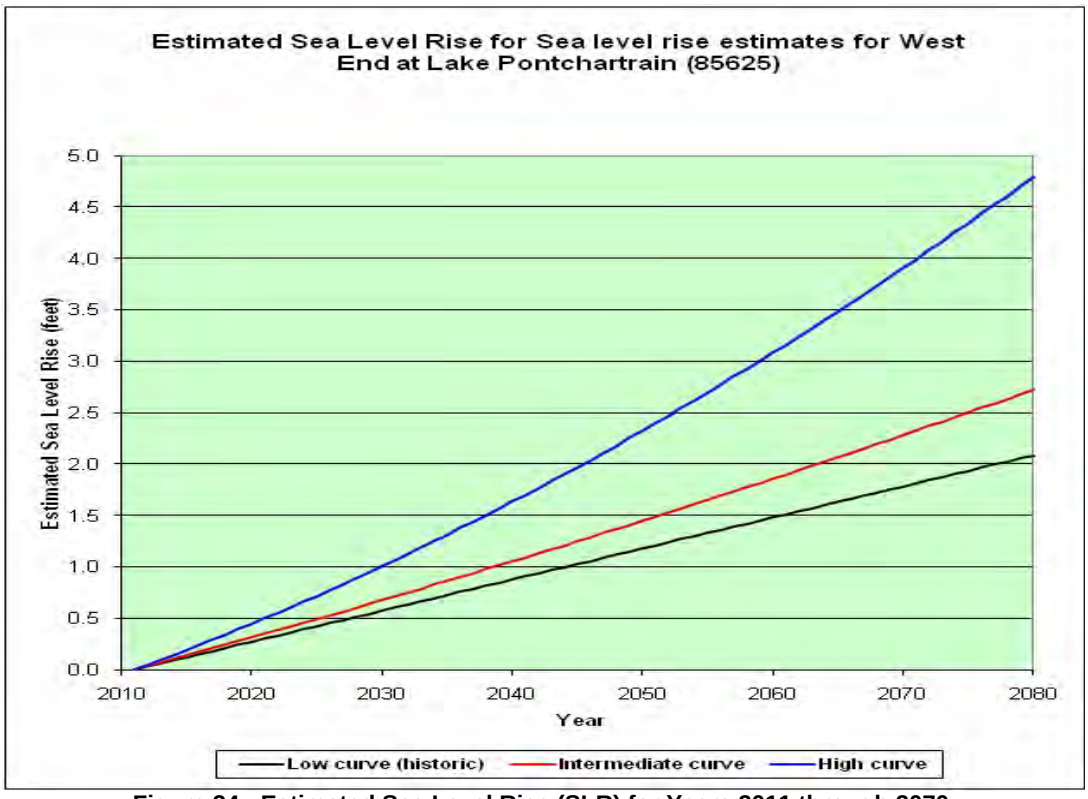

Figure 34: Estimated Sea Level Rise (SLR) for Years 2011 through 2070

Water Quality

This water resource is significant because of the Clean Water Act, as amended, the Pollution Prevention Act, the Safe Drinking Water Act, and the Water Resources Planning Act, regulations which provide for the protection of U.S. waters for the purposes of drinking, recreation, and wildlife. It also provides for the purposes of restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters. Study area water quality is influenced by basin elevations, surface water budget, land cover and use, coastal and geological processes, and regional weather. The study area is in the southwestern portion of a basin consisting of uplands to the north and estuary to the south, with increasing estuary salinity eastward. The estuary has experienced hydromodification via the construction of canals and embankments. Historical study area water quality is depicted in several references which include the review of data from basin tributaries and estuary lakes and passes. Garrison (1999) provides a statistical summary of general parameters, major ions, nutrients, trace metals, and organic compounds for water quality data collected in Lake Maurepas between 1943 and 1995. Overall, the summary suggests the lake is freshwater, oligotrophic, and does not contain elevated contaminant levels. To determine the most prevalent water quality issues present in the study area, historical Section 305(b) lists were reviewed to determine the most significant causes and sources of subsegment impairment. The most current (2012) 303(d) list for the study area is depicted in Table 11. Ordered by decreasing frequency cited, suspected causes of impairment include non-native aquatic plants, low dissolved oxygen, mercury, elevated turbidity, and fecal coliform, while suspected sources of impairment include wetland habitat modification, introduction of non-native organisms, atmospheric deposition, unknown sources, on-site treatment systems, natural sources, and agriculture.

Table 11: Study Area 2013 303(d) List

Subsegment	Impaired Use for Suspected Cause	Suspected Cause of Impairment	Suspected Source of Impairment	IR Category	TMDL Priority
040401	FWP	Dissolved Oxygen	Wetland Habitat Modification	IRC 5	L
		Mercury	Atmospheric Deposition	IRC 4a	
			Source Unknown	IRC 4a	
		Non-Native Aquatic Plants	Introduction of Non-native Organisms	IRC 4b	
		Turbidity	Wetland Habitat Modification	IRC 4a	
	ONR	Turbidity	Wetland Habitat Modification	IRC 4a	
	PCR	Water Temperature	Natural Sources	IRC 5	L
			Wetland Habitat Modification	IRC 5	L
040403	FWP	Dissolved Oxygen	Agriculture	IRC 5	L
			Wetland Habitat Modification	IRC 5	L
		Mercury	Atmospheric Deposition	IRC 4a	
				IRC 5	L
			Source Unknown	IRC 4a	
				IRC 5	L
		Non-Native Aquatic Plants	Introduction of Non-native Organisms	IRC 4b	
040404	FWP	Dissolved Oxygen	On-site Treatment Systems	IRC 5	L
		Non-Native Aquatic Plants	Introduction of Non-native Organisms	IRC 4b	
	PCR	Fecal Coliform	On-site Treatment Systems	IRC 5	H
040602	FWP	Non-Native Aquatic Plants	Introduction of Non-native Organisms	IRC 4b	

Both historical 305(b) and current 303(d) lists suggest primary study area water quality problems relate to hypoxia. As a further to this suggestion, in 2011 a TMDL report was prepared for the lower Amite River watershed (located just north of subsegments partially included in the study area) to address organic enrichment and low dissolved oxygen. Long-term water quality monitoring in the study area was conducted by the Louisiana Department of Environmental Quality (LDEQ). Water quality trends in the study area based on this water quality assessment would be expected to continue. In particular, low dissolved oxygen conditions in the Maurepas Swamps and increasing marine influence in the northern study area are expected to persist, while the historically most common suspected causes of impairment within the study area would continue to generate water quality problems in competition with management efforts to eliminate impairments. With project water quality is addressed in the EIS.

Climatology

Temperature

Records of temperature are available from "Climatological Data" for Louisiana, published by the National Climatic Data Center. The study areas can be described by using the normal temperature data observed at the Hammond, and Donaldsonville stations. These stations are shown in Table one below with the monthly and annual mean normals which are based on the period of 1991-2011. The average annual mean normal temperature is 59.4^{o}F, with monthly mean temperature normal varying from 81.9^{o}F in July to 48.7^{o}F in December.

Precipitation

Records of precipitation are available from “Climatological Data” for Louisiana, published by the National Climatic Data Center. Two stations in the Louisiana study have been used to show the rainfall data for the areas of Donaldsonville and Ponchatoula/Hammond. Both stations have normal precipitation records which are based on the period of 1991-2011. The average annual normal rainfall of the two stations is 58.14 inches. The wettest normal month is June with a monthly average of 6.48 inches. October is the driest normal month averaging 4.11 inches and Donaldsonville has the greatest day with 24.49 inches of rain falling in June 2001.

Geotechnical

Engineering included the preparation of earthwork stability templates, settlement and lift schedule predictions, preparation of schematic alignment layouts, schematic pump station layouts, and scoping level project cost estimates for the elimination of alternatives to determine a tentatively selected plan. Schematic earthwork templates and settlement and lift schedule predictions were also performed.

The process to complete the scoping level engineering started with the geotechnical evaluation of the different alignments. The geotechnical evaluation consisted of reviewing existing soil boring data, preparation of earthwork stability templates, T-Wall analysis, settlement predictions, additional lifts, and secondary settlement predictions.

Geotechnical data was used to develop soil design parameters for the proposed alignments. At the time of the geotechnical report, four alternative alignments (reduced to three in August 2012) were being considered for the project. These alignments are denoted as Alignments A, C and D. Eighty three borings have been utilized for this screening study, with 23 geologic reaches and eleven soil reaches being developed. The alignments and reaches, as well as the developed soil design parameters, are shown in tabular and graphical form in the Draft Geotechnical Report Appendix I from March 2012.

Of the 83 borings furnished, 32 borings are located on Alignment A from its western limit at Hope Canal to its intersection with I-10 west of Highway 3188. These 32 borings comprise Soil Reaches 1 through 5. An additional 17 borings are located on the portion of Alignment A which coincides with I-10 from Highway 3188 to just west of the intersection with I-55 and comprise Soil Reaches 6 and 7. Thus, over half of the available data and selected reaches coincide with Alignment A.

The proposed alignments from the I-55 interchange to the St. Charles Parish line vary among the furnished drawings. For the purposes of this study, Alignment A is referenced as Alignment A in the geologic descriptions and reaches. Alignments C and D should be considered to coincide with Reach A in this area. Soil Reaches 8 through 10 were developed from the 27 borings in this area. However, as noted, these borings may not coincide with any or all of the current alignments.

Two of the available borings were utilized to define Soil Reach 11 at Mississippi Bayou. The remaining three borings were included with Soil Reach 1, but these borings coincide with Alignment C along the western side of the project.

Geotechnical data is not available for the portions of Alignments C and D which did not coincide with Alignment A at the time of this study. It has been projected that anticipated geologies at these locations are based on available data and information.

It should be noted that the geotechnical investigation was limited for this preliminary screening phase and did not include any exploration.

Methodology and Assumptions. The analyses consider the HSDRRS design guidelines dated 23 October 2007, with the geotechnical section as updated on 12 June 2008, although the scope does not include all cases required by this guideline. Required factors of safety and design cases are based on these guidelines. The HSDRRS design guidelines have been updated since issuance of the draft report. The scope of this study only includes an evaluation of Q-case parameters assuming eventual use of S-case parameters will be less restrictive.

Water Levels. Hydraulic design criteria were selected based on GFI in the form of preliminary hydrographic survey maps. The levees were evaluated using the water levels furnished for the

future conditions anticipated for the year 2020. To include structural superiority, the floodwall analyses are based on water levels projected for the year 2070.

The scope of this alternative alignment screening level study included stability analyses by Spencer's Method for water at the project grade level (PGL), still water level (SWL) and low water level (LWL) at the levees. The scope did not include consideration of the Top of Levee (TOL), as this was not considered a critical design case for this alternative alignment screening level study. The scope for this study also did not include an evaluation of stability by the Method of Planes (MOP) analyses. Stability analyses for the structures only considered extreme water level (EWL) and SWL.

Stability Analyses. Stability of earthen levees for the 11 soil design reaches were evaluated. Five of these reaches were also evaluated with geotextile reinforcement to reduce the size of the berms. Nine structures (T-walls and gates) were also evaluated.

Levee Stability. The earthen levees generally consist of a 10-ft levee crown with 3 horizontal on 1 vertical (3H:1V) side slopes. Substantial stability berms on the flood side and protected side are required for Soil Reaches 6 through 10. For these reaches, the berms can be reduced with the addition of geotextile reinforcement. A tabular summary of the results along with a plate of the governing stability analysis results are provided in the Draft Geotechnical Report Appendix I from March 2012 (which is available upon request).

Structure Stability. The T-walls and gates are located within Soil Design Reaches 1, 8 and 11. The majority of the cases analyzed indicate the presence of an unbalanced load. A tabular summary of all the results along with a plate of the governing analyses are included in the Final Geotechnical Report Appendix I from February 2014 (which is available upon request). In addition to stability analyses, estimates of allowable pile load capacity were also computed for each soil reach where structures will be located.

Underseepage Analysis for Levees. With large stability berms required for several levees and considering a predominantly clay foundation, levee underseepage potential is not a significant design concern for most of the design soil reaches. However, Soil Reach 11 identified channel fill that will require either a cutoff, relief wells or seepage berms. Detailed underseepage analyses will be required during final design of theRecommended Plan to meet the HSDRRS design guidelines. The final field investigation should consider the estimated locations of abandoned distributaries and channel fill. Additional measures may be required to ensure adequate factors of safety are maintained.

Underseepage Analysis for Structures. Underseepage of pile-supported T-walls was evaluated using the Lane's Weighted Creep Ratio (LWCR) method to establish the tip elevations for the sheet pile cutoff wall. The flow path was assumed only to be the penetration of the sheet pile and horizontal contacts were not assumed. The sheet pile tip embedments are governed by seepage instead of the HSDRRS requirement of 5 feet of penetration below the critical failure plane (for unbalanced load cases).

Settlement Analyses. Settlement analyses were performed for Soil Reaches 1, 4, 6 and 10. An evaluation of the time-rate of consolidation settlement was not conducted; however, estimates for lift construction are available.

In general, settlement parameters for all reaches considered the surficial natural levee deposits and underlying Pleistocene deposits as precompressed. In addition, based on the available data, the swamp deposits were modeled to have an over consolidation ratio (OCR) between 3 and 10 in Soil Reaches 1 and 4 and between 1 and 2 in Soil Reaches 6 and 10. The interdistributary clays were typically modeled as normally consolidated. These values were based on the available boring data and correlations of moisture content to compression ratio

(CR) values developed in the region. The parameters generally only consider the stress history at the available boring locations. The stress history at alignments away from the boring data was not assumed.

The higher OCR values in the swamp deposits may only be applicable to previously developed areas in Alignment A. Thus, even in Soil Reach 1, additional lifts may be needed to maintain the levee height in previously undeveloped areas along Hope Canal and along Alignment C. Due to the shallow depth of the Pleistocene interface on the western side of the project, additional fill height would be anticipated to be low. However, moving eastward along the project as the Pleistocene interface increases in depth, the potential for lift construction would increase. Further, it appears current alignments diverge from developed areas east of the I-10/I-55 interchange, increasing this potential even further.

Based on the parameters developed for Soil Reaches 1 and 4, a minimum of 1.5-ft overbuild was assumed in all of the levee stability analyses. The overbuild height for Soil Reach 1 did not require consideration of submergence. Submergence was considered for Soil Reach 4. Settlements greater than 1.5 feet were computed for Soil Reaches 6 and 10 where larger berms and/or greater fill heights would be required. Thus, lift construction will be required for these reaches to maintain the design grade.

The greatest levee height and greatest settlement were computed for Soil Reach 10. This soil reach also has the deepest Pleistocene interface. For Soil Reach 10, an overbuild height of 2.6 feet was computed. It was estimated an additional 3 inches of settlement would occur for this overbuild once the initial levee is fully consolidated. This resulted in a total overbuild of approximately 3 feet. It was determined that only one additional lift thickness be assumed and this lift may be considered as 1.5 feet with an initial overbuild of 1.5 feet. It was also decided that this lift schedule be assumed for Soil Reaches 8, 9 and 10. Based on calculations for Soil Reach 6, it was estimated the overbuild would need to be increased from 1.5 feet to 2.5 feet. Thus, a 1-ft lift thickness beyond the initial 1.5-ft overbuild should be assumed. This lift thickness was applied to Soil Reaches 6 and 7. No lift schedule is deemed necessary for Soil Reaches 1 through 4 and 11 on Alignment A.

The furnished hydraulic data is based on a design year of 2020. The design levee heights were considered to occur from 2012 to 2020. This is a relatively short design period. Therefore, only one construction lift was assumed to be feasible. It was determined that this lift be estimated to occur halfway through the design period or four years into the eight-year design. Given the limited data for this screening study, only assumed time-rate of settlement parameters could be developed. However, even these assumptions would not address the stress history and time-rate away from the boring locations. For alignments within previously undeveloped areas, an additional lift or increased lift thickness may be required.

Datum and Topography

The furnished soil borings and the soil parameter plots are referenced to NGVD. These elevations were reduced by 1 foot for conversion to the NAVD88 datum. Water levels were provided in NAVD88. All the analyses for this feasibility report reflect the NAVD88 datum. Topographic survey data was not obtained for the alternative alignments. Review of available Lidar data indicated average grade at Elevation 1.0 NAVD88 should be used for the analyses of the levees. While the ground elevation varies along the length of each alignment, the assumed ground elevation of 1.0 NAVD88 was appropriate for the majority of the alignment and conservative for the areas of higher ground elevation. With the exception of furnished gate elevations, average grade at Elevation 1.0 was also used for the typical T-wall analyses.

Civil/Structural Design

Three alternatives were evaluated for scoping level engineering: Alignment A, Alignment C and Alignment D. Prior to the scoping level engineering, the alignments consisted of non-dimensional generalized locations on large scale mapping. The purpose of the scoping level engineering was to refine the generalized alignment locations into levee cross sections coordinated with existing topography features (streams, channels, wetlands, etc.) and existing infrastructure (highways, pipelines, utilities, etc.).

After the levee templates were completed, it was decided to apply the design templates to Alignments A, C and D.

A set of standard details was prepared to provide a schematic elevation view of the typical pump station T-Wall, Interstate T-Wall, Roadway/Railroad Floodgate T-Wall and Pipeline T-Wall. These typical elevations included clearance recommendations from the geotechnical engineers to ensure the new construction would not adversely impact existing infrastructure. Drawings showing the typical elevations are available upon request.

The pump station flow rates and gravity drainage gate sizes were computed. These pump station flow rates and gravity drainage gate sizes were based upon hydrologic units defined in the existing SWMM model. If multiple drainage outfalls existed in the hydrologic unit, the projected pump station flows and gravity drainage gate sizes were divided based upon the percentage of the outfall's contributory area in the delineated hydrologic unit. The pump stations were grouped into twelve types based upon the pump and gate sizes. Typical Floor Plans were developed for each pump station type. These typical floor plans and a typical elevation through the station are available upon request.

A "smoothed" version of **Alignment A** was used in order to minimize the encapsulation of wetlands in the protection system. Alignment A begins at the Upper Guide Levee of the Bonnet Carre' Spillway and travels westerly parallel to an existing pipeline corridor, around the Interstate 10/Interstate 55/US Highway 51 interchange, then follows Interstate 10 to the LA 3188 (Belle Terre Boulevard) interchange, then southerly and westerly paralleling the wetland wet/dry line to Mt. Airy where it terminates at the Mississippi River levee. The "smoothed" alignment was placed on the DOQQ base map and adjusted in a few minor locations. These locations included the Interstate 10 crossing east of the LaPlace interchange, the Interstate 55 crossing north of the US Highway 51 entrance ramp, the Interstate 10 crossing west of the Belle Terre interchange, and the existing water tower adjacent to the Belle Terre interchange. The modifications at the Interstate crossings were performed to cross the elevated structures with a ninety degree crossing that will ultimately be passed between existing bridge bents with a T-Wall. The Interstate 55 crossing was moved north to include the entrance/exit ramps from US Highway 55 and provide access for evacuation and recovery.

The top of levee elevation (net elevation) for this alignment is El. 13.5 NAVD88 (based on providing 100-Year protection in the Baseline Year of 2020), then decreases to El. 13.2 NAVD88 (at approx. Baseline Station 421+00), then decreases to El. 11.5 NAVD88 (at approx. Baseline Station 552+00), then decreases to El. 10.5 NAVD88 (at approx. Baseline Station 614+00), then decreases to El. 10.0 NAVD88 (at approx. Baseline Station 700+00), then decreases to El. 9.0 NAVD88 (at approx. Baseline Station 821+00) and finally decreases to El. 7.0 NAVD88 (at approx. Baseline Station 1013+00). The levee design, which involves the placement (in 2 lifts, 5 years apart) of approx. 3.1 million cubic yards of compacted and uncompacted clay fill, on top of 3.7 million square yards of geotextile fabric (with a 70-ft. width) along with a 100-ft. base width, 3:1 side slopes and 10-ft. crown width, creates a footprint of 411

acres. An aggregate limestone road (6 ft. wide x 8 in. thick) sits on top of the levee crown, a total of 29,615 cubic yards.

The design levee templates were placed along the proposed Alignment A at the defined soil and hydraulic reaches and based upon the recommended offsets for future maintenance activities, impacts to existing pile supported structures, offsets for stability from potential excavations (pipeline rights-of-way) and existing drainage features. Special attention was made to locate the right-of-way limits for the proposed levee sections to coincide with the existing rights-of-way from highways, pipelines etc. to avoid remainder parcels that were nonfunctional to the original owner. After the earthen embankments were placed on the base map and transitions performed from template section to template section, Alignment A was evaluated for specialty locations such as pump stations, T-Walls, gates, ramps, and pipeline crossings. The typical elevation details described above were utilized at appropriate locations and widths adjusted based upon the pump station size, Interstate crossing width, roadway/railway width, number of pipelines, etc. Alignment A was approximately 107,800 feet (20.41 miles) long and included 4,774 feet of T-Wall, 240 feet of drainage gates, 1,218 feet of roadway gates, two railway gates, seventy pipeline crossings, and eight pump stations. Schematic plans and typical levee sections (first and second lifts) were developed for Alignment A with levee template section, pump station, gate, T-Wall and pipeline crossings annotated. These schematic plans and typical levee sections are available upon request.

Alignment C begins at the Upper Guide Levee of the Bonnet Carre' Spillway and travels westerly parallel to an existing pipeline corridor, around the Interstate 10/Interstate 55/US Highway 51 interchange, then follows the existing pipeline corridor to Interstate 10/LA 3188 (Belle Terre Boulevard) interchange, then southerly and westerly paralleling the existing pipeline corridor to Mt. Airy where it terminates at the Mississippi River levee. Alignment C was developed to minimize the number of pipeline crossings.

The top of levee elevation (net elevation) for this alignment is El. 13.5 NAVD88 (based on providing 100-Year protection in the Baseline Year of 2020), then decreases to El. 13.2 NAVD88 (at approx. Baseline Station 304+00), then decreases to El. 12.2 NAVD88 (at approx. Baseline Station 354+00), then decreases to El. 10.2 NAVD88 (at approx. Baseline Station 612+00), then decreases to El. 9.0 NAVD88 (at approx. Baseline Station 722+00), then decreases to El. 7.5 NAVD88 (at approx. Baseline Station 905+00) and finally decreases to El. 7.0 NAVD88 (at approx. Baseline Station 968+00). The levee design, which involves the placement (in 2 lifts, 5 years apart) of approx. 3.1 million cubic yards of compacted and uncompacted clay fill, on top of 3.4 million square yards of geotextile fabric (with a 70-ft. width) along with a 100-ft. base width, 3:1 side slopes and 10-ft. crown width, creates a footprint of 856 acres. An aggregate limestone road (6 ft. wide x 8 in. thick) sits on top of the levee crown, a total of 26,124 cubic yards. A conveyance canal is situated along the entire levee (with a bottom depth elevation of El.-10 ft. NAVD88).

The design levee templates were placed along the proposed Alignment C at the defined soil and hydraulic reaches and based upon the recommended offsets for future maintenance activities, impacts to existing pile supported structures, offsets for stability from potential excavations (pipeline rights-of-way) and existing drainage features similar to Alignment A. There was a section of Alignment C from the Interstate 10/LA 3188 (Belle Terre Boulevard) interchange to the Mt. Airy community where there were no soil boring data and design levee templates were not developed. The other alignment's design levee templates that were in the closest proximity of the required hydraulic reach defined were used. Special attention was made to locate the right-of-way limits for the proposed levee sections to coincide with the existing rights-of-way from highways, pipelines etc. to avoid remainder parcels that were nonfunctional to the original owner. Once all the required design levee templates were selected for the hydraulic reaches,

the levee sections were transitioned together similar to Alignment A. Alignment C was evaluated for specialty locations such as pump stations, T-Walls, gates, ramps and pipeline crossings.

Alignment C was approximately 96,500 feet (18.27 miles) long and included 5,304 feet of T-Wall, 2080 feet of drainage gates, 288 feet of roadway gates, two railway gates, thirty-six pipeline crossings, and four pump stations. Schematic plans and typical levee sections (first and second lifts) were developed for Alignment C with levee template section, pump station, gate, T-Wall and pipeline crossings annotated. These schematic plans and typical levee sections are available upon request.

Alignment D begins at the Upper Guide Levee of the Bonnet Carre' Spillway and travels westerly parallel to an existing pipeline corridor, around the Interstate 10/Interstate 55/US Highway 51 interchange, then follows the existing pipeline corridor to Interstate 10/LA 3188 (Belle Terre Boulevard) interchange, then westerly paralleling the Interstate 10 right-of-way approximately to the St James/Ascension Parish line, then turns northerly through the McElroy Swamp to the New River Canal, then westerly to the Marvin Braud Pump Station levee. Alignment D was developed to provide flood protection to the maximum number of communities in St Charles, St. John the Baptist, St. James, and Ascension Parishes and protect the Interstate 10 corridor. Alignment D also minimizes the number of pipeline crossings.

The top of levee elevation (net elevation) for this alignment is El. 13.5 NAVD88 (based on providing 100-Year protection in the Baseline Year of 2020), then decreases to El. 13.2 NAVD88 (at approx. Baseline Station 305+00), then decreases to El. 12.2 NAVD88 (at approx. Baseline Station 354+00), then decreases to El. 10.2 NAVD88 (at approx. Baseline Station 600+00), then decreases to El. 9.5 NAVD88 (at approx. Baseline Station 750+00) and finally decreases to El. 8.0 NAVD88 (at approx. Baseline Station 940+00). The levee design, which involves the placement (in 2 lifts, 5 years apart) of approx. 3.8 million cubic yards of compacted and uncompacted clay fill, on top of 3.1 million square yards of geotextile fabric (with a 70-ft. width) along with a 100-ft. base width, 3:1 side slopes and 10-ft. crown width, creates a footprint of 1,181 acres. An aggregate limestone road (6 ft. wide x 8 in. thick) sits on top of the levee crown, a total of 36,880 cubic yards. A conveyance canal is situated along the entire levee (with a bottom depth elevation of El.-10 ft. NAVD88).

The design levee templates were placed along the proposed Alignment D at the defined soil and hydraulic reaches and based upon the recommended offsets for future maintenance activities, impacts to existing pile supported structures, offsets for stability from potential excavations (pipeline rights-of-way) and existing drainage features similar to Alignments A and C. There was a section of Alignment D from the Interstate 10/Hope Canal crossing to the Marvin Braud levee where there were no soil boring data and design levee templates were not developed. The other alignment's design levee templates that were in the closest proximity of the required hydraulic reach defined were used. Special attention was made to locate the right-of-way limits for the proposed levee sections to coincide with the existing rights-of-way from highways, pipelines, etc. to avoid remainder parcels that were nonfunctional to the original owner. Once all of the required design levee templates were selected for the hydraulic reaches, the levee sections were transitioned together similar to Alignments A and C. Alignment D was evaluated for specialty locations such as pump stations, T-Walls, gates, ramps and pipeline crossings.

Alignment D was approximately 149,300 feet (28.28 miles) long and included 4,011 feet of T-Wall, 396 feet of drainage gates, 306 feet of roadway gates, no railway gates, fourteen pipeline crossings, and six pump stations. Schematic plans and typical levee sections (first and second lifts) were developed for Alignment D with levee template section, pump station, gate, T-Wall,

and pipeline crossings annotated. These schematic plans and typical levee sections are available upon request.

Quantities. Quantities were computed for clearing and grubbing, geotextile, earthwork, aggregate roadway, turf establishment, T-Walls, drainage gates, roadway gates, railroad gates, pump stations and pipeline relocations.

Clearing and grubbing was based upon the proposed levee right-of-way limits denoted on the typical levee sections for the length of the reach and converted to acres. Geotextile was based upon the proposed width denoted on the typical levee sections for the length of the reach and converted to square yards. Earthwork was computed by end area denoted on the typical levee sections for the length of the reach. To determine the end area for each typical levee section, the average groundline elevation along the alignment centerline was computed. LIDAR data from the Louisiana State University Atlas Database was loaded into ArcGIS and the EZProfiler extension was used to obtain x, y, z, coordinates in Louisiana State Plane Coordinate System. The EZProfiler parameters were set to obtain coordinates and elevations every 45 feet along the alignment since the LIDAR data had 15 feet by 15 feet pixels. The EZProfiler dumped the coordinate and elevation data into an Excel spread, where the groundline elevation was averaged. The average groundline elevation was included in the levee typical section and the end areas were computed for each individual reach. After the end areas were computed, the length of the earthen levee segments were multiplied by the end area and ten by a 1.25 consolidation factor before converting into cubic yards. The 1.25 consolidation factor was used to account for consolidation and compaction of underlying existing soils as the new earthwork lifts are performed. Turf establishment quantities were set equal to the clearing and grubbing limits and converted to acres. Aggregate road surfacing was computed from the levee segment length and a section 6 feet wide and 8 inch deep then converted to cubic yards. T-Walls, Drainage Gates, and Roadway Gates were tabulated by length and incremental wall heights. An incremental wall height of 5 feet was set as the criteria. Railroad gates were measured per each. Pipeline relocations were measured per each and the incremental pipeline size. Incremental pipeline sizes were set at less than or equal to 6 inches, greater than 6 inches up to 12 inches, greater than 12 inches up to 18 inches, greater than 18 inches up to 24 inches and greater than 24 inches. All quantities for Alignments A, C and D were computed in the same manner.

Relocations

An ArcGIS State of La. Oil Spill Response Database was used to identify the pipeline locations for each alignment. This database contained not only the shapefiles of the pipelines but in most instances the owner, size, type and the carried material. This data was used for each of the three alignments. The assumption for each alignment was that a pipeline floodwall would be required wherever a pipeline crossed the levee footprint. The pipeline would cross through the pipeline floodwall. It was decided that the existing carrier line would remain in operation while a bypass line would be constructed through a sleeve in the T-wall cutoff piles. When the bypass would be complete and in place, the switch over-tie in with the existing line then would follow. A unit cost for the different pipe size ranges was used (unit costs were furnished by USACE). See below.

Pipeline Relocations

Description	Estimated Quantity (Q)	Units	Unit Cost (UC)
≤6" Diameter	14	Each	$515,000
>6" to ≤12" Diameter	16	Each	$700,000
>18" to ≤24" Diameter	5	Each	$1,550,000
> 24" Diameter	1	Each	$1,920,000

Cost Estimates

After each alignment's quantities were finalized, cost estimates were prepared for each alignment. For each item, the item description, item quantity, unit of measure, unit cost, item cost, contingency and total item cost was tabulated in an Excel spreadsheet; the same information was later prepared in MII MCACES format. Since the unit of measure for the pump stations was set by the cubic feet per second (cfs) flow rate of each type of pump station, separate quantities and costs were computed for each type of pump station. Separate tabs for each pump station were created in the Excel spreadsheet (and subsequently shown in the MII MCACES format for each alignment). The cost for each pump station was divided by the flow rate to determine the unit cost. All cost estimates for Alignments A, C and D were computed in the same manner.

WEST SHORE-LAKE PONTCHARTRAIN HURRICANE PROTECTION

FEASIBILITY STUDY

COST ENGINEERING APPENDIX

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Cost Estimate

Section 1. Cost estimate development

a) The project cost estimate was developed in the MCACES MII cost estimating software and used the standard approaches for a feasibility estimate structure regarding labor, equipment, materials, crews, unit prices, quotes, sub- and prime contractor markups. This philosophy was taken wherever practical within the time constraints. It was supplemented with estimating information from other sources where necessary such as quotes, bid data, and A-E estimates. The intent was to provide or convey a "fair and reasonable" estimate that which depicts the local market conditions. The estimates assume a typical application of tiering subcontractors. Given the long time over which this project/program is to be constructed and the unknown economic status during that time, demands from non-governmental civil works projects were not considered to dampen the competition and increase prices.

Section 2. Estimate Structure:

a) The estimate is structured to reflect the projects performed. The estimate has been subdivided by USACE feature codes that include levees, floodwalls, drainage structure, pipeline relocations, and pump stations.

Section 3. Bid competition:

a) It is assumed that there will not be an economically saturated market and that bidding competition will be present.

Section 4. Contract Acquisition Strategy:

a) It is assumed that the contract acquisition strategy will be similar to past projects with large unrestricted design/bid/build contracts. There are no declared contract acquisition plan/types at this time.

Section 5. Labor Shortages:

a) It is assumed there will be a normal labor market.

Section 6. Labor Rates:

a) Local labor market wages are above the local Davis-Bacon Wage Determination and actual rates have been used. This is based upon local information and payroll data received from the New Orleans District Construction Representatives and estimators with experiences in past years.

Section 7. Materials:

a) Cost quotes are used on major construction items when available. Recent quotes may include concrete, steel and concrete piling, rock, gravel and sand. Assumptions include:
    i) Materials will be purchased as part of the construction contract. The estimate does anticipate government furnished materials for borrow. Prices include delivery of materials.
    ii) Concrete - will be purchased from commercial batch plants.

iii) Borrow Material and Haul - Borrow material is considered the highest risk in the contracts, given the large quantities required, uncertainties of sources and materials near the many contract locations. Specific borrow sources have been identified so a conservative estimated haul distance was used. Borrow pit (Bonnet Carre' Spillway) is currently in use and within this distance. All borrow material is assumed Government furnished. NO contractor furnished borrow source are used.

b) The borrow quantity calculations followed the MVN Geotechnical guidance:

c) Hauled Levee: 10 BCY of borrow material = 12 LCY hauled = 8 ECY compacted.

d) An assumed average one-way haul distance of 13 miles for 100yr was used based upon the local Government Furnished pit.

e) Haul speeds are estimated using 40 mph speed average given the long distances and rural areas.

f) The 1st lift is an initial lift with geotextile fabric on many design sections. 2nd lift qty assumes construction begins at the pre-degraded 1st lift elevation. All lifts include an overbuild from 1.5 feet to 1.0 feet to account for settlement between lifts. Settlement is predicted to be from 2.5 feet to 0.25 feet. The smaller overbuild and settlement values are for the later year construction lifts.

g) Rock and stone - The New Orleans delta area has no rock sources. Historically, rock is barged from northern sources on the Mississippi River. This decision is based upon local knowledge, experience and supported with cost quotes.

Section 8. Equipment:

a) Rates used are based from the latest USACE EP-1110-1-8, Region III. Adjustments are made for fuel and facility capital cost of money (FCCM). Judicious use of owned verses rental rates was considered based on typical contractor usage and local equipment availability. Only a few select pieces of marine \ marsh equipment are considered rental. Full FCCM/Cost of Money rate is latest available; MII program takes EP recommended discount, no other adjustments have been made to the FCCM.

i) Trucking: The estimate assumed independent self-employed trucking subcontractors due to the large numbers of trucks required.

ii) Dozers: dozers of the D-5/D-6 variety were chosen based on historical knowledge. Heavier equipment gets mired in the mud and soft soils.

iii) Rental Rates: Rental rates were used for marsh equipment where rental is typical such as marsh backhoes.

Section 9. Fuel:

a) Fuels (gasoline, on and off-road diesel) were based on local market averages for on-road and off-road for the Gulf Coast area. The Team found that fuels fluctuate irrationally; thus, used an average.

Section 10. Crews:

a) Major crew and productivity rates were developed and studied by senior USACE estimators familiar with the type of work. All of the work is typical to the New Orleans District. The crews and productivities were checked by local MVN estimators, discussions with contractors and comparisons with historical cost data. Major crews include clearing and grubbing, hauling, earthwork, piling and concrete.

b) Most crew work hours are assumed to be 10 hrs 6 days/wk which is typical to the area.

c) A 10% "markup on labor for weather delay" is selectively applied to the labor in major earthwork placing detail items and associated items that would be affected by small amounts of weather making it unsafe or difficult to place (trying to run dump trucks on a wet levee) or be detrimental/non-compliant to the work being done (trying to place/compact material in the rain). The 10% markup is to cover the common practice of paying for labor "showing up" to the job site and then being sent home due to minor weather which is part of known average weather impacts as reflected within the standard contract specifications. The markup was not applied to small quantities where this can be scheduled around.

Section 11. Unit Prices:

a) The unit prices found within the various project estimates will fluctuate within a range between similar construction units such as floodwall concrete, earthwork, and piling. Variances are a result of differing haul distances, small or large business markups, subcontracted items, designs and estimates by others.

Section 12. Relocation Cost:

a) Relocation costs are defined as the relocation of utilities required for project purposes. In cases where potential significant impacts were known, costs were included within the cost estimate. Public roads, bridges, or railroads were not relocated on this project. Floodgates and T-Walls were included in the cost estimate to accommodate roads, bridges, and railroads.

Section 13. Mobilization:

a) Contractor mobilization and demobilization are based on the assumption that most of the contractors will be coming from within the Gulf Coast/Southern region. Mob/demob costs are based on historical studies of detailed Government estimate mob/demobs which averaged 4.9 to 5% of the construction costs. With undefined acquisition strategies and assumed individual project limits for the large number of potential contracts in this program, the estimate utilizes a more comprehensive approx. 5% value applied at each contract rather than risking minimizing mob/demob costs by detailing costs based on an

assumed number of contracts. The 5% value also matches well with the 5% value previously prescribed by Walla Walla District, which has studied historical rates.

Section 14. Field Office Overhead:

a) The estimate used a field office overhead rate of 12% for the prime contractors at budget level development. Based on historical studies and experience, Walla Walla District has recommended typical rates ranging from 9% to 11% for large civil works projects; however, the 9-11% rate does not consider possible incentives such as camps, allowances, travel trailers, meals, etc. which have been used previously to facilitate projects. With undefined acquisition strategies and assumed individual project limits for the multiple number of potential contracts in this program, the estimate utilizes a more comprehensive percentage based approach applied at each contract rather than risking minimizing overhead costs by detailing costs based on an assumed number of contracts. The applied rates were previously discussed among numerous USACE District cost engineers including Walla Walla, Vicksburg, Norfolk, Huntington, St. Paul and New Orleans.

Section 15. Overhead assumptions may include:

a) Superintendent, office manager, pickups, periodic travel, costs, communications, temporary offices (contractor and government), office furniture, office supplies, computers and software, as-built drawings and minor designs, tool trailers, staging setup, camp and kitchen maintenance and utilities, utility service, toilets, safety equipment, security and fencing, small hand and power tools, project signs, traffic control, surveys, temp fuel tank station, generators, compressors, lighting, and minor miscellaneous.

Section 16. Home Office Overhead:

a) Estimate percentages range based upon consideration of 8(a), small business and unrestricted prime contractors. The rates are based upon estimating and negotiating experience, and consultation with local construction representatives. The applied rates were previously discussed among numerous USACE District cost engineers including Walla Walla, Vicksburg, Norfolk, Huntington, St. Paul and New Orleans.

Section 17. Taxes:

a) Local taxes will be applied, using an average between the parishes that contain the work. Reference the LA parish tax rate website: http://www.laota.com/pta.htm

Section 18. Bond:

a) Bond is assumed 1% applied against the prime contractor, assuming large contracts.

Section 19. E&D and S&A:

a) USACE Costs to manage design (PED) and construction (S&A) are based on New Orleans District Programmatic Cost Estimate guidance:

    i) Planning, Engineering & Design (PED): The PED cost includes such costs as project management, engineering, planning, designs, investigations, studies, reviews, value engineering and engineering during construction (EDC). Historically New Orleans

District has used an approximate 12% rate for E&D/EDC, applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis and St. Louis have reported values ranging from 10-15%. Additional costs were added for project management, engineering, planning, designs, investigations, studies, reviews, value engineering. Specific PED costs were originally calculated and then that same percentage was carried forward on all future updates.

ii) Supervision & Administration (S&A): Historically, New Orleans District used a range from 5% to 15% depending on project size and type applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis and St. Louis report values ranging from 7.5-10%. Consideration includes that a portion of the S&A effort could be performed by contractors. Based on discussions with MVN Construction Division, an S&A cost based on contract durations was developed. Specific S&A costs were originally calculated and then that same percentage was carried forward on all future updates.

Section 20. Contingencies:

a) Contingencies were developed using the USACE Cost and Schedule Risk Analysis (CSRA) process and the Crystal Ball software that evaluates schedule and cost related risks. See summary in Cost Schedule Risk Analysis (CSRA) section.

Section 21. Escalation:

a) Escalation used in the TPCS is based upon the US Army Corps of Engineers Engineering Manual (EM) 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) revised 30 Sept 2013.

Section 22. HTRW:

a) The estimate includes no costs for any potential Hazardous, Toxic, and Radioactive Waste (HTRW) concerns. Phase 1 HTRW investigations are already complete and the result of this investigation is that no further investigation is recommended.

Schedule

The project schedule was developed based on the construction of the individual features of work to include the entire West Shore Lake Pontchartrain, LA Project which includes construction of earthen levees, floodwalls, floodgates, pumping stations and drainage structures along a 18-mile alignment through LaPlace, Reserve, Garyville and Mt. Airy. Final levee elevations and structure elevations range from +16.0 to +19 ft NAVD88. Structures include a 1 navigable floodgate structure, 6 environmental water control structures, 1 road gate, 2 RR gates, and fronting protection for 4 proposed pumping stations.

A levee lift schedule was laid out that allows for a minimum of 3 years of settlement between levee lifts, minimizes adjacent/conflicting work zones, reduces the cost of interest during construction, and delivers the specified level of risk reduction (1%) by the project base year and maintains that level 50-years into the future.

Total Project Cost Summary (TPCS)

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: West Shore Lake Pontchartrain Study
PROJECT NO: 108870
LOCATION: St. John The Baptist and St. Charles Parishes, LA

DISTRICT: MVN New Orleans District PREPARED: 6/27/2014
POC: CHIEF, COST ENGINEERING, THOMAS D. MURPHY, P.E.

This Estimate reflects the scope and schedule in report; West Shore Lake Pontchartrain Study Report 2014

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2015 Effective Price Level Date: 1 OCT 14								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: 1-Oct-13 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
02	RELOCATIONS	$14,768	$4,430	30.0%	$19,198	1.6%	$14,998	$4,499	$19,497	$0		$16,130	$4,839	$20,969
06	FISH & WILDLIFE FACILITIES	$87,628	$21,907	25.0%	$109,535	1.6%	$88,990	$22,248	$111,238	$0		$95,708	$23,928	$119,636
11	LEVEES & FLOODWALLS	$290,883	$87,265	30.0%	$378,148	1.6%	$295,408	$88,622	$384,030	$0		$377,140	$113,141	$490,281
13	PUMPING PLANT	$75,691	$22,707	30.0%	$98,398	1.6%	$76,868	$23,060	$99,928	$0		$82,671	$24,801	$107,472
	CONSTRUCTION ESTIMATE TOTALS:	$468,970	$136,309		$605,279	1.6%	$476,264	$138,429	$614,693	$0		$571,649	$166,709	$738,358
01	LANDS AND DAMAGES	$7,638	$1,909	25.0%	$9,547	1.6%	$7,756	$1,939	$9,695	$0		$7,901	$1,975	$9,876
30	PLANNING, ENGINEERING & DESIGN	$38,189	$11,455	30.0%	$49,644	2.2%	$39,012	$11,705	$50,717	$0		$64,562	$19,380	$83,942
31	CONSTRUCTION MANAGEMENT	$32,366	$9,711	30.0%	$42,077	2.2%	$33,065	$9,921	$42,986	$0		$56,253	$16,878	$73,131
	PROJECT COST TOTALS:	$547,163	$159,384	29.1%	$706,547		$556,097	$161,994	**$718,091**	$0		$700,365	$204,942	$905,307

ESTIMATED FEDERAL COST:	**65%**	**$588,450**
ESTIMATED NON-FEDERAL COST:	**35%**	**$316,857**
ESTIMATED TOTAL PROJECT COST:		**$905,307**

_____ CHIEF, COST ENGINEERING, THOMAS D. MURPHY, P.E.

_____ PROJECT MANAGER, JEFFREY J. VARISCO

_____ CHIEF, REAL ESTATE, LINDA LABURE

_____ CHIEF, PLANNING, TROY CONSTANCE

_____ CHIEF, ENGINEERING, MARK R. HOAGUE, P.E.

_____ CHIEF, OPERATIONS, CHRIS ACCARDO

_____ CHIEF, CONSTRUCTION, STUART S. WAITS, P.E.

_____ CHIEF, CONTRACTING, TIMOTHY BLACK

_____ CHIEF, PM-PB, MARK WINGATE

_____ CHIEF, DPM, GARY HAWKINS

MII Cost Estimate

WEST SHORE LAKE PONTCHARTRAIN

HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY

INTEGRATED DRAFT FEASIBILITY REPORT

AND ENVIRONMENTAL IMPACT STATEMENT

Estimated by

Designed by

Prepared by Miguel Ramos

Preparation Date 2/11/2014

Effective Date of Pricing 2/11/2014

Estimated Construction Time Days

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11 01 Levees 1
11 02 Floodwalls 1
13 PUMPING PLANT 1
13 01 Pumping Stations 1
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02 RELOCATIONS 2
02 01 Pipelines 2
02 01 01 SectionC4, Sta. 278+27.66 2
02 01 02 SectionC5, Sta. 279+17.82 2
02 01 03 SectionC5, Sta. 282+89.77 2
02 01 04 SectionC5, Sta. 301+77.52 2
02 01 05 SectionC7, Sta. 359+12.35 2
02 01 06 SectionC7, Sta. 359+94.66 2
02 01 07 SectionC7, Sta. 363+92.87 2
02 01 08 SectionC10, Sta. 539+22.35 2
02 01 09 SectionC15, Sta. 659+33.14 2
02 01 10 SectionC15, Sta. 659+68.54 2
02 01 11 SectionC15, Sta. 659+94.36 2
02 01 12 SectionC18, Sta. 846+28.98 2
02 01 13 SectionC18, Sta. 846+35.39 2
02 01 14 SectionC18, Sta. 847+12.35 2
02 01 15 SectionC18, Sta. 847+22.35 2
02 01 16 SectionC18, Sta. 847+64.36 2
02 01 17 SectionC19, Sta. 860+72.35 2
02 01 18 SectionC20, Sta. 918+33.25 2
02 01 19 SectionC22, Sta. 971+62.57 2
02 01 20 SectionC22, Sta. 972+22.53 2
02 01 21 SectionC22, Sta. 972+33.25 2
02 01 22 SectionC22, Sta. 972+55.31 2
02 01 23 SectionC22, Sta. 972+62.39 2
02 01 24 SectionC22, Sta. 973+01.55 2
02 01 25 SectionC22, Sta. 973+26.55 2
02 01 26 SectionC22, Sta. 973+30.22 2
02 01 27 SectionC22, Sta. 973+36.22 2
02 01 28 SectionC22, Sta. 973+58.11 2
02 01 29 SectionC22, Sta. 973+99.62 2
02 01 30 SectionC22, Sta. 974+99.22 2
02 01 31 SectionC22, Sta. 981+84.33 2
02 01 32 SectionC22, Sta. 983+02.36 2
02 01 33 SectionC22, Sta. 983+18.66 2
02 01 34 SectionC22, Sta. 983+28.47 2
02 01 35 SectionC22, Sta.970+82.33 2
02 01 36 SectionC22, Sta.973+87.33 2
06 FISH & WILDLIFE FACILITIES 2
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11 01 Levees 2
11 01 01 1stLift 2
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11 01 06 St. James Parish - Non Structural Risk Reduction 2
11 02 Floodwalls 2
11 02 01 T-wall Interstate: C4; Sta. 229+54 to +236+00 2
11 02 02 T-Wall and DrainageStructurePS; C4; Sta. 261+79 to 264+90 3
11 02 03 T-wall and Swing Gate: C5; Sta. 299+66 to to 301+54 3
11 02 04 T-wall Interstate: C5; Sta. 302+14 to +304+61 3
11 02 05 T-wall and Pipeline: C7; Sta. 358+25 to +363+75 3
11 02 06 T-wall and Pipeline: C8; Sta. 387+77 to +394+00 3
11 02 07 T-Wall and DrainageStructurePS; C8; Sta. 450+40 to 453+40 3
11 02 08 T-wall and Swing Gate: C10; Sta. 512+35 to to 513+35 3
11 02 09 T-wall Interstate: C12; Sta. 607+11 to +612+85 3
11 02 10 T-Wall and DrainageStructurePS; C14; Sta. 659+22 to 663+17 3
11 02 11 T-wall and Swing Gate: C17; Sta. 752+70 to to 755+57 3
11 02 12 T-wall and Pipeline: C18; Sta. 846+00 to +850+00 3
11 02 13 T-wall and Pipeline: C19; Sta. 859+00 to +862+00 3
11 02 14 T-Wall and DrainageStructurePS; C20; Sta. 934+82 to 937+57 3
11 02 15 T-wall and Pipeline: C22; Sta. 971+31 to +974+32 3
11 02 16 T-wall and RR gate: C22; Sta. 983+56 to to 985+06 3
11 02 17 T-wall and RR gate: C22; Sta. 1045+21 to to 1045+74 3
13 PUMPING PLANT 3
13 01 Pumping Stations 3
13 01 01 Mobilization and demobilization 3
13 01 02 C4: Sta. 261+79 to 264+90: 1100 cfs 3
13 01 03 C8: Sta. 450+40 to 453+40: 200 cfs 3
13 01 04 C14: Sta. 659+22 to 663+17: 400 cfs 3
13 01 05 C20: Sta. 934+82 to 937+57: 450 cfs 3

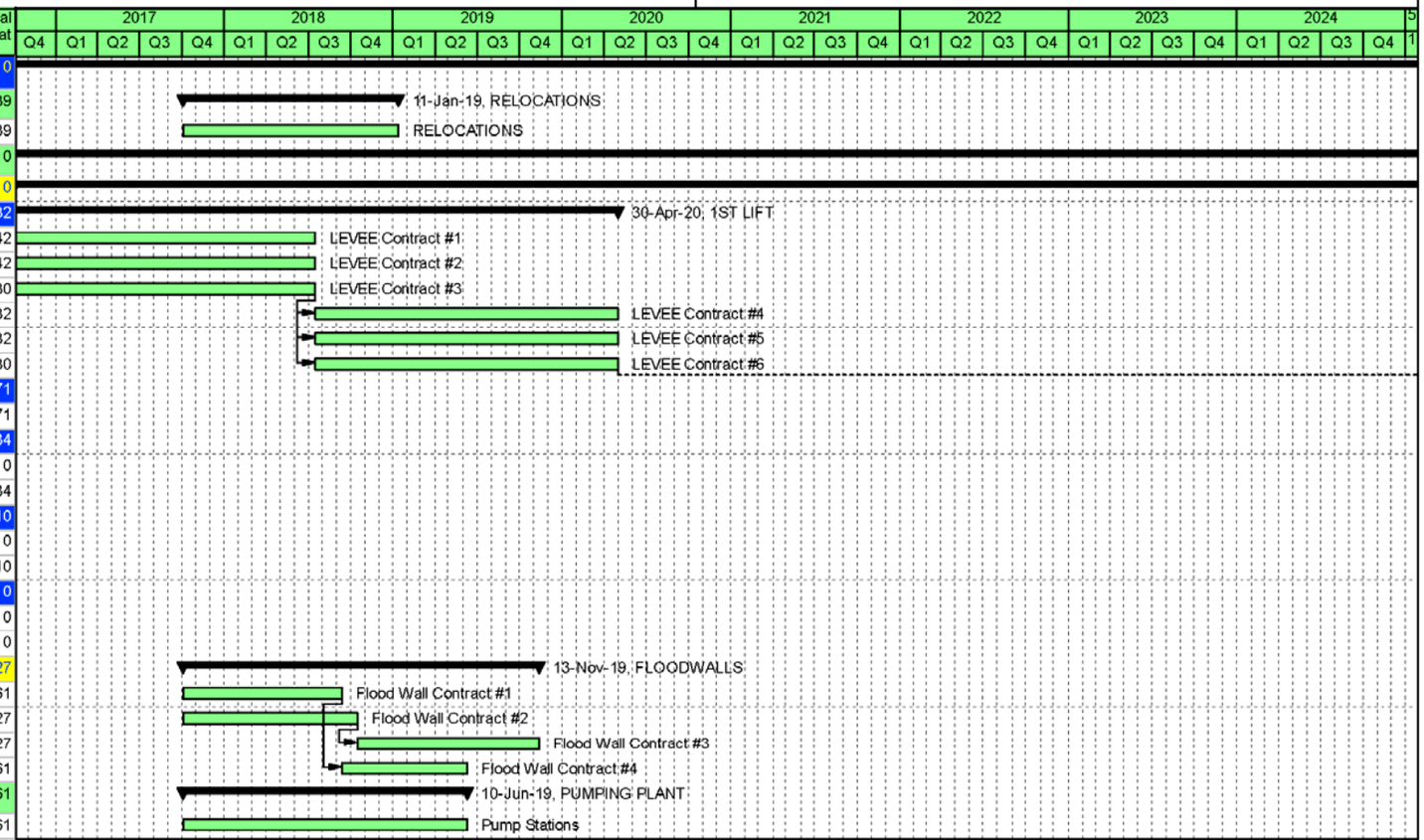
Description	ContractCost	ProjectCost
ProjectTop Level Cost Summary	**468,969,069.53**	**468,969,069.53**
02 RELOCATIONS	**14,767,635.81**	**14,767,635.81**
02 01 Pipelines	**14,767,635.81**	**14,767,635.81**
06 FISH & WILDLIFE FACILITIES	**87,628,000.00**	**87,628,000.00**
11 LEVEES & FLOODWALLS	**290,882,619.67**	**290,882,619.67**
11 01 Levees	**207,039,617.69**	**207,039,617.69**
11 02 Floodwalls	**83,843,001.98**	**83,843,001.98**
13 PUMPING PLANT	**75,690,814.06**	**75,690,814.06**
13 01 Pumping Stations	**75,690,814.06**	**75,690,814.06**

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost	ContractCost	CostToPrime
Project Cost Summary	**48,127,914.35**	**75,155,567.99**	**58,772,943.00**	**202,675,807.09**	**384,732,232.42**	**468,969,069.53**	**262,024,157.66**
02 RELOCATIONS	**1,660,594.94**	**270,544.62**	**3,552,201.00**	**5,839,192.96**	**11,322,533.52**	**14,767,635.81**	**11,322,533.52**
02 01 Pipelines	**1,660,594.94**	**270,544.62**	**3,552,201.00**	**5,839,192.96**	**11,322,533.52**	**14,767,635.81**	**11,322,533.52**
02 01 01 SectionC4, Sta. 278+27.66	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 02 SectionC5, Sta. 279+17.82	**33,669.75**	**6,528.03**	**82,169.65**	**126,297.78**	**248,665.21**	**324,326.46**	**248,665.21**
02 01 03 SectionC5, Sta. 282+89.77	**40,354.56**	**7,338.05**	**81,700.95**	**144,194.44**	**273,588.01**	**356,832.51**	**273,588.01**
02 01 04 SectionC5, Sta. 301+77.52	**63,123.78**	**10,107.23**	**185,937.65**	**151,366.67**	**410,535.32**	**535,448.73**	**410,535.32**
02 01 05 SectionC7, Sta. 359+12.35	**40,354.56**	**7,338.05**	**81,700.95**	**144,194.44**	**273,588.01**	**356,832.51**	**273,588.01**
02 01 06 SectionC7, Sta. 359+94.66	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 07 SectionC7, Sta. 363+92.87	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 08 SectionC10, Sta. 539+22.35	**33,669.75**	**6,528.03**	**82,169.65**	**126,297.78**	**248,665.21**	**324,326.46**	**248,665.21**
02 01 09 SectionC15, Sta. 659+33.14	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 10 SectionC15, Sta. 659+68.54	**33,669.75**	**6,528.03**	**82,169.65**	**126,297.78**	**248,665.21**	**324,326.46**	**248,665.21**
02 01 11 SectionC15, Sta. 659+94.36	**33,669.75**	**6,528.03**	**82,169.65**	**126,297.78**	**248,665.21**	**324,326.46**	**248,665.21**
02 01 12 SectionC18, Sta. 846+28.98	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 13 SectionC18, Sta. 846+35.39	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 14 SectionC18, Sta. 847+12.35	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 15 SectionC18, Sta. 847+22.35	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 16 SectionC18, Sta. 847+64.36	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 17 SectionC19, Sta. 860+72.35	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 18 SectionC20, Sta. 918+33.25	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 19 SectionC22, Sta. 971+62.57	**63,123.78**	**10,107.23**	**185,937.65**	**151,366.67**	**410,535.32**	**535,448.73**	**410,535.32**
02 01 20 SectionC22, Sta. 972+22.53	**36,319.74**	**6,770.63**	**82,169.65**	**139,183.33**	**264,443.35**	**344,905.42**	**264,443.35**
02 01 21 SectionC22, Sta. 972+33.25	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 22 SectionC22, Sta. 972+55.31	**36,319.74**	**6,770.63**	**82,169.65**	**139,183.33**	**264,443.35**	**344,905.42**	**264,443.35**
02 01 23 SectionC22, Sta. 972+62.39	**63,205.27**	**10,107.87**	**185,937.65**	**151,366.67**	**410,617.45**	**535,555.84**	**410,617.45**
02 01 24 SectionC22, Sta. 973+01.55	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 25 SectionC22, Sta. 973+26.55	**72,225.61**	**11,287.33**	**185,937.65**	**159,488.89**	**428,939.48**	**559,452.70**	**428,939.48**
02 01 26 SectionC22, Sta. 973+30.22	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 27 SectionC22, Sta. 973+36.22	**40,354.56**	**7,338.05**	**81,700.95**	**144,194.44**	**273,588.01**	**356,832.51**	**273,588.01**
02 01 28 SectionC22, Sta. 973+58.11	**61,602.61**	**7,600.81**	**81,700.95**	**245,875.93**	**396,780.30**	**517,508.46**	**396,780.30**
02 01 29 SectionC22, Sta. 973+99.62	**55,537.92**	**9,336.78**	**163,047.65**	**147,305.56**	**375,227.91**	**489,398.35**	**375,227.91**
02 01 30 SectionC22, Sta. 974+99.22	**36,319.74**	**6,770.63**	**82,169.65**	**139,183.33**	**264,443.35**	**344,905.42**	**264,443.35**
02 01 31 SectionC22, Sta. 981+84.33	**36,319.74**	**6,770.63**	**82,169.65**	**139,183.33**	**264,443.35**	**344,905.42**	**264,443.35**
02 01 32 SectionC22, Sta. 983+02.36	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 33 SectionC22, Sta. 983+18.66	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
02 01 34 SectionC22, Sta. 983+28.47	**63,205.27**	**10,107.87**	**185,937.65**	**151,366.67**	**410,617.45**	**535,555.84**	**410,617.45**
02 01 35 SectionC22, Sta.970+82.33	**40,354.56**	**7,338.05**	**81,700.95**	**144,194.44**	**273,588.01**	**356,832.51**	**273,588.01**
02 01 36 SectionC22, Sta.973+87.33	**34,597.62**	**6,613.70**	**82,169.65**	**132,122.22**	**255,503.19**	**333,245.04**	**255,503.19**
06 FISH & WILDLIFE FACILITIES	**0.00**	**0.00**	**0.00**	**87,628,000.00**	**87,628,000.00**	**87,628,000.00**	**0.00**
11 LEVEES & FLOODWALLS	**39,836,939.00**	**73,873,942.67**	**47,171,411.68**	**65,763,755.26**	**226,646,048.62**	**290,882,619.67**	**198,482,181.82**
11 01 Levees	**34,768,541.85**	**70,135,413.52**	**5,367,208.40**	**51,952,820.06**	**162,223,983.83**	**207,039,617.69**	**134,654,117.03**
11 01 01 1stLift	**20,879,057.46**	**39,316,772.28**	**2,793,475.28**	**8,202,781.00**	**71,192,086.02**	**96,588,321.09**	**75,111,220.66**
11 01 02 2nd Lift	**1,502,323.52**	**3,778,790.77**	**341,587.43**	**1,600,558.63**	**7,223,260.34**	**9,621,763.38**	**7,433,858.57**
11 01 03 2030 Lift	**4,026,111.63**	**8,830,191.02**	**744,048.56**	**2,825,932.83**	**16,426,284.04**	**21,980,240.93**	**17,009,684.97**
11 01 04 2045 Lift	**4,732,586.91**	**10,027,916.57**	**744,048.56**	**3,096,123.04**	**18,600,675.08**	**24,923,034.49**	**19,296,153.31**
11 01 05 2060 Lift	**3,628,462.33**	**8,181,742.89**	**744,048.56**	**2,730,726.56**	**15,284,980.35**	**20,429,559.80**	**15,803,199.53**
11 01 06 St. James Parish - Non Structural Risk Reduction	**0.00**	**0.00**	**0.00**	**33,496,698.00**	**33,496,698.00**	**33,496,698.00**	**0.00**
11 02 Floodwalls	**5,068,397.15**	**3,738,529.15**	**41,804,203.28**	**13,810,935.20**	**64,422,064.79**	**83,843,001.98**	**63,828,064.79**
11 02 01 T-wall Interstate: C4; Sta. 229+54 to +236+00	**543,440.11**	**428,140.32**	**4,738,881.19**	**623,245.25**	**6,333,706.86**	**8,260,861.06**	**6,333,706.86**

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost	ContractCost	CostToPrime
11 02 02 T-Wall and DrainageStructurePS; C4; Sta. 261+79 to 264+90	372,104.76	234,420.02	2,759,138.59	1,185,472.13	4,551,135.50	5,935,907.50	4,551,135.50
11 02 03 T-wall and Swing Gate: C5; Sta. 299+66 to to 301+54	175,698.73	128,114.38	1,710,294.13	605,641.00	2,619,748.24	3,416,857.88	2,619,748.24
11 02 04 T-wall Interstate: C5; Sta. 302+14 to +304+61	214,087.28	167,384.62	1,850,896.78	424,417.25	2,656,785.93	3,465,165.02	2,656,785.93
11 02 05 T-wall and Pipeline: C7; Sta. 358+25 to +363+75	447,951.48	353,280.85	3,934,062.76	659,237.00	5,394,532.09	7,035,923.99	5,394,532.09
11 02 06 T-wall and Pipeline: C8; Sta. 387+77 to +394+00	506,135.01	399,545.23	4,451,095.51	669,820.88	6,026,596.63	7,860,306.54	6,026,596.63
11 02 07 T-Wall and DrainageStructurePS; C8; Sta. 450+40 to 453+40	360,800.40	226,331.42	2,667,659.85	1,185,512.05	4,440,303.72	5,791,352.98	4,440,303.72
11 02 08 T-wall and Swing Gate: C10; Sta. 512+35 to to 513+35	109,645.45	77,797.80	1,107,615.59	592,597.38	1,887,656.22	2,462,012.54	1,887,656.22
11 02 09 T-wall Interstate: C12; Sta. 607+11 to +612+85	467,188.47	369,481.02	3,922,818.31	535,662.25	5,295,150.05	6,906,303.02	5,295,150.05
11 02 10 T-Wall and DrainageStructurePS; C14; Sta. 659+22 to 663+17	430,312.51	278,867.42	3,163,908.91	1,199,811.80	5,072,900.64	6,616,429.88	5,072,900.64
11 02 11 T-wall and Swing Gate: C17; Sta. 752+70 to to 755+57	238,425.99	176,578.71	2,086,017.77	620,237.50	3,121,259.97	4,070,964.37	3,121,259.97
11 02 12 T-wall and Pipeline: C18; Sta. 846+00 to +850+00	320,809.49	251,007.91	2,607,258.85	637,137.88	3,816,214.13	4,977,371.92	3,816,214.13
11 02 13 T-wall and Pipeline: C19; Sta. 859+00 to +862+00	243,611.53	190,253.35	1,977,996.68	622,199.13	3,034,060.69	3,957,233.00	3,034,060.69
11 02 14 T-Wall and DrainageStructurePS; C20; Sta. 934+82 to 937+57	264,248.81	170,569.68	1,715,224.92	1,177,526.73	3,327,570.13	4,340,048.43	3,327,570.13
11 02 15 T-wall and Pipeline: C22; Sta. 971+31 to +974+32	236,179.95	182,477.91	1,686,451.15	622,200.00	2,727,309.01	3,557,146.12	2,727,309.01
11 02 16 T-wall and RR gate: C22; Sta. 983+56 to to 985+06	95,770.21	73,733.78	901,664.28	1,225,160.13	2,296,328.40	2,904,663.17	1,999,328.40
11 02 17 T-wall and RR gate: C22; Sta. 1045+21 to to 1045+74	41,986.99	30,544.74	523,218.00	1,225,056.88	1,820,806.60	2,284,454.56	1,523,806.60
13 PUMPING PLANT	6,630,380.40	1,011,080.70	8,049,330.32	43,444,858.86	59,135,650.29	75,690,814.06	52,219,442.32
13 01 Pumping Stations	6,630,380.40	1,011,080.70	8,049,330.32	43,444,858.86	59,135,650.29	75,690,814.06	52,219,442.32
13 01 01 Mobilization and demobilization	0.00	0.00	0.00	3,188,310.12	3,188,310.12	4,158,415.84	3,188,310.12
13 01 02 C4: Sta. 261+79 to 264+90: 1100 cfs	1,806,475.61	272,412.48	2,191,632.04	14,280,182.00	18,550,702.14	23,787,349.26	16,600,583.14
13 01 03 C8: Sta. 450+40 to 453+40: 200 cfs	1,641,579.11	250,272.81	2,007,212.91	6,702,370.00	10,601,434.84	13,445,609.02	9,122,320.56
13 01 04 C14: Sta. 659+22 to 663+17: 400 cfs	1,619,481.31	249,610.29	1,989,001.69	9,181,655.37	13,039,748.66	16,527,213.09	11,121,813.34
13 01 05 C20: Sta. 934+82 to 937+57: 450 cfs	1,562,844.37	238,785.12	1,861,483.68	10,092,341.37	13,755,454.53	17,772,226.84	12,186,415.16

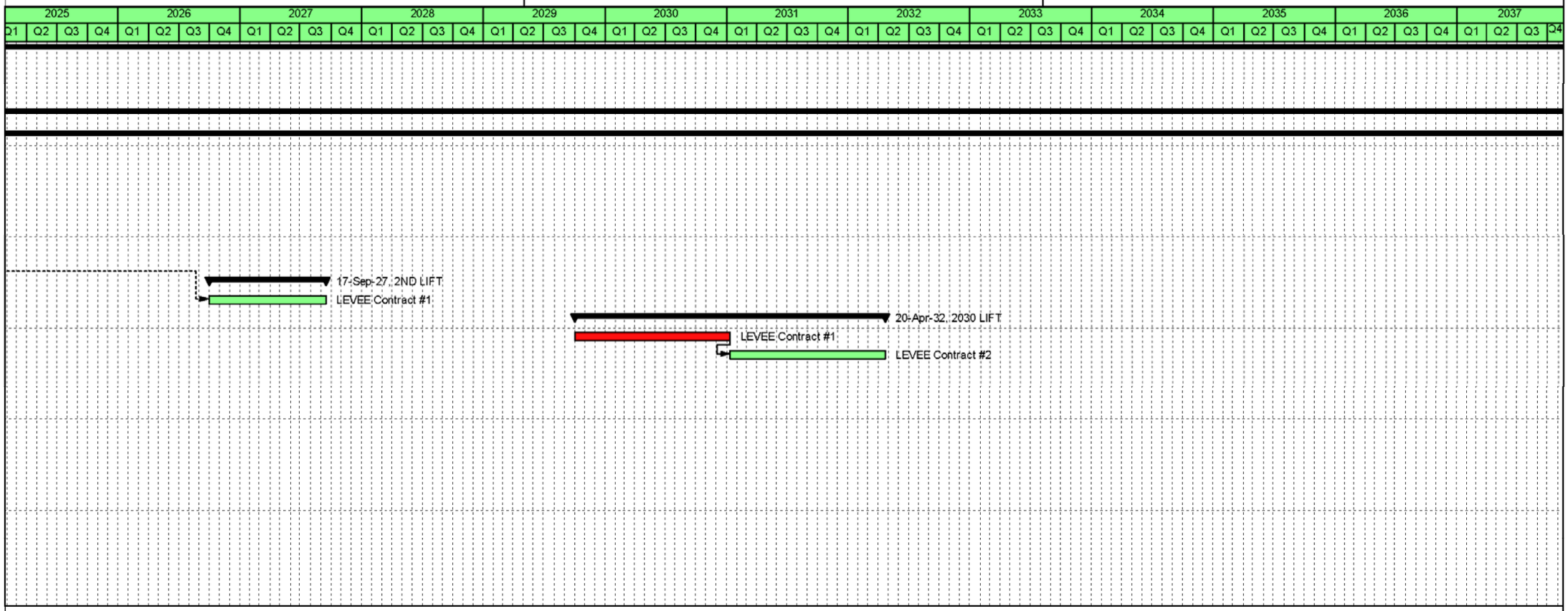
Project Construction Schedule

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
West Shore Lake Pontchartrain Fe		14502	03-Oct-16	27-Jan-63	0
RELOCATIONS		400	03-Oct-17	11-Jan-19	13789
A1020	RELOCATIONS	400	03-Oct-17*	11-Jan-19	13789
LEVEES & FLOODWALLS		14502	03-Oct-16	27-Jan-63	0
LEVEES		14502	03-Oct-16	27-Jan-63	0
1ST LIFT		1120	03-Oct-16	30-Apr-20	13382
A'	LEVEE Contract #1	560	03-Oct-16	17-Jul-18	13942
A'	LEVEE Contract #2	560	03-Oct-16	17-Jul-18	13942
A'	LEVEE Contract #3	560	03-Oct-16	17-Jul-18	13080
A'	LEVEE Contract #4	560	18-Jul-18	30-Apr-20	13382
A'	LEVEE Contract #5	560	18-Jul-18	30-Apr-20	13382
A'	LEVEE Contract #6	560	18-Jul-18	30-Apr-20	13080
2ND LIFT		302	01-Oct-26	17-Sep-27	11071
A'	LEVEE Contract #1	302	01-Oct-26*	17-Sep-27	11071
2030 LIFT		798	03-Oct-29	20-Apr-32	9634
A'	LEVEE Contract #1	399	03-Oct-29*	10-Jan-31	0
A'	LEVEE Contract #2	399	11-Jan-31	20-Apr-32	9634
2045 LIFT		926	03-Oct-44	17-Sep-47	4810
A'	LEVEE Contract #1	463	03-Oct-44*	26-Mar-46	0
A'	LEVEE Contract #2	463	27-Mar-46	17-Sep-47	4810
2060 LIFT		726	04-Oct-60	27-Jan-63	0
A'	LEVEE Contract #1	363	04-Oct-60*	30-Nov-61	0
A'	LEVEE Contract #2	363	01-Dec-61	27-Jan-63	0
FLOODWALLS		662	03-Oct-17	13-Nov-19	13527
A1120	Flood Wall Contract #1	296	03-Oct-17*	12-Sep-18	13661
A1130	Flood Wall Contract #2	324	03-Oct-17*	15-Oct-18	13527
A1140	Flood Wall Contract #3	338	16-Oct-18	13-Nov-19	13527
A1150	Flood Wall Contract #4	232	13-Sep-18	10-Jun-19	13661
PUMPING PLANT		528	03-Oct-17	10-Jun-19	13661
A1190	Pump Stations	528	03-Oct-17*	10-Jun-19	13661



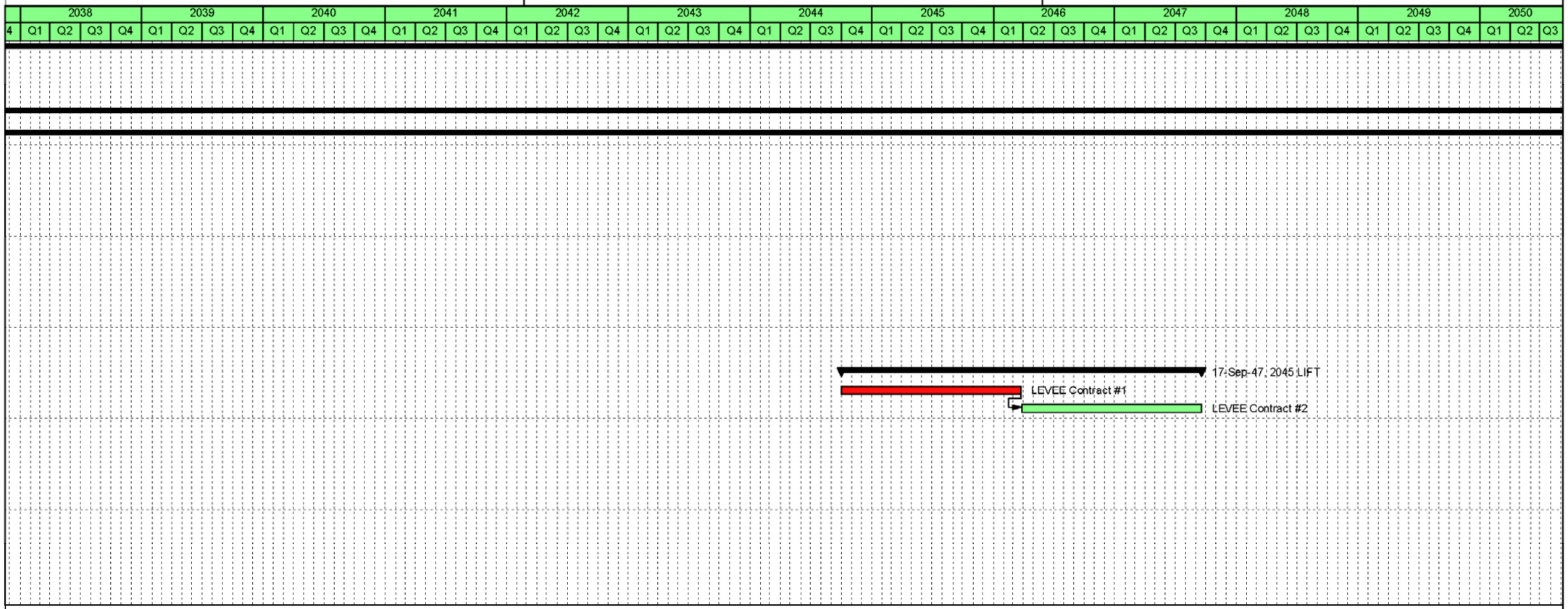
Remaining Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | Summary

US Army Corps of Engineers
Team New Orleans
BUILDING STRONG



Remaining Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | Summary

US Army Corps of Engineers
Team New Orleans
BUILDING STRONG



Remaining Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | Summary

US Army Corps of Engineers
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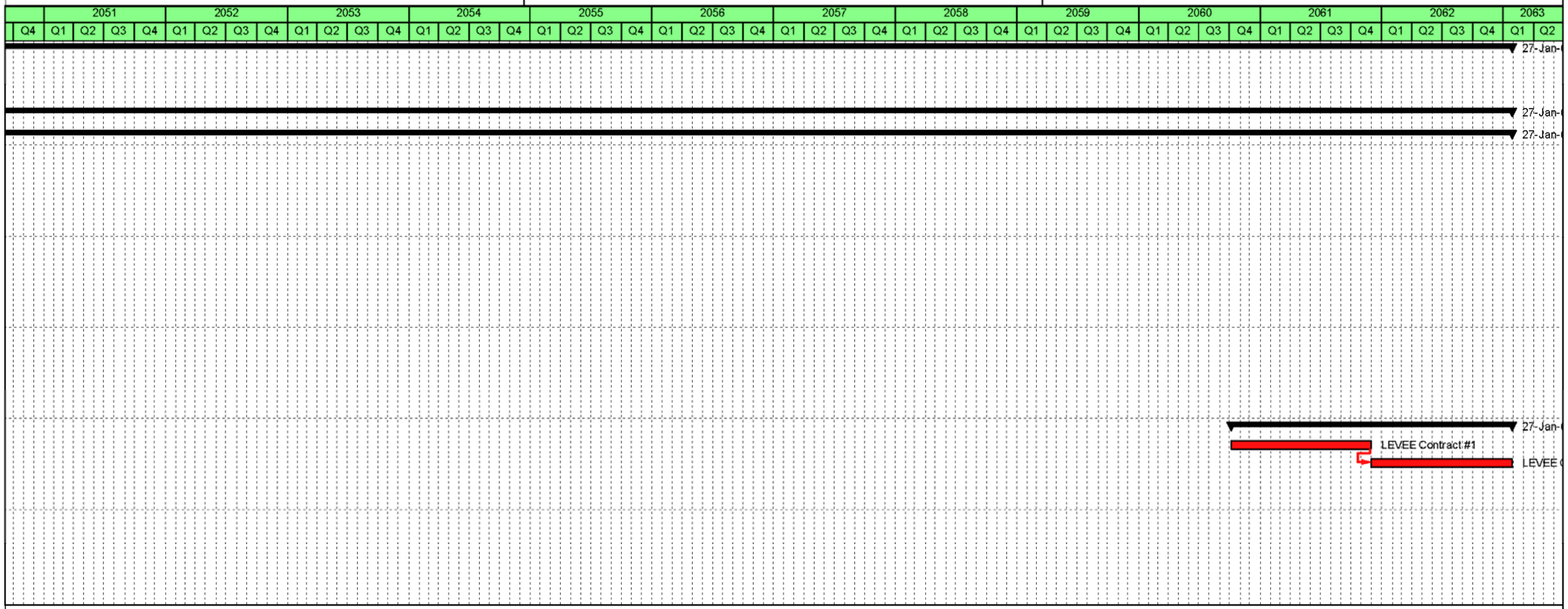

Remaining Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | Summary

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Cost and Schedule Risk Analysis (CSRA)

In an effort to identify the applicable cost and schedule risks inherent with execution of the Recommended Alternative, we prepared a Cost and Schedule Risk Analysis as per ER 1110-2-1302 of 15-Sep-2008. These were implemented in an effort to determine a contingency cost required for cost estimating and based on the risk items associated with the project. The results of these analyses are determined by qualifying and quantifying all potential cost risks and running a Monte Carlo simulation to produce the frequency spectrum and probability range for the applied risk costs. The cost contingency is obtained from the 80-percent contingency as determined by this analysis.

The initial Risk Register considered 38 risk items. From the initial 38 risk items, a total of 6 potential moderate and high risk items were chosen for modeling purposes for the Cost Risk Analysis and 5 risk items for the Schedule Risk Analysis. Assumptions were made for each risk item before running the Monte Carlo simulation. The result of the simulation for the Cost and Schedule Risk Analysis gave a 27% and 5.5% percent (rounded) contingency respectively at the 80-percent confidence level.

The contingency cost for this project was utilized for a Micro Computer Aided Cost Estimating System (MCACES) estimation of the costs associated with the 100 Year Protection Plan (1% Annual Chance Surge Risk Reduction Plan). The potential cost risks developed during this analysis also serve as an indicator of how to avoid unforeseen escalation of project costs throughout project implementation and therefore, may be used as a valuable tool in all future aspect of the project study, design, and construction planning and estimation.

The major contributors to the resulting total project cost contingency for the Cost Estimate were:

- (CON-1) Construction Modifications - risk of contract modifications.
- (TL-4) Borrow/fill sources identified / secured – risk of having to purchase borrow material for future lifts.
- (PR-4) Fuel Cost - risk of inflation on the cost of fuel.

The major contributors to the resulting total project schedule contingency for the project schedule were:

- (CA-2) Numerous Separate Contracts – risk of delays in schedule due to protests, access to projects, multiple contractors coordinating work effort and highway traffic.
- (PPM-3) Funding Availability at Pre-solicitation stage - risk of delays in schedule due to lack of funding during early stages (PED phase) of the project.
- (PR-6) Stakeholders request late changes risk of delays in schedule due to any additional work or alignment.

The corresponding Total Cost including contingency (cost & schedule) for the Cost Risk Analysis is presented on table 1.

Table 1. Cost Contingency Analysis Table

Confidence Level	Value	Contingency
Most Likely Cost Estimate	**$381,341,070**	**0.00%**
5%	**$427,641,254**	**12.14%**
50%	**$463,402,864**	**21.52%**
80%	**$484,330,803**	**27.01%**
95%	**$503,822,683**	**32.12%**

The corresponding Total Cost including contingency (cost & schedule) for the Project Schedule is presented on Table 2.

Table 2. Schedule Contingency Analysis Table

Confidence Level	Value	Contingency
Most Likely Cost Estimate	**557.0 Months**	**0.00%**
5%	**568.5 Months**	**2.07%**
50%	**580.5 Months**	**4.22%**
80%	**587.5 Months**	**5.48%**
95%	**593.7 Months**	**6.59%**

The rounded contingency percentages for **Project Cost (27%)** and for the **Project Schedule (5.5%)** were transferred to the TPCS for final calculation of total contingency and cost. Lands and Damages cost and contingency are not included in the above. (NOTE: The rounding of the contingencies causes the totals on the TPCS to be slightly higher than and not add up to exactly the costs above.)

For more detailed information on the CSRA, see the complete CSRA Risk Report.

US Army Corps
of Engineers®

WEST SHORE LAKE PONTCHARTRAIN HURRICANE AND STORM DAMAGE RISK REDUCTION PROJECT

Project Cost and Schedule Risk Analysis Report

Prepared for:
U.S. Army Corps of Engineers
Mississippi Valley Division
New Orleans District

Prepared by:
New Orleans District

Date: **27 JUN 2014**

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APPENDIX

APPENDIX A Detailed Risk Register

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), New Orleans District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Presque Isle Shoreline Erosion Control Project. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis, *Monte-Carlo* based-study was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The risk analysis is based upon the recommended plan of 18.27-mile levee around Montz, Laplace, Reserve and Garyville, reducing risk to over 7,000 structures. Additionally, four miles of I-10 flooded during Hurricane Isaac is within the proposed system. The plan includes non-structural measures for 1,571 structures in Gramercy, Lutcher and Grand Point. The estimated base cost, excluding contingencies approximates $560M which includes:

- 01 Lands and Damages
- 02 Relocations
- 06 Fish and Wildlife
- 11 Levees and Floodwalls
- 13 Pumping Plant
- 30 Planning, Engineering and Design (PED)
- 31 Construction Management

.

Of the above, the 01 Lands and Damages and the 06 Fish and Wildlife contingencies were provided by others. This risk analysis was devoted to the main construction features: Relocations, Levees and Floodwalls and Pumping Plants, approximating $400M. The other costs excluded from this study are the PED and Construction Management costs. Those two costs, based as a percent of the construction base costs, received the same applied contingency percent.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and per cent values. Should cost vary to a slight degree with similar scope and risks, contingency per cent values will be reported, cost values rounded. The study resulted in a 29% contingency with an 80% confidence level of successful project completion.

Table 1 Construction Contingency Results

Confidence Level	Base Cost	Contingency $	Contingency (%)
5%	$381,341,070	$50,845,549	13.33%
50%	$381,341,070	$91,328,758	23.95%
80%	$381,341,070	$115,043,125	30.17%
90%	$381,341,070	$126,816,303	33.26%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register in February 2014, focusing on construction, contract acquisition, design, project management, programmatic and construction management risks. The study outcome identified key cost and schedule risks resulting in an approximate 30% contingency of the costs studied.

Cost Risks: From the CSRA, the key or greater identified Cost Risks include:

- (CON-1) Construction Contract Modifications – Technical complexities and site conditions could result in increased risk of contract modifications. Detailed geotechnical and hydraulic investigations may reduce these risks.

- (TL-4) Borrow Sources Identified/Secured – The uncertainty of a secured borrow source for the last five lifts. Alternative borrow sources may need to be approved in order to reduce this risk.

- CA-1 Contract Acquisition Impacts – Type of contracts and possible impacts to cost and schedule. Early PDT involvement with Contracting and Project Management may lessen the risks and solidify the types of solicitations.

- TL-2 Design Development – Design details for the structural elements whether preliminary or detailed and their impact to costs. Further investigations in the design phases may lessen this risk.

- EST-1 Labor & Equipment Availability/Pricing – Variances in availability of equipment and labor throughout the project and impacts to costs.

- EST-3 Estimate quality when developed by others – Inaccuracies due to a large use of lump sums in the MII could cause changes to cost. Further design and additional QC/QA may reduce this risk.

- PR-1 Funding Availability for PED and Construction – Impacts to costs due to funding variances causing delays and escalation of costs.

- PR-4 Fuel Cost – Fuel price variances impacts to construction costs.

Schedule Risks: Schedule risks indicate a duration uncertainty which can also be translated into cost impacts. The greatest identified schedule risks include:

- CA-2 Numerous Separate Contracts – Numerous separate contracts increases the risks of protests, access to projects choke points, multiple contractor coordination.

- PPM-2 Smart Planning Pilot – Impacts to schedule due to unplanned work or requests for additional modeling/investigations under PED.

- PPM-3 Funding Availability at Pre-solicitation Stage – Impacts to schedule due to lack of funding during PED.

- PR-1 Funding Availability for PED and Construction – Impacts to schedule due to funding variances causing delays and increased costs

- PR-6 Stakeholder Request Late Changes – Additional work or alignment changes would impact costs and increase schedule delays.

Recommendations: Further iterative project and risk study is important throughout the project life-cycle in order to efficiently manage and maintain a reasonable cost and schedule. Certain risks are outside the PDT control, while certain risks can be managed to lessen impact in cost and time. The more critical items that warrant attention are:

- Work to identify and procure quality borrow sources close to the project location. This brings dividends related to haul time and productivity. Closer borrow sources are key in decreasing the cost and risk impacts to this project.

- Identify and resolve the mitigation requirements and concerns in order to gain a better understanding of cost implications.

1. PURPOSE

The study purpose is to provide a recommendation for Federal participation in hurricane storm damage risk reduction for St. Charles, St. John the Baptist and St. James Parishes that would be economically and environmentally justified. The study addresses flooding caused by storm surge but does not address rainfall flooding. There have been significant changes over the last 40 years, especially since Hurricane Katrina. Population has grown over the past few decades. This report presents a collaboratively-developed plan prepared in accordance with the National Environmental Policy Act (NEPA) and Engineering Regulation 1105-2-100, the USACE Planning Guidance Notebook. It consists of a main report and appendices, and identifies the expected benefits, estimated cost and implementation responsibilities for a tentatively selected plan (TSP). The report provides an overview of the study and summarizes detailed information found in technical appendices. The report is an interim response to the study authority. Flooding cause by storm surge damages homes, businesses and infrastructure. Surge travels from the Gulf of Mexico into the basin and floods the three study area parishes and beyond (Figure 1-3).

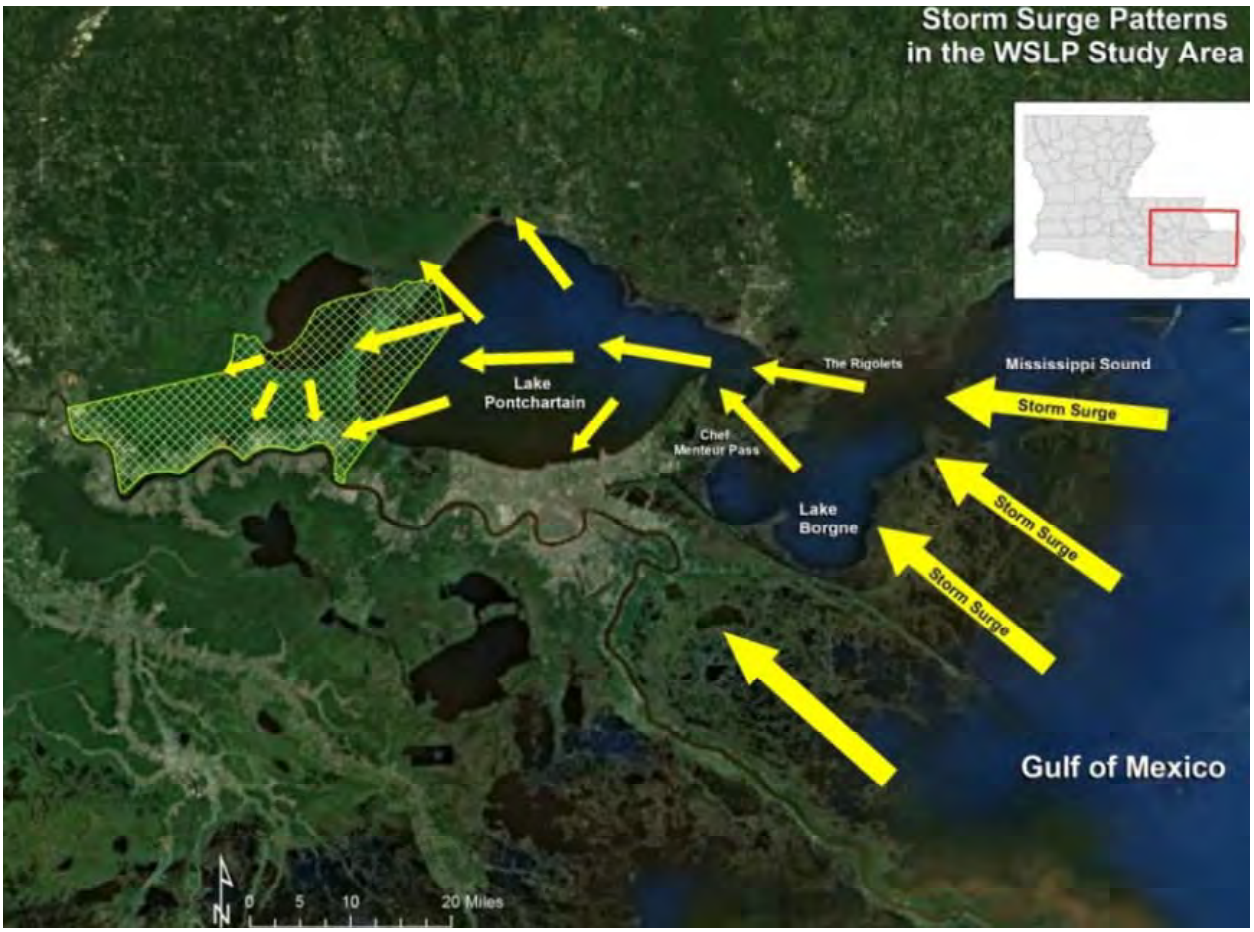

Figure 1 Area Storm Surge Patterns

Since 1855, 70 hurricanes have made landfall within 65 nautical miles of Laplace. Hurricanes Betsy (1965), Camille (1969), Juan (1985), Andrew (1992), Katrina and Rita (2005), Gustav and Ike (2008), and Isaac (2012) caused storm surge flooding. Hurricane Isaac's surge, measured from 6 to 8 feet in the area, threatened lives and damaged more than 7,000 homes, closed roads and disrupted the Nationally-significant energy industry. Businesses and workers serving the Port of South Louisiana are located in the area. The port is the largest volume port in the Western Hemisphere and the ninth largest in the world. It stretches 54 miles on the Mississippi River between New Orleans and Baton Rouge. Hurricane Isaac disrupted port logistics. Its storm surge blocked facility access closing the port. Oil refineries, including the Nation's third largest, were shutdown. Gasoline production stopped. Regional and National fuel prices spiked. The storm caused extensive agricultural losses due to an inability to drain storm surge water from fields.

The study area setting offers bounty of natural resources but it was historically subject to flooding from the river and nearby lakes. Levees were constructed along the Mississippi River starting in the 1700s to combat annual floods. These levees allowed settlement of the area and agricultural production and the harvesting of natural resources. The area remains susceptible to floods from tropical storms and hurricanes. Some natural protection is afforded by large cypress swamp that separates developed areas from nearby tidal lakes. The swamp has degraded over time and the buffer it provides between the lakes and towns is decreasing. As a result, flooding from storm surge (Figure 1-3) remains a risk that is expected to increase over time. The management of Mississippi River flood risk, and the accompanying development of interior drainage systems, allowed urban and suburban expansion in much of the region beyond the natural high-ground near the Mississippi River. Population has increased with suburban development between Baton Rouge and New Orleans. Residents are attracted to the area because of employment opportunities, quality of life, and access to recreation. These factors, increasing population and degrading natural buffers, combine to increase storm surge flooding risks.

2. BACKGROUND

The study area (Figure 1-1) is located in southeast Louisiana between the Mississippi River, and Lakes Maurepas and Pontchartrain.

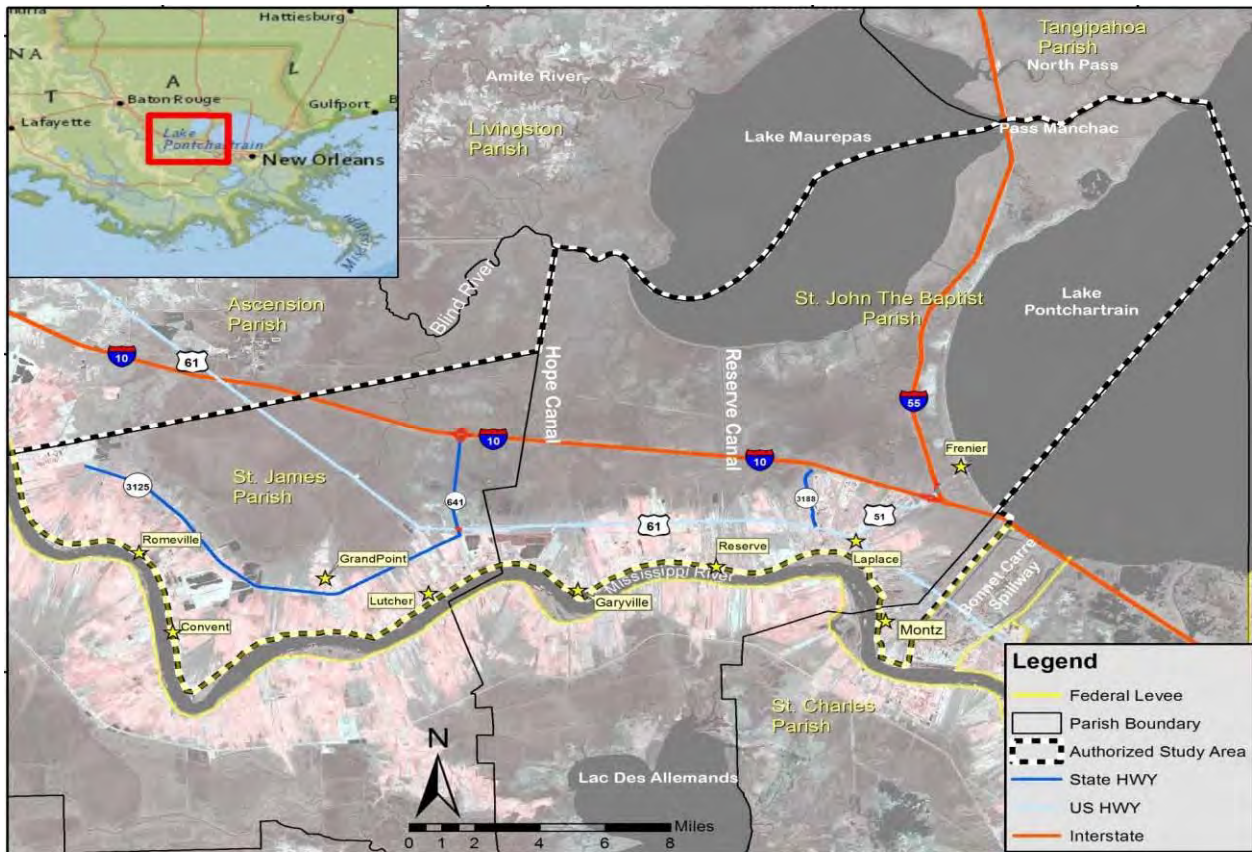

Figure 2 West Shore Lake Pontchartrain Authorized Study Area

The towns of Montz, Laplace, Reserve, Lutcher,
Gramercy, Grand Point, Convent, Garyville and Romeville are area communities. The 184,351 study acre area occupies a portion of one of the oldest delta complexes in the Mississippi River Deltaic Plain. It is located in the lower Mississippi River alluvial plain in the Pontchartrain Basin. The area includes residential and commercial developments south of Interstate 10 (I-10). West of Laplace, a majority of the developed areas are found between U.S. Highway 61 (US-61) and the Mississippi River levee. The area north of I-10 comprises the State of Louisiana's Maurepas Swamp Wildlife Management Area (WMA). The project area includes lands potentially impacted by the proposed action. Hurricane or tropical storm winds push on the ocean's surface, causing a rise of water over and
above the predicted tide. This is called storm surge. Hurricanes and tropical storms are an important part of Louisiana's history and culture. The region experiences tropical waves, depressions, storms and hurricanes. The study area is highly susceptible to storm surge. The destruction caused by a 1915 hurricane was recounted years later:
"… an enormous storm surge advanced with great rapidity upon the western shore of Lake Pontchartrain well ahead of the eye of the hurricane which very nearly struck Frenier head on. As the storm came ashore in the New Orleans area, fifty people drowned as a thirteen foot storm surge swept the Rigolets railroad bridge away. It should also be emphasized that damage and destruction to homes and property were occurring even as the eye of the hurricane was 165 miles from Frenier. Two-hundred seventy-five Louisianians lost their lives

as a result of the "Great West Indian Hurricane of 1915." (Landry 1996)
Recent hurricanes impacting the area include Katrina and Rita in 2005, Gustav and Ike in 2008, and Isaac in 2012. These storms threatened a region that plays a vital national economic role and that serves as a key transportation corridor.
An important swamp buffer separating development from nearby lakes has been impacted over time. The closure of bayous and the construction of levees cut off the annual flooding that historically nourished and maintained the cypress/tupelo habitat in the Maurepas Swamp. The cypress forests of the swamp were logged in the 1890s –1930s. Canals and railroads were built through the swamp to remove cut timber (Figure1-2). The swamp is converting to fragmented marsh and open water (USACE 2010a, USACE 2010b). The area may experience up to 2.32-feet of relative sea level rise (RSLR) over the next 50-years under an “intermediate “scenario. The surge buffer benefits of the swamp will continue to diminish as it degrades and disappears and sea level rises.

3. REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all project features. The study and presentation can include or exclude consideration for operation and maintenance or life cycle costs, depending upon the program or decision document intended for funding.

3.1 Project Scope

The U.S. Congress recognized the need for a hurricane and storm damage risk reduction project in the area. Two Congressional resolutions authorize this study. The first was adopted on July 29, 1971 by the U.S. House of Representatives Committee on Public Works.
“RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on Lake Pontchartrain and Vicinity, Louisiana, published as House Document No. 231, 89th Congress, First Session, and other pertinent reports, with a view to determining whether modifications to the recommendations contained therein are advisable at this time, with particular reference to providing additional levees for hurricane protection and flood control in St. John the Baptist Parish and that part of St. Charles Parish west of the Bonnet Carré Spillway."

The U.S. Senate Committee on Public Works adopted a resolution on September 20, 1974.
“RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on Lake Pontchartrain and Vicinity, Louisiana, published as House Document No. 231, 89th Congress, First Session, and other pertinent reports, with a view to determining whether modifications to the recommendations contained therein are advisable at this time, for hurricane protection and flood control in St. James Parish."

The study was first funded in the 1980s. A 1985 Reconnaissance Report found that there was no justified structural plan suitable for Federal participation. A 1987 reconnaissance report

indicated that under Federal criteria a solution could not be found that would be economically justified or environmentally acceptable. Because of increasing population and economic activity, a 1997 reconnaissance report indicated that the study should proceed into feasibility phase. A Feasibility Cost Share Agreement was executed with the Pontchartrain Levee District (PLD) in 1998. The study stopped in 2002. Following Hurricane Katrina, renewed interest by the levee district led to an amended agreement in 2008. Planning for the project was underway when Hurricane Isaac hit in August2012. President Obama traveled to Laplace, Louisiana after the storm to view the damage and visit with residents and local leaders. The President said, **"*We're getting on the case to figure out what happened here and what we can do to make sure it won't happen again.*"** The USACE's post-Isaac damage assessment met the first part of the President's commitment. This study will help deliver the second part.

The report includes the project technical scope, feasibility level estimates developed by the engineering design firm Burk-Kleinpeter, Inc. (BKI), and the New Orleans District Cost Engineering. Construction schedules were developed by the New Orleans District Cost Engineering. New Orleans District Cost Engineering performed the Quality Control Review of BKI's work and did and internal independent review of work prepared by New Orleans District Cost Engineering. Consequently, these documents serve as the basis for the risk analysis. In general terms, the construction scope consists of the following:

- Lands and Damages
- Relocations
- Levees and Floodwalls
- Pumping Plant
- Planning, Engineering and Design
- Construction Management

3.2 USACE Risk Analysis Process

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering DX). The risk analysis process reflected within the risk analysis report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses

through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects.
- ER 1110-2-1302, Civil Works Cost Engineering.
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.
- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX.
- Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.

4. METHODOLOGY/PROCESS

The Project Delivery Team is composed of various USACE New Orleans District branches including Project Management, Real Estate, Planning, Contracting, Structures and Levee Design, Hydrologic and Geotechnical and Cost Engineering Offices.

The District PDT conducted a February 2014 risk identification meeting, completing a draft risk register in support of a risk analysis study and modeling. Participants in the risk identification meetings included:

Miguel Ramos	USACE New Orleans	Cost Engineer
Henry Picard	A/E firm Burk Kleinpeter, Inc.	Designer & Cost Engineer
David Boyd	A/E firm Burk Kleinpeter, Inc.	Designer & Cost Engineer
Jeffery Varisco	USACE New Orleans	Project Manager
Travis Creel	USACE New Orleans	Planner
Walter Teckemeyer	USACE New Orleans	Project Engineer
Darrell Normand	USACE New Orleans	Cost Engineer

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A parallel process is also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering DX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. Because Crystal Ball is an Excel add-in, the schedules for each option are recreated in an Excel format from their native format. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results would be provided in section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT are considered a qualitative process that results in establishing a risk register that serves as the document for the further study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and is considered.

A formal PDT meeting was held Feb 24, 2014 at the New Orleans District for the purposes of identifying and assessing risk factors. The meeting included qualified representatives from multiple project team disciplines and functions, for example:

- Project/program managers.
- Planners
- Project Engineers
- Geotechnical Engineers
- Structural Engineers
- Relocations, Real Estate, Economist, Construction (on call)
- Hydraulic Engineers
- Civil, structural, geotechnical, and hydraulic design.
- Cost and schedule engineers.

The initial meeting focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Subsequent meetings and phone conversations focused primarily on risk factor assessment and quantification.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following elements of each risk factor were discussed by the PDT to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

The risk discussions focused on the various project features as presented within the USACE Civil Works Work Breakdown Structure for cost accounting purposes. It was recognized that the various features carry differing degrees of risk as related to cost,

schedule, design complexity, and design progress. The example features under study are presented in table 1:

Table 2 Work Breakdown Structure by Feature

01	LANDS AND DAMAGES
02	RELOCATIONS
11	LEVEES & FLOODWALLS
13	PUMPING PLANT
30	PLANNING, ENGINEERING & DESIGN
31	CONSTRUCTION MANAGEMENT

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For schedule contingency analysis, the option schedule contingency is calculated as the difference between the P80 option duration forecast and the base schedule duration. These contingencies are then used to calculate the time value of money impact of project delays that are included in the presentation of total cost contingency in section 6. The resulting time value of money, or added risk escalation, is then added into the contingency amount to reflect the USACE standard for presenting the "total project cost" for the fully funded project amount.

Schedule contingency is analyzed only on the basis of each option and not allocated to specific tasks. Based on Cost Engineering DX guidance, only critical path and near critical path tasks are considered to be uncertain for the purposes of contingency analysis.

5. KEY ASSUMPTIONS

Key assumptions are those that are most likely to significantly affect the determinations and/or estimates of risk presented in the risk analysis. The key assumptions are important to help ensure that project leadership and other decision makers understand the steps, logic, limitations, and decisions made in the risk analysis, as well as any resultant limitations on the use of outcomes and results.

The following is an example of key assumptions for the risk analysis that could be identified by the PDT and risk analyst.

- Level of Design: The cost comparisons and risk analyses performed and reflected within this report are based upon design scope and estimates that are considered to be well developed and designed.
- Design Scope: The prescribed scope satisfies the requirements of this acquisition given that it is a re-authorization along the already approved alignment with minor adjustments.
- Operation and Maintenance: Operation and maintenance activities were not included in the cost estimate or schedules
- Contract Acquisition Strategy: Consistent with cost estimate and schedule assumptions, it is assumed that the contract acquisition strategy is predominately firm fixed price.
- Confidence Levels: The Walla Walla Cost Engineering Dx guidance generally focuses on the eighty-percent level of confidence (80%) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (80%) was used. It should be noted that the use of 80% as a decision criteria is a moderate risk aversion approach, generally resulting in higher cost contingencies. However, the 80% level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to completely capture actual project costs.
- Only moderate and high risk levels were applied for the purposes of the CSRA analysis.

The following list identifies the key risk analysis assumptions and limitations within the context of the Morganza to the Gulf of Mexico PAC CSRA. For each item, the context is first provided and then followed by the key assumption or limitation.

- *Unknown Decisions or Decision Makers:* The CSRA was prepared using a framework to generate contingency information that is appropriate for use by State of Louisiana and USACE decision makers for scheduling, budgeting, and project control purposes. The framework may generate results that are appropriate for use by a wide variety of decision makers or stakeholders;

however, the assumed use of CSRA results is limited to scheduling, budgeting, and project control. Other uses by unknown decision makers may not be appropriate.

- *Dynamic Risks:* Risk events are dynamic, not static, and should be evaluated regularly through all phases of design, construction and O&M (if required). The CSRA is based on the identification and assessment of risks as of the date of this document. Reduced utility of current CSRA results should be assumed if the likelihood and impact of risks change over time.
- *Causal Relationships:* With the exception of risk events identified as correlated in the risk register, it is assumed that the impacts of risks are independent and that the realization of one risk does not cause the realization of another. Significant variance of the risk model results from actual project costs and schedules may be experienced if significant causal relationships exist between risks assumed to be independent.
- *Conservation of Market Pricing Risk:* The CSRA assumes that market pricing risks are not created or destroyed but can only be transferred or shared *at a price* as a result of various contract acquisition strategies. As an example, it is assumed that a contractor will add a level of contingency to a fixed price bid, relative to a cost reimbursable bid, that is reflective of the risk transferred contractually from the Government to the contractor. Other aspects of contract acquisition strategies not related to market pricing, such as the management cost of modifications or claims, are not included in this assumption. Any contract acquisition strategy that actually transfers market pricing risk to a contractor *at no cost* to the Government is not reflected in the CSRA.
- *Unknown Unknown* and *Unknowable Risks*: The Kinetin Framework describes decision-making contexts, in part, by characteristic types of uncertainty. Simple, complicated, complex and chaotic contexts within the framework are respectively associated with *known known*, *known unknown*, *unknown unknown* and *unknowable* uncertainties. The CSRA process focuses on *known known* and *known unknown* risks and is not intended to quantify the impacts of *unknown unknown* or *unknowable* risks. Significant variance of the risk model results from actual project costs and schedules may be experienced if *unknown unknowable* risks, as defined in the Cynefin Framework, are realized.

6. RISK ANALYSIS RESULTS

The following sections discuss the risk register, cost risk analysis results, schedule risk analysis results, and the combined cost and schedule risk analysis results.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the risk studies and Crystal Ball risk models. A summary risk register that includes typical risk events studied (high and moderate levels) should be presented in a table in this section. The risk register reflects the results of risk factor identification

and assessment, risk factor quantification, and contingency analysis. A more detailed risk register would be provided in appendix A. The detailed risk registers of appendix A include low level and unrated risks, as well as additional information regarding the specific nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting risk analysis feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Risk Analysis - Cost Contingency Results

The cost risk model was run from the project Risk Register for all the project construction work. There were eight risks applicable to the project construction work. As shown in Table 2, there were a total of eight risks used in the modeling for the risk analyses which had a cost impact of moderate or high. The risk was analyzed using the low, most likely, and high estimates for each risk item and the items associated variance distribution. The analysis produced a sensitivity chart of the risk items and confidence levels from 0 to 100% and the associated contingency amount.

The cost sensitivity chart for the Project Cost is shown in Figure 3. The sensitivity chart shows the influence of each risk items on the resulting cost contingency. The risk items are ranked according to their importance to the cost contingency. As shown in the Cost Sensitivity Charts, Possible Construction Modifications and Borrow/Fill Sources Identified items had the most influence on the cost contingency.

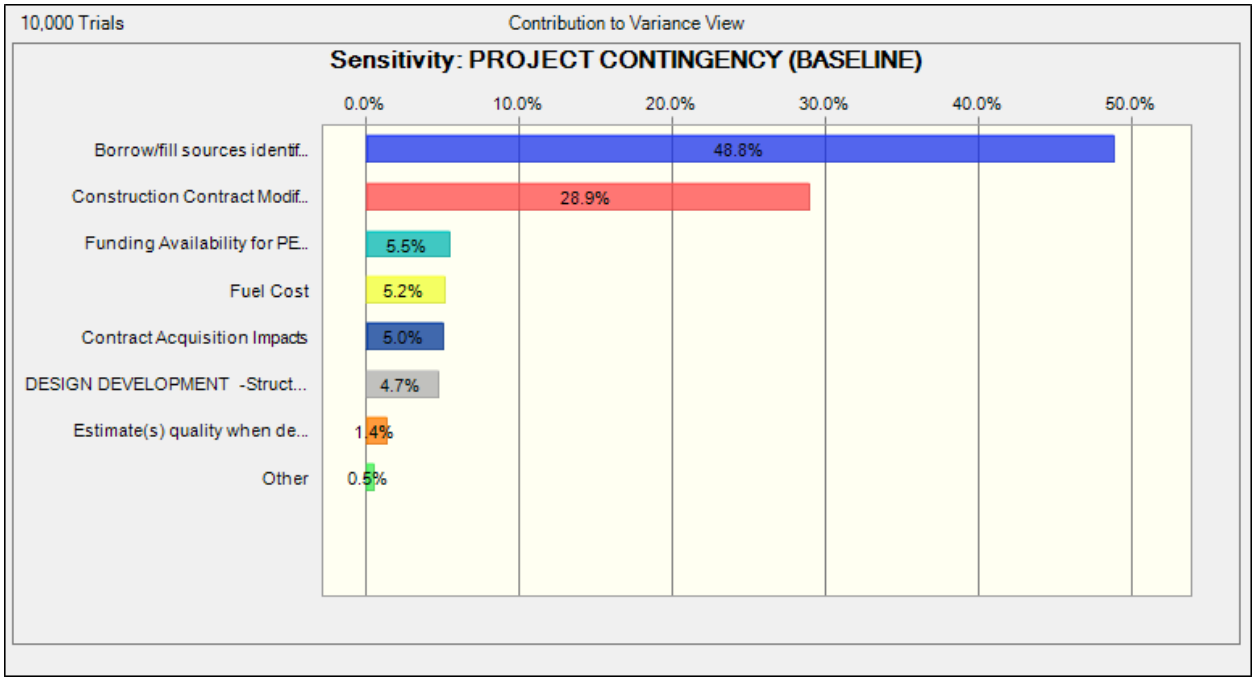

Figure 3 Project Cost Sensitivity Chart

The cost risk analysis also produced a confidence table in five percent increments of project confidence associated with contingency dollars. The confidence levels are shown in Table 3. As seen in the table, all of the associated contingency dollar amounts are positive. The contingency dollar amounts range from over $15 million to over $193 million. The recommended cost contingency amount for the project is $115,965,059.

Table 3 Project Cost Confidence Table

Confidence Level	Value	Contingency
0%	**$411,083,188**	**4.02%**
5%	**$441,601,870**	**11.74%**
10%	**$448,582,338**	**13.51%**
15%	**$453,790,781**	**14.83%**
20%	**$458,090,305**	**15.92%**
25%	**$461,725,542**	**16.84%**
30%	**$465,248,288**	**17.73%**
35%	**$468,462,654**	**18.54%**
40%	**$471,503,691**	**19.31%**
45%	**$474,341,807**	**20.03%**
50%	**$477,518,142**	**20.83%**
55%	**$480,516,261**	**21.59%**
60%	**$483,587,157**	**22.37%**
65%	**$487,146,543**	**23.27%**
70%	**$490,737,500**	**24.18%**
75%	**$494,456,374**	**25.12%**
80%	**$498,653,172**	**26.18%**
85%	**$503,477,035**	**27.40%**
90%	**$509,651,756**	**28.96%**
95%	**$519,422,304**	**31.44%**
100%	**$566,003,261**	**43.22%**

6.3 Schedule Risk Analysis - Schedule Contingency Results

A schedule risk analysis was conducted on five risks of the risk register, shown in Appendix A, which had a schedule impact of moderate or high. The project Risk Register originally considered over 40 risk items but only 5 risks were determined to have an impact on the overall program schedule. The risk was analyzed using the low, most likely, and high estimates for each risk item and the items associated variance distribution. The analysis produced a sensitivity chart of the risk items and confidence levels from 0 to 100% and the associated contingency amount.

The schedule sensitivity chart is shown in Figure 4 below. The sensitivity chart shows the influence of each risk items on the resulting schedule contingency. The risk items are ranked according to their importance to the schedule contingency. As shown in the Schedule Sensitivity Chart, the Numerous Separate Contracts (CA-2) item had the most influence on the schedule contingency. It is important to note again that the schedule is for a Program rather than a Single Project and therefore very few items were considered to be a High risk to the program and did not significantly affect the overall schedule.

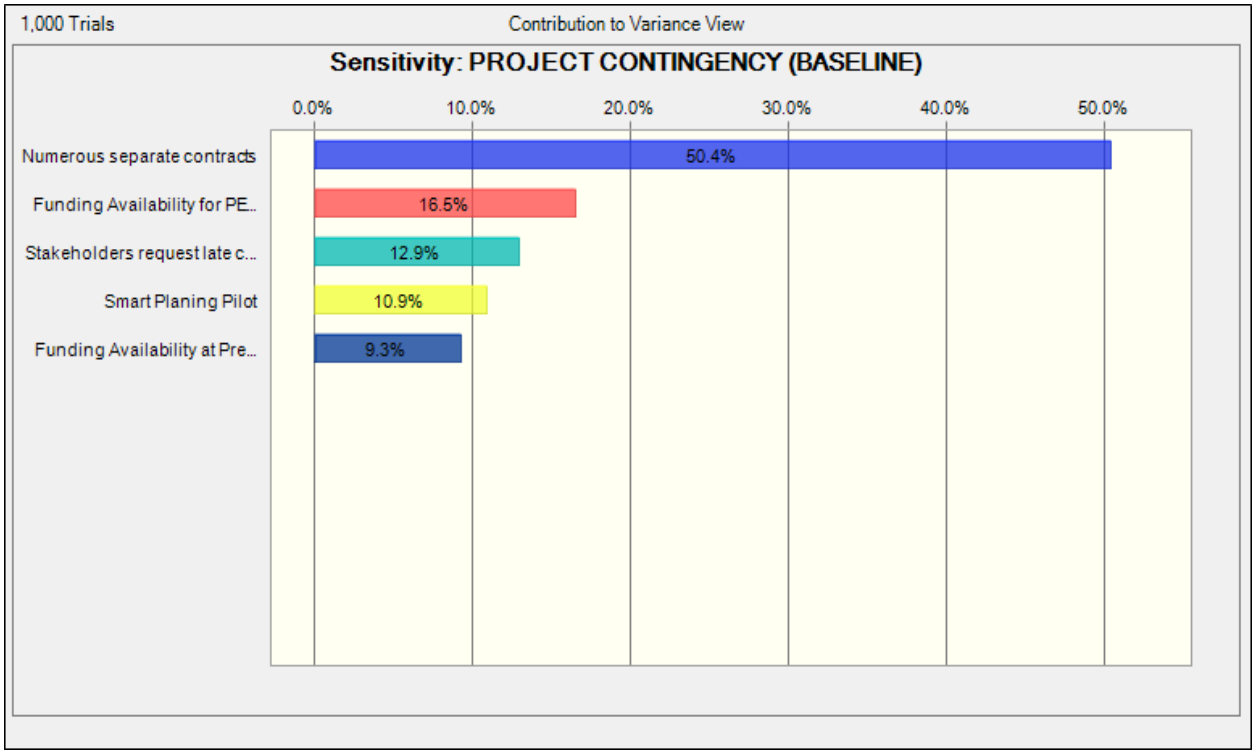

Figure 4 Project Schedule Sensitivity Chart

The schedule risk analysis also produced a confidence table in five percent increments of project confidence associated with contingency months. The confidence table is shown in Table 4 below. As seen in the table, all the associated contingency month amounts are positive. The contingency month amounts range from 4.1 months to over 56 months. The recommended schedule contingency amount is 30.5 months. Note that these results reflect only those contingencies established from the schedule risk analysis.

Confidence Level	Value	Contingency
0%	**4.1 Months**	**0.74%**
5%	**11.5 Months**	**2.07%**
10%	**13.8 Months**	**2.48%**
15%	**15.5 Months**	**2.79%**
20%	**17.2 Months**	**3.09%**
25%	**18.3 Months**	**3.28%**
30%	**19.2 Months**	**3.45%**
35%	**20.4 Months**	**3.66%**
40%	**21.3 Months**	**3.83%**
45%	**22.3 Months**	**4.00%**
50%	**23.5 Months**	**4.22%**
55%	**24.3 Months**	**4.36%**
60%	**25.5 Months**	**4.57%**
65%	**26.7 Months**	**4.79%**
70%	**27.9 Months**	**5.02%**
75%	**29.0 Months**	**5.20%**
80%	**30.5 Months**	**5.48%**
85%	**32.3 Months**	**5.79%**
90%	**34.2 Months**	**6.13%**
95%	**36.7 Months**	**6.59%**
100%	**56.1 Months**	**10.06%**

Table 4 Project Schedule Confidence Table

6.4 Combined Cost and Schedule Contingency Results

To obtain an overall feature contingency, the cost risk analysis confidence table and the schedule risk analysis confidence table are combined. That combined table is shown in Table 8. To obtain the final contingency dollar amount, the schedule contingency is converted into dollars by using the time value of money.

Confidence Level	Contingency	Contingency
0%	**$15,893,329**	**4.1 Months**
5%	**$51,126,450**	**11.5 Months**
10%	**$59,042,361**	**13.8 Months**
15%	**$64,958,788**	**15.5 Months**
20%	**$69,935,351**	**17.2 Months**
25%	**$74,017,034**	**18.3 Months**
30%	**$77,931,608**	**19.2 Months**
35%	**$81,613,631**	**20.4 Months**
40%	**$85,047,490**	**21.3 Months**
45%	**$88,271,729**	**22.3 Months**
50%	**$91,939,953**	**23.5 Months**
55%	**$95,274,616**	**24.3 Months**
60%	**$98,825,250**	**25.5 Months**
65%	**$102,881,524**	**26.7 Months**
70%	**$106,983,530**	**27.9 Months**
75%	**$111,126,364**	**29.0 Months**
80%	**$115,965,059**	**30.5 Months**
85%	**$121,487,874**	**32.3 Months**
90%	**$128,442,416**	**34.2 Months**
95%	**$139,262,068**	**36.7 Months**
100%	**$193,756,345**	**56.1 Months**

Table 5 Combined Confidence Table

7. MAJOR FINDINGS/OBSERVATIONS

The cost and schedule risk analysis resulted in a recommended combined cost contingency of $115,043,125 and a schedule recommended contingency of 30.5 months. The project construction costs for confidence levels 0 to 100% are shown below. Table 6 presents construction costs, which include base cost plus cost and schedule contingencies. Lands and Damages cost and contingency are not included. Figure 5 illustrates the construction cost risk analysis confidence curve. The recommended contingency is 31% based on the 80% confidence level. These contingencies were applied to the detailed estimate for the recommended plan for the West Shore Lake Pontchartrain project. The rounded contingency percentage of 31.0% was transferred to the TPCS for final calculation of Total Contingency and Total Cost. Lands and Damages cost and contingency are not included in the above numbers. Note: The rounding of contingencies causes the totals on the TPCS to be slightly higher than and not add up to exactly the costs above.

Table 6 Project Contingencies

Confidence Level	Project Cost	Contingency ($)	Contingency (%)
0%	**$397,563,680**	**$16,222,611**	**4.25%**
5%	**$432,186,618**	**$50,845,549**	**13.33%**
10%	**$439,852,326**	**$58,511,257**	**15.34%**
15%	**$445,540,981**	**$64,199,911**	**16.84%**
20%	**$450,600,904**	**$69,259,834**	**18.16%**
25%	**$454,852,849**	**$73,511,780**	**19.28%**
30%	**$458,992,901**	**$77,651,832**	**20.36%**
35%	**$462,313,871**	**$80,972,802**	**21.23%**
40%	**$465,774,512**	**$84,433,442**	**22.14%**
45%	**$469,188,782**	**$87,847,712**	**23.04%**
50%	**$472,669,827**	**$91,328,758**	**23.95%**
55%	**$476,002,448**	**$94,661,379**	**24.82%**
60%	**$479,746,788**	**$98,405,719**	**25.81%**
65%	**$483,360,794**	**$102,019,724**	**26.75%**
70%	**$487,188,388**	**$105,847,318**	**27.76%**
75%	**$491,442,168**	**$110,101,099**	**28.87%**
80%	**$496,384,194**	**$115,043,125**	**30.17%**
85%	**$501,851,947**	**$120,510,877**	**31.60%**
90%	**$508,157,373**	**$126,816,303**	**33.26%**
95%	**$518,313,292**	**$136,972,223**	**35.92%**
100%	**$568,598,326**	**$187,257,256**	**49.10%**

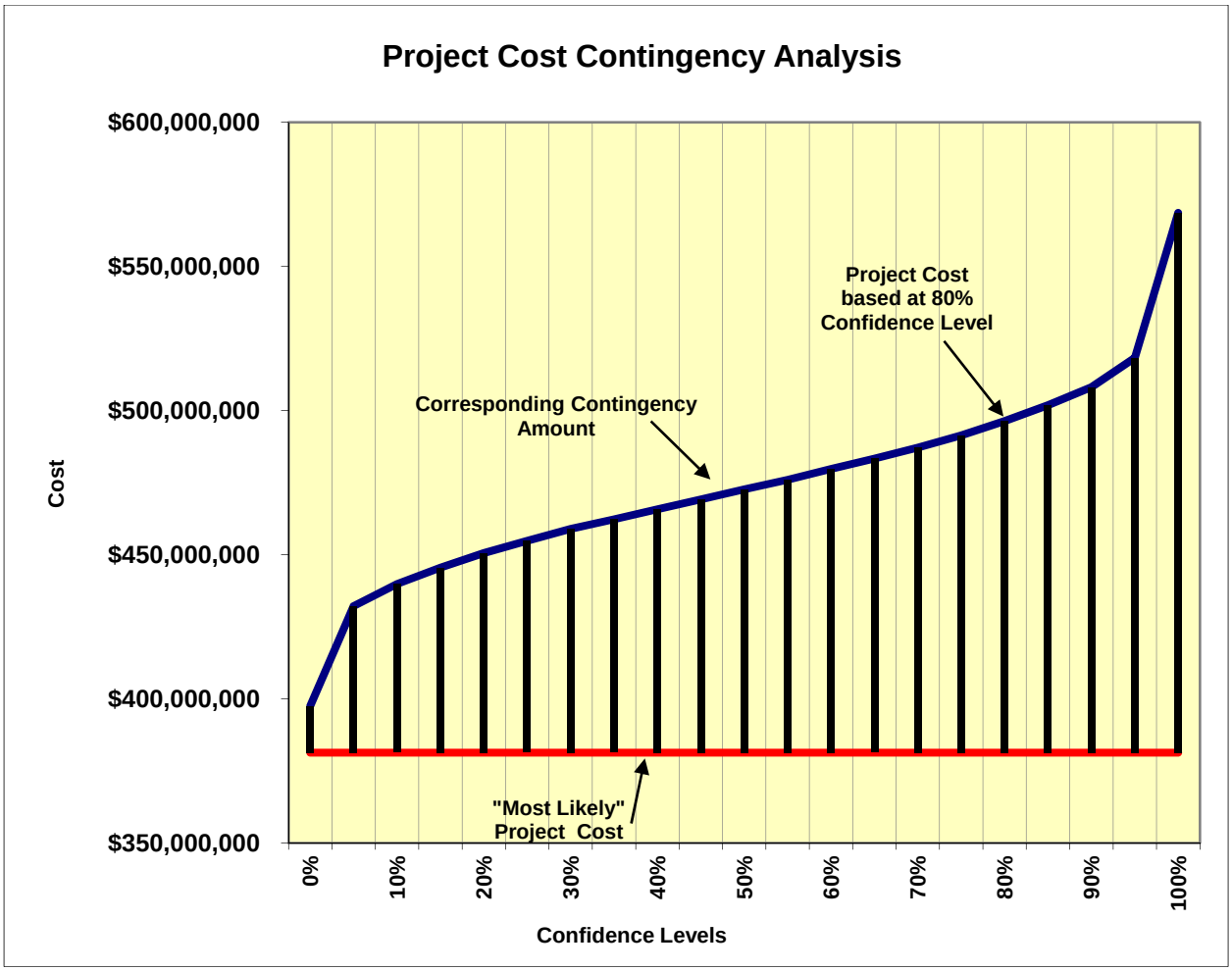

Figure 5 Sample of Project Confidence Curves

The major contributors to the resulting total project cost contingency for the project were:

- (CON-1) Construction Contract Modifications – Technical complexities and site conditions could result in increased risk of contract modifications.
- (TL-4) Borrow Sources Identified/Secured – The uncertainty of a secured borrow source for the last five lifts.
- CA-1 Contract Acquisition Impacts – Type of contracts and possible impacts to cost and schedule.
- TL-2 Design Development – Design details for the structural elements whether preliminary or detailed and their impact to costs.

- EST-1 Labor & Equipment Availability/Pricing – Variances in availability of equipment and labor throughout the project and impacts to costs.

- EST-3 Estimate quality when developed by others – Inaccuracies due to a large use of lump sums in the MII could cause changes to cost.

- PR-1 Funding Availability for PED and Construction – Impacts to costs due to funding variances causing delays and escalation of costs.

- PR-4 Fuel Cost – Fuel price variances impacts to construction costs.

The major contributor to the resulting total project contingency for the Schedule feature was:

- CA-2 Numerous Separate Contracts – Numerous separate contracts increases the risks of protests, access to projects choke points, and multiple contractor coordination.

- PPM-2 Smart Planning Pilot – Impacts to schedule due to unplanned work or requests for additional modeling/investigations under PED.

- PPM-3 Funding Availability at Pre-solicitation Stage – Impacts to schedule due to lack of funding during PED.

- PR-1 Funding Availability for PED and Construction – Impacts to schedule due to funding variances causing delays and increased costs

- PR-6 Stakeholder Request Late Changes – Additional work or alignment changes would impact costs and increase schedule delays.

These items are discussed in more detail in the Mitigation Recommendations section.

Lands and Damages are not included in the CSRA because it was not considered to be an overall program risk by the PDT. Lands and Damages is a very small project cost and any schedule delay in a specific location would not significantly affect the midpoint of the overall program. The Local Sponsor is responsible for LERRDs and in order to serve as the Non-Federal sponsor must have the authority to appropriate (take) property.

The above risk analysis results are intended to provide project leadership with risk and contingency information to support project management in scheduling, budgeting, and project control, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. These conclusions were reached by identifying and assessing risk items for use in the risk

analysis. These quantitative impacts of these risk items are then analyzed using a combination of professional judgment, empirical data, and analytical techniques.

8. MITIGATION RECOMMENDATIONS

An important outcome of the cost and schedule risk analysis is the communication of high risk areas which have a high potential to affect the project cost and/or schedule. For the West Shore Lake Pontchartrain project, the high cost risk item is the Construction Modifications and Unidentified Borrow Sources. The high Schedule Risk item is the Numerous Separate Contract for the schedule. Some of these risk items might be mitigated, reducing the risk of an increased project cost.

Construction modifications are very common and often inevitable on a project of this magnitude. No cost for modifications was included in the base cost estimate and the amount of additional cost due to modifications can be mitigated by ensuring QA/QC Guidance is followed and quality products are advertized for construction.

The borrow pit location is the Government property Bonnet Carre' Spillway at this time. Encouraging local sponsors to find suitable borrow at closest possible distance can mitigate the risk of unsecured borrow pit locations the last three lifts (years 2030, 2045, 2060).

Funding availability for PED and construction is a more uncontrollable element that may require the involvement and influence of higher level parish, state and federal elected officials to acquire necessary funding and maintain the funding integrity.

Fuel cost is a more uncontrollable element that may require the investigation of more fuel efficient construction equipment that could help offset the increases in fuel costs and availability.

SMART planning pilot impacts can be adjusted thru early discussions among the PDT, external local officials,

Numerous Separate Contracts might be mitigated by choosing certain contracting methods over other know less efficient methods. Request for Proposal method may reduce the risk of protest and awarding a contract to a contractor that may not perform well.

APPENDIX A

DETAILED RISK REGISTERS

(Present the detailed Risk Register here, covering all risk events, regardless of low, medium, or high risk concerns)

Appendix A Risk Register

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost		
				Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)						
	PROJECT & PROGRAM MGMT					
PPM-1	Project Personnel Resources	Gov't personnel resources for project management and execution may be insufficient during peak periods of PED and Procurement.	Do not feel will be an issue. Personnel turnover and reassignments have been relatively low. Generally decreased District workload, this would be mainstay project.	Unlikely	Negligible	LOW
PPM-2	Smart Planing Pilot	First project to use new process.	We could run into unplanned work that must be accommodated. External agencies could request additional modeling/investigations under PED.	Likely	Negligible	LOW
PPM-2a	Funding Availability at Pre-solicitation stage	Lack of funding for the early stages of the project.	Lack of funding could impact the schedule and its previously set milestones.	Very Likely	Significant	HIGH

	CONTRACT ACQUISITION RISKS	-	-			
CA-1	Contract Acquisition Impacts	Unknown acquisition strategy	Acquisition startegy not yet defined. Estimate assumes typical sub-contracting. If other acquisition strategies are used on any one/or selected projects, would have minimal impact on overall project cost or schedule. Also combine with related risks from reduced competition and increased protests.	Likely	Marginal	MODERATE
CA-2	Numerous separate contracts	Protest, access to projects, multiple contractors coordinating work effort and highway traffic.	During solicitation, a protest could delay the contruction schedule. Multiple concurrent construction projects require coordination between contractors as well as impact on access roads between borrow sources and project sites.	Unlikely	Marginal	LOW
	TECHNICAL RISKS	-	-			
TL-1	ADEQUATE TECHNICAL STAFF	Gov't personnel resources for project management and execution may be insufficient during peak periods of PED and Procurement.	Do not feel will be an issue. Personnel turnover and reassignments have been relatively low. Generally decreased District workload, this would be mainstay project.	Unlikely	Marginal	LOW
TL-2	DESIGN DEVELOPMENT -Structural	What level of design? Confidence in critical qtys.	Feasibility level designs (close to 35%). Estimates are conservative. More savings may be gained through optimizing aspects of the designs, such as pile layout. Structures are typical to MVN.	Likely	Marginal	MODERATE

TL-3	DESIGN DEVELOPMENT - Geotechnical	What level of design? Confidence in critical qtys.	We have a good amount of data on 2/3 of the levee reaches. In developing the feasibility design, we used the most conservative data on the reaches where no boring/soil information was available. A 25% settlement factor has been included in the quantities. A 5% increase can be expected.	Likely	Negligible	LOW
TL-3	DESIGN DEVELOPMENT - Mechanical and electrical	What level of design? Confidence in critical qtys.	We expect minimal impact on the design. A/E has a wealth of experience on the design of Pumping Stations as well of MVN having major experience on this type of structure.	Unlikely	Marginal	LOW
TL-4	Borrow/fill sources identified / secured	Unidentified borrow sources.	Unknown borrow sources could inpact price of levee embankment of future lifts. This would include the development of new government furnished borrow pits.	Likely	Significant	HIGH
TL-5	Sufficiency/condition of borrow / fill sites	Unknown volume of available suitable material in borrow source.	Uncertainty of how much clearing and grubbing, waste of over burden, amount of processing necessary to achieve a suitable material for use as embankment. Historicaly the Corps has chosen borrow sources with a large portion of the source material as being suitable.	Unlikely	Marginal	LOW
TL-6	EMBANKMENT (Adjacent BORROW)	quality/avail of excavated material from the adjacent canal.	Top assumed unsuitable and wasted. Assumed wet and will process, included in cost and schedule. The cost and effort of achieving a suitable material from the excavated material would be too high in comparison to hauling in the material. The excavated material will be disposed as benefitialuse on the mitigation plan.This item will be removed for the refined risk register.	Likely	Negligible	LOW

	LANDS AND DAMAGES RISKS	-	-			
LD-1	Real Estate Plan	Do we have a RE plan?	Locals are acquiring much of the needed property now for the current interim work along the proposed alignment. Only considering one alignment. We already know many of the landowners. Real estate cost will be very small % of total project cost. Environmental mitigation has been identified. Mitigation included in project plan. LERDs is a Local Sponsor responsibility	Unlikely	Marginal	LOW
LD-2	Relocation Plan	Do we have a plan? Have the owners been contacted and provided input?	Cannot currently access all potential reaches in the proposed alignment. We are using 3 available databases for locating pipelinse utilities etc. There is a small degree of uncertainty because while the owners have been contacted, they have provided little information. At this point most relocation plans are assumptions. Compensability report will be included, most will be compensable. Locals are building in these areas now.	Unlikely	Marginal	LOW
LD-4	BORROW AREA	borrow area NOT indentified for haul-in material yet.	covered in FL-5	Unlikely	Marginal	LOW
	REGULATORY AND ENVIRONMENTAL RISKS	-	-			

RE-1	Impacts to High Value Habitats	Impacts to High Value Habitats (incl Essential fish habitat)	Bottom land hardwoods and forested wetlands have been accounted for under the Habitat Evaluation, mitigation plan and included in the overall project costs. Any additional impacts found would require adding a structure or modify exisiting structure.This risk item will be addressed by Planning Division.	Likely	Marginal	MODERATE
RE-2	HAZARDOUS WASTE SITE ANALYSIS	HTRW Phase I site assesment is already completed.	Avoiding all HTRW issues. Nothing in alignment triggerd Phase II investigation.	Very Unlikely	Significant	LOW
RE-3	NEPA	more NEPA required	NEPA is currently being acquired on the structural plan. Programatic EIS is being acquired for the non-structural plan. Any significant design changes will be addressed under supplemental NEPA documentation. This risk item will be addressed by Planning Division.	Likely	Marginal	MODERATE
RE-4	Cultural	potential that sites will be found.	No cultural issues have been identified.	Very Unlikely	Negligible	LOW
	CONSTRUCTION RISKS	-	-			
CON-1	Construction Contract Modifications	construction contract modifications can impact construction cost and schedule growth.	Technical complexities and site conditions could result in increased risk of contract modifications. Will impact costs, but little overall impact to larger project timeline	Very Likely	Significant	HIGH
CON-2	Alignment Revisions	Alignment revisions can impact Lands and Damages, Real Estate, Relocations, Environmental Mitigation and Utilities.	Already have borings for 2/3 of the aligment. We will be staying within the selected feasibility aligment.	Very Unlikely	Marginal	LOW

CON-3	WEATHER	impacts to project	Long overall project schedule so flexibility included. Typical conditions are already included in the schedule and costs.	Likely	Negligible	LOW
CON-4	ACCELERATED CONTRACT SCHEDULE	will jobs be rushed	currently not a time sensative project	Very Unlikely	Marginal	LOW
CON-5	Unknown Utilities	Unknown utilities may impact costs.	Investigations done with all available databases including the Louisiana Oil Spill Response Database. Locals doing work now in many areas. Impact as compared to total project cost is small.	Likely	Negligible	LOW
CON-6	Work location/condition	Marshy area.	Common South LA work condition, marsh conditions assumed in costs and schedule.	Very Likely	Negligible	LOW
CON-7	Embankment production	Assumed production rate for embankment.	Due to embankment quality, project conditions, or other factor, contractors should be able to achieve historical production on these projects. There will be variations which could impact costs. Impact to overall project schedule will be small.	Likely	Negligible	LOW
CON-8	Conflicts with other contracts		See item CA-2	Unlikely	Marginal	LOW
CON-9	Site access / restrictions (highways, bridges, dams, water, overhead / underground utilities)		See item CA-2	Very Unlikely	Marginal	LOW

CON-10	Material availability and delivery		See item TL-5	Unlikely	Marginal	LOW
	ESTIMATE AND SCHEDULE RISKS	-	-			
EST-1	LABOR & equipment AVAILABILITY/PRICING	labor shortages and increase rates	Possibility that out of state labor would be required due to labor shortage.	Unlikely	Significant	MODERATE
EST-2	MATERIAL AVAILABILITY/PRICING	material shortages and increased cost	projects are using standard mateirals, national economy is in a slump, quotes for all major materials	Unlikely	Marginal	LOW
EST-3	Estimate(s) quality when developed by others	Increased time and schedule inpact.	Possible increased time and schedule inpact due to estimmate being developed by A/E Firm and QA being performed by MVN. Inaccuracies due to large use of Lump Sum items in the MII could cause changes in the cost. BKI has vast experience in the design of pumping stations but due to the early stages of the design, details were not developed in order to capture some costs accurately.	Likely	Marginal	MODERATE
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)						
PR-1	Funding Availability for PED and Construction	Project is not authorized/funded. Design and construction delays could occur pending funding, resulting in increased escalation	Project is not authorized/funded. Design and construction delays could occur pending funding, resulting in increased escalation costs.	Very Likely	Significant	HIGH

		costs.				
PR-2	Bid Protest Potential	bid protests causing issues with award	See item CA-2	Likely	Negligible	LOW
PR-3	Bid Competition	low bid competition, increased cost	Good competition, not competing with HSDRRS. Lots of local contractors. - Combine in Contract acquisition risk and with Bid protest risks .	Very Unlikely	Marginal	LOW
PR-4	fuel cost	potential for escalating fuel prices	if fuel prices escalate dramatically with global recovery, could increase costs of constructing project, especially levees with much of it truck hauled	Likely	Marginal	MODERATE
PR-5	Local communities pose objections	Local communities delay project.	Locals might request to be included in the alignment. Causing delays to the schedule but should not increase the cost of the project.	Likely	Negligible	LOW
PR-6	Stakeholders request late changes	Delayed project and increased costs.	Any additional work or alignment change would result on increased costs and schedule delays.	Unlikely	Negligible	LOW

ALIGNMENT C1 – OVERALL PLAN VIEWS

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER	C1.0
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
P.L.D. PROJECT	
USACE PROJECT	

BOARD OF COMMISSIONERS SOUTHEAST LOUISIANA FLOOD PROTECTION AUTHORITY

WEST SHORE – LAKE PONTCHARTRAIN, LA

HURRICANE PROTECTION PROJECT

PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE LANDS: Alignment C

STATE OF LOUISIANA

BKI

MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	1 OF 45

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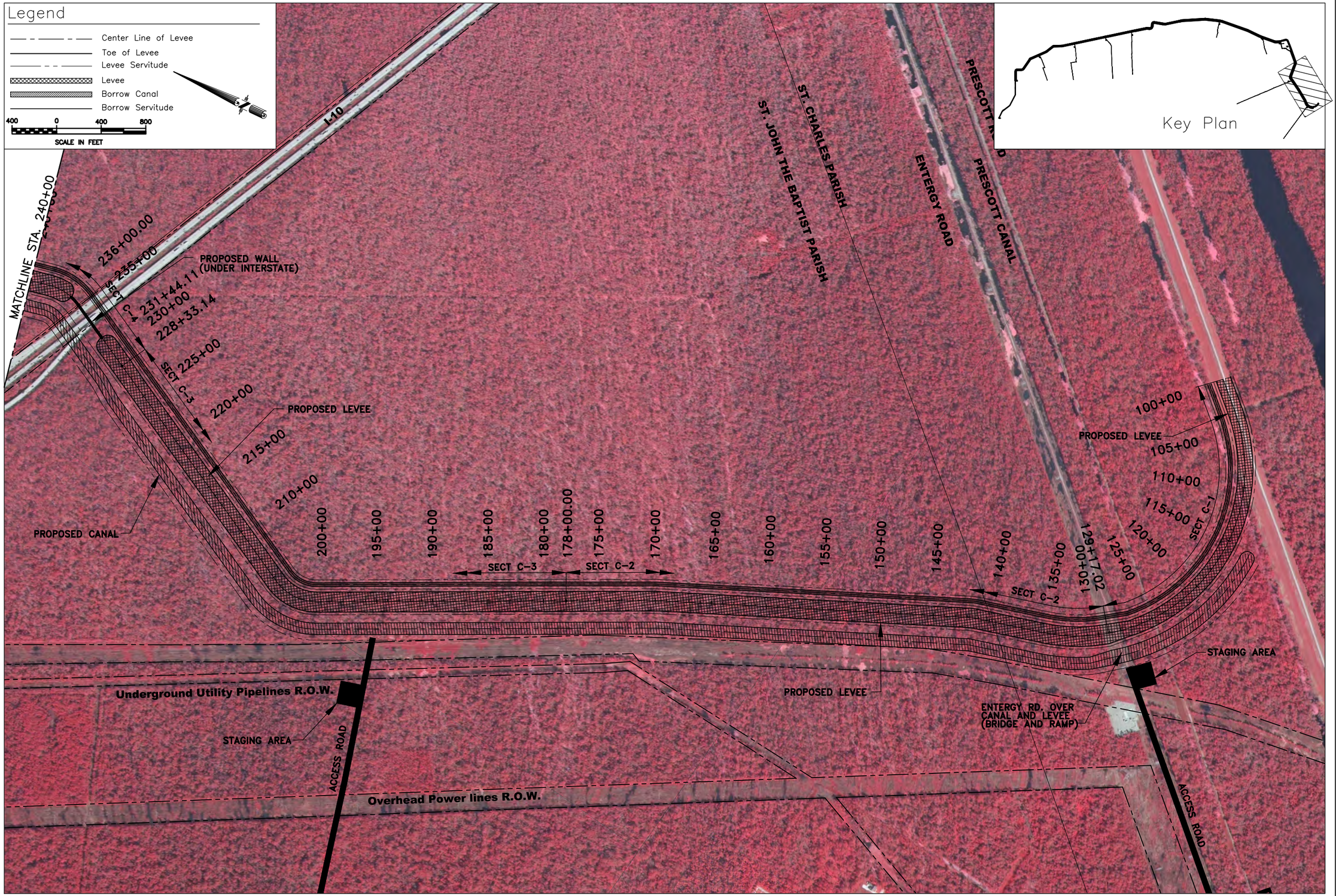

SHEET NUMBER C1.1

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

P.L.D. PROJECT

USACE PROJECT

BOARD OF COMMISSIONERS ☆ PONTCHARTRAIN LEVEE DISTRICT ☆ STATE OF LOUISIANA

WEST SHORE – LAKE PONTCHARTRAIN, LA

HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE LANES: Alignment C

STATE OF LOUISIANA ☆ DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

BKI
MA GSA

DESIGNED	D.E.B./T.N.P.
CHECKED	H.M.P.
DETAILED	G.A.D.
CHECKED	D.E.B./T.N.P.
DATE	03/2014
SHEET	2 OF 21

NO.	DATE	REVISION DESCRIPTION	BY

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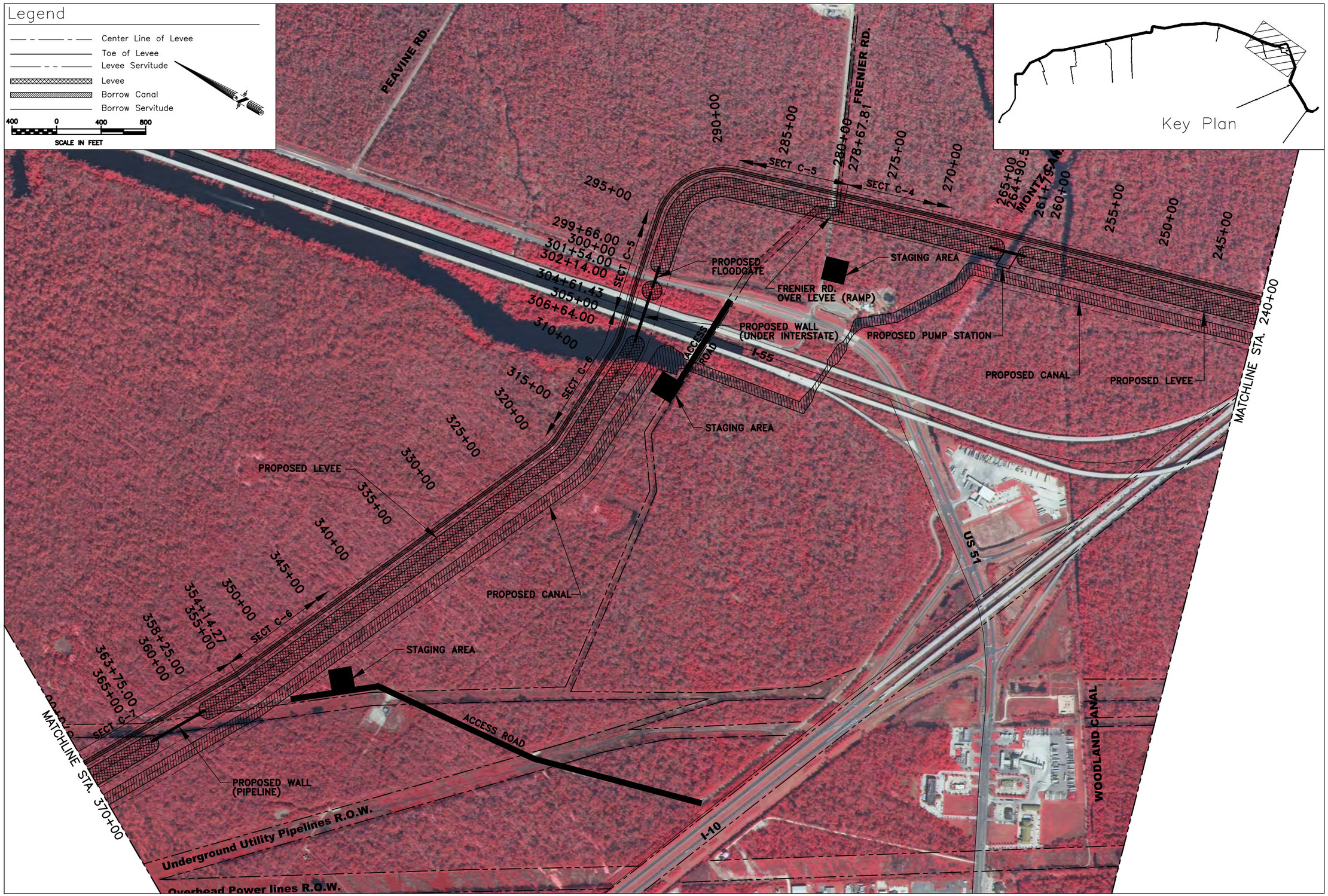

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FILE NAME: X.DWG

SHEET NUMBER	C1.2
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
P.L.D. PROJECT	
USACE PROJECT	

BOARD OF COMMISSIONERS ★ PORT OF NEW ORLEANS ★ PONTCHARTRAIN LEVEE DISTRICT

WEST SHORE – LAKE PONTCHARTRAIN, LA

HURRICANE PROTECTION PROJECT

PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

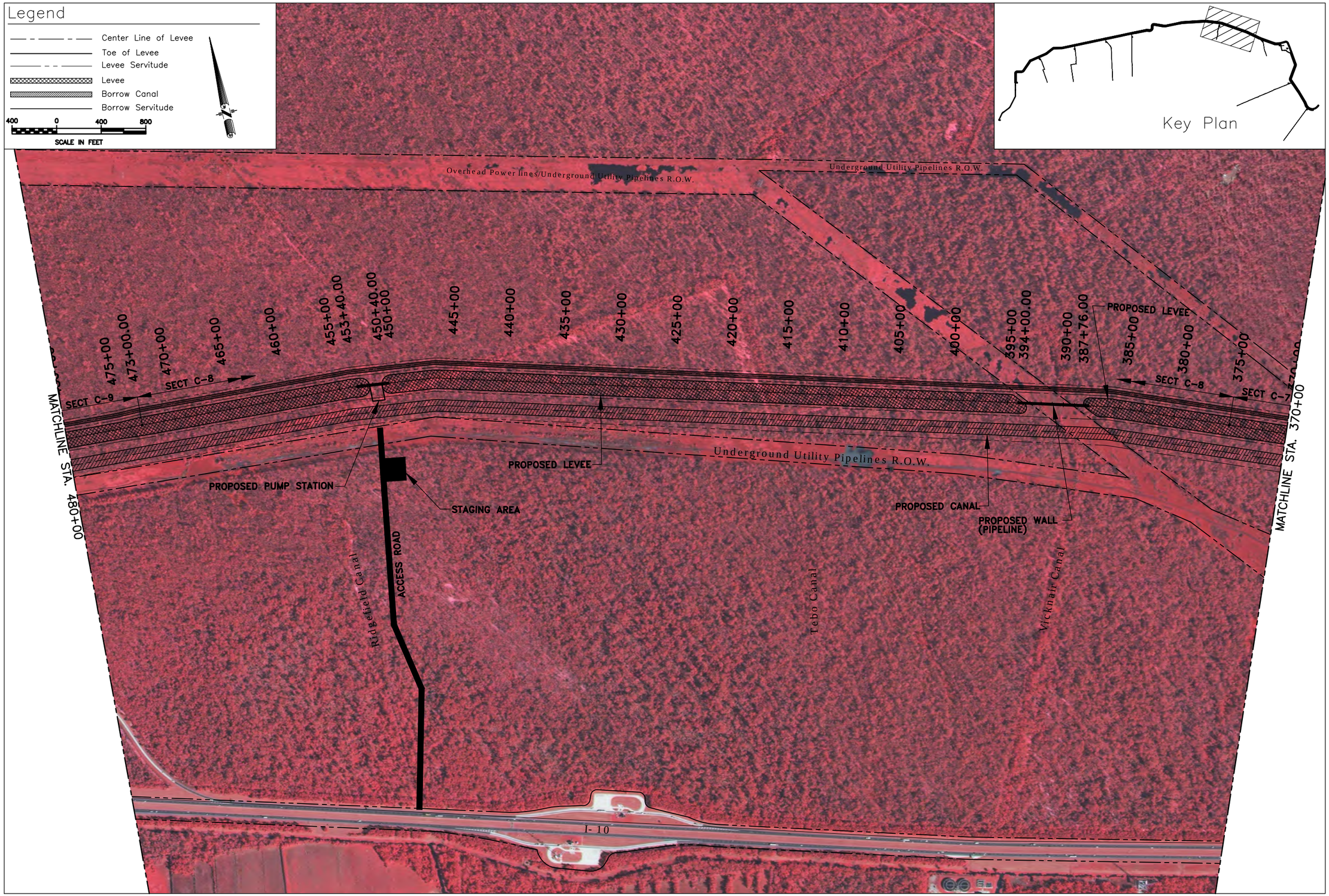
STATE OF LOUISIANA ★ DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

BKI

MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	3 OF 45

NO.	DATE	REVISION DESCRIPTION	BY



XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER	C1.3
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
PLD PROJECT	
USACE PROJECT	

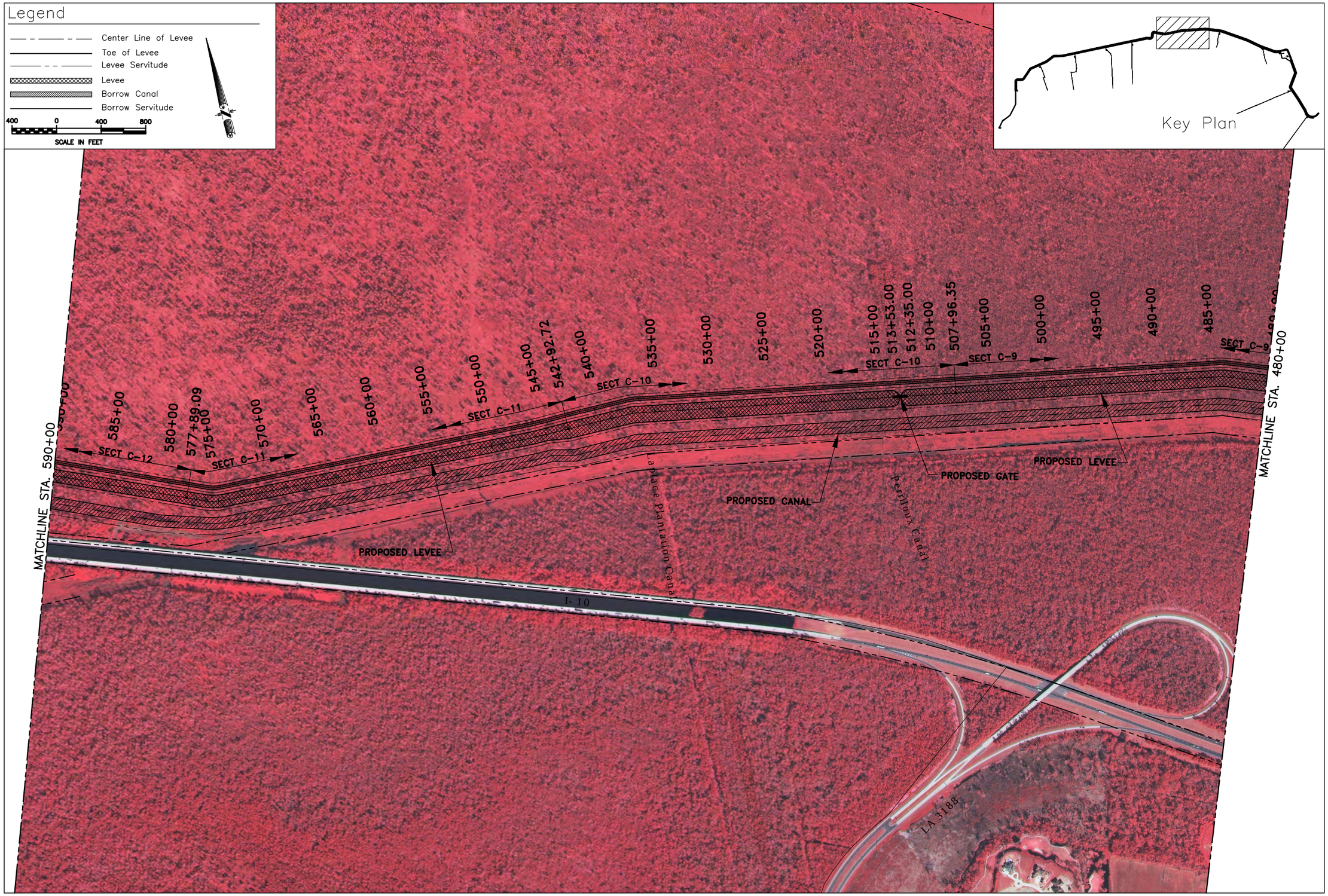
WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE LINES: Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	4 OF 45

NO.	DATE	REVISION DESCRIPTION	BY



SHEET NUMBER	C1.4
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
P.L.D. PROJECT	
USACE PROJECT	

BOARD OF COMMISSIONERS ★ LAKE PONTCHARTRAIN BASIN FLOOD CONTROL ★ ESTABLISHED 1928

STATE OF LOUISIANA ★ DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT ★ ESTABLISHED 1921

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE LANES: Alignment C

BKI
MA GSA

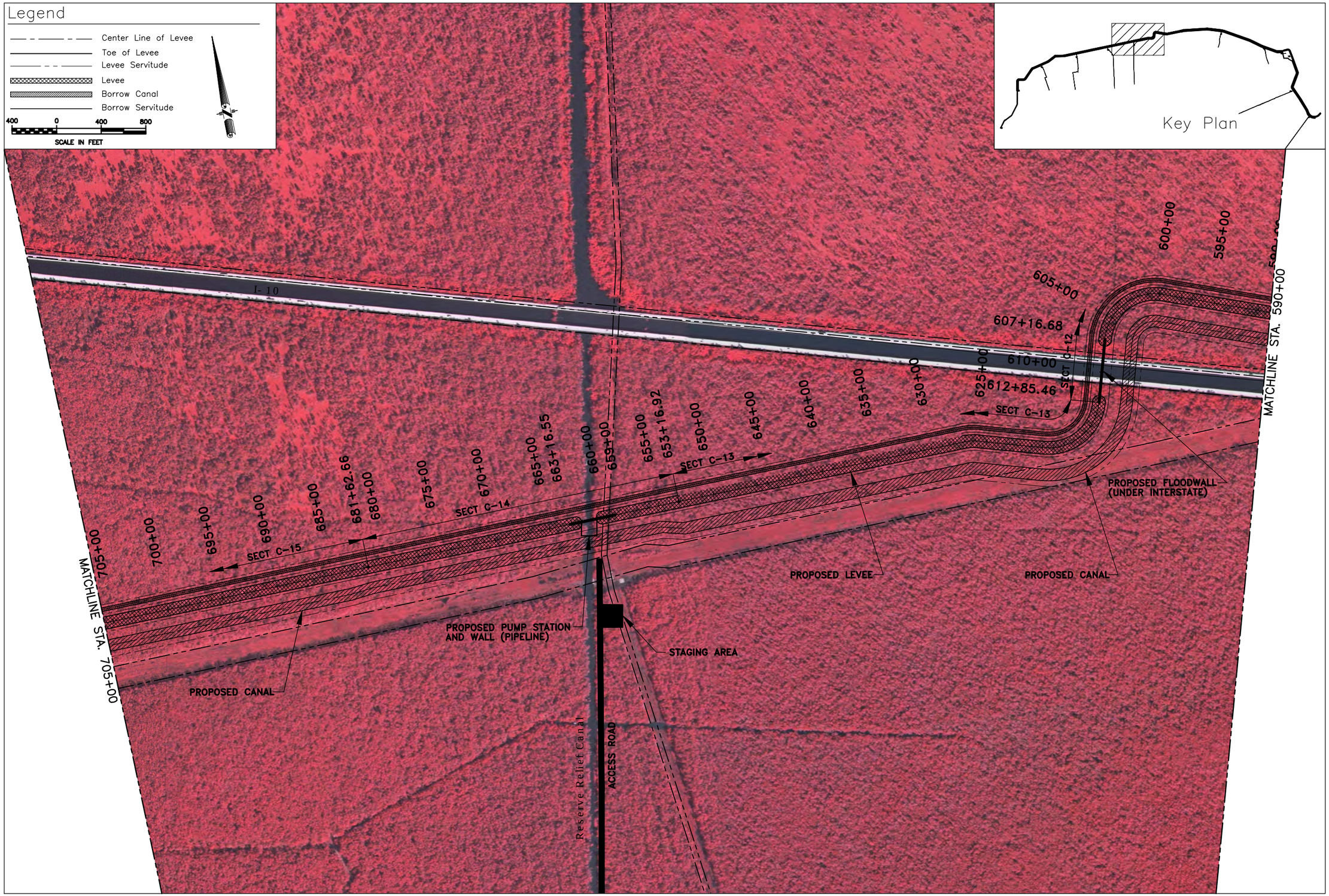
DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	5 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

XREF: NONE

DATE:

FILE NAME: X.DWG



SHEET NUMBER C1.5

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES

P.L.D. PROJECT

USACE PROJECT

LAKE PONTCHARTRAIN BASIN FOUNDATION

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE CLASS: Alignment C

STATE OF LOUISIANA

BKI
MA GSA

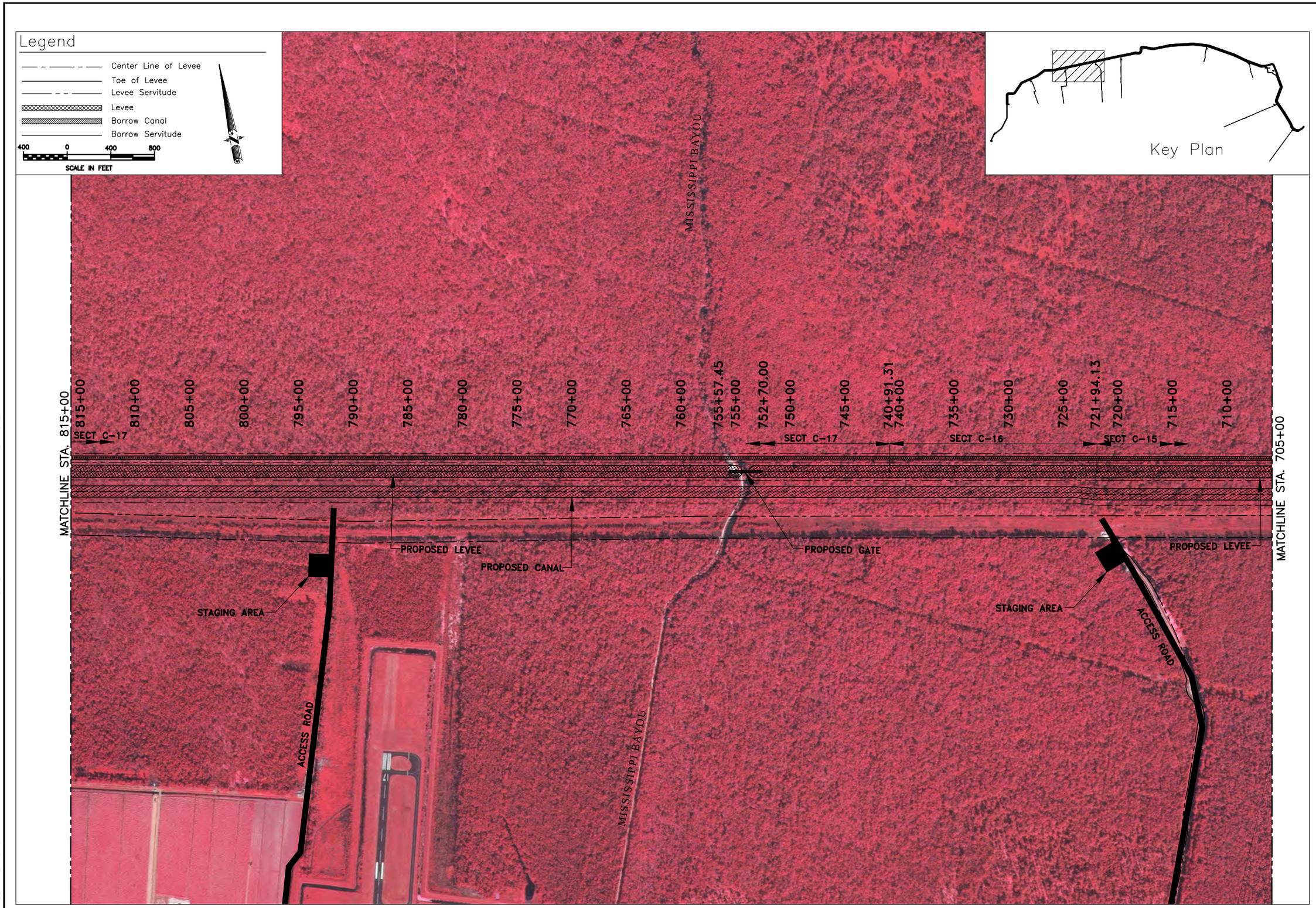
DESIGNED	DEB/TNP HMP
CHECKED	
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	6 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

FILE NAME: X.DWG

DATE:

XREF: NONE



SHEET NUMBER C1.6

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

P.L.D. PROJECT

USACE PROJECT

LEVEE BOARD OF COMMISSIONERS ☆ LAKE PONTCHARTRAIN

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE LANES: Alignment C

STATE OF LOUISIANA

BKI
MA GSA

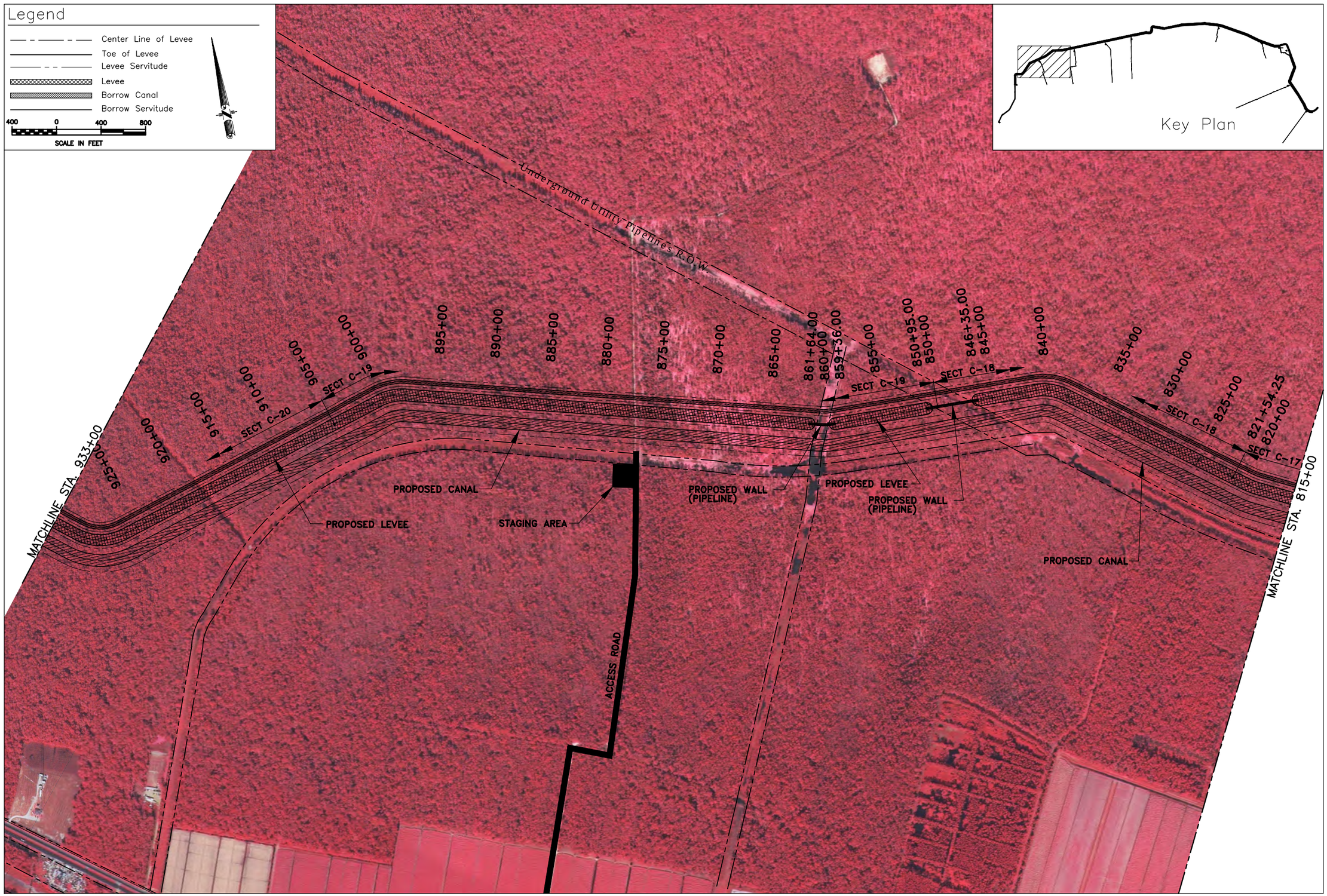
DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 7 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

FILE NAME: X.DWG

DATE:

XREF: NONE



XREF: NONE

DATE:

FILE NAME: X.DWG

NO.	DATE	REVISION DESCRIPTION	BY

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 8 OF 45

SHEET NUMBER C1.7

PARISH ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES

P.L.D. PROJECT

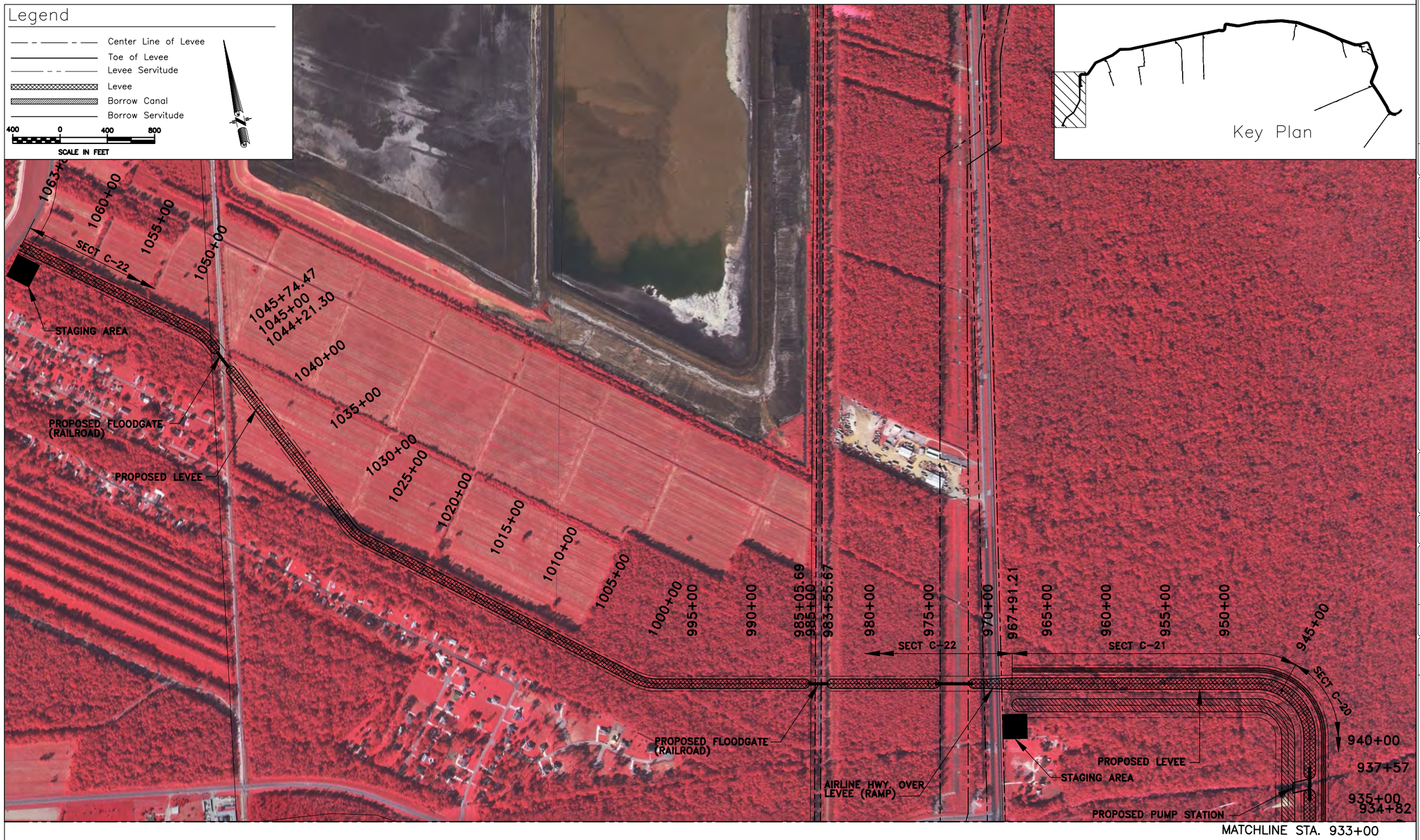
USACE PROJECT

LEVEE PLANS

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C

BKI
MA GSA



SHEET NUMBER C1.8

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

P.L.D. PROJECT

USACE PROJECT

LEVEE LANES

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 9 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

XREF: NONE

DATE:

FILE NAME: X.DWG

ALIGNMENT C2 – 1ST LIFT (Year 2020)

Legend

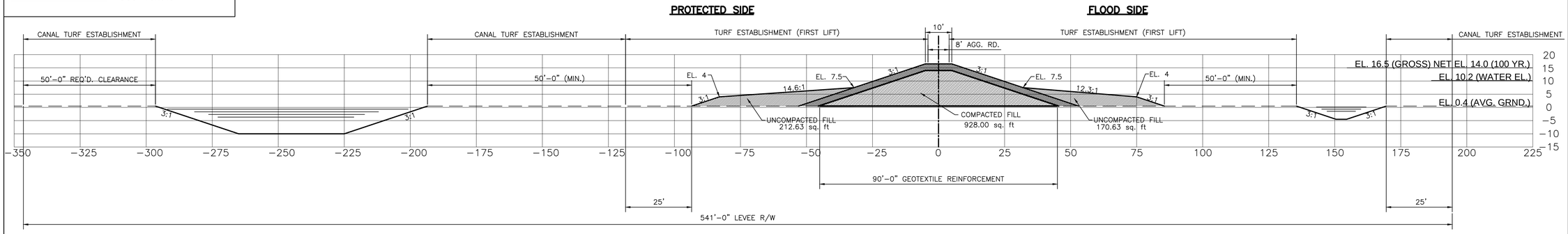
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10.0 NAVD88

0 20 40

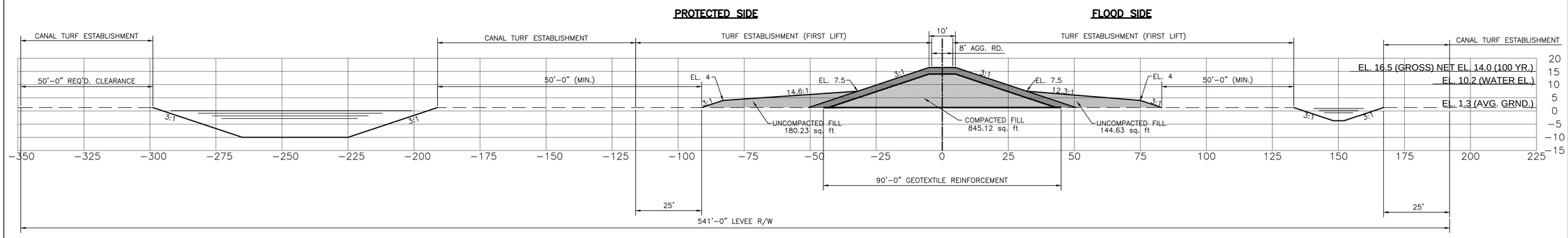
SCALE IN FEET



Levee Section C−3 (Sta. 178+00.00 thru Sta. 228+33.14)

First Lift

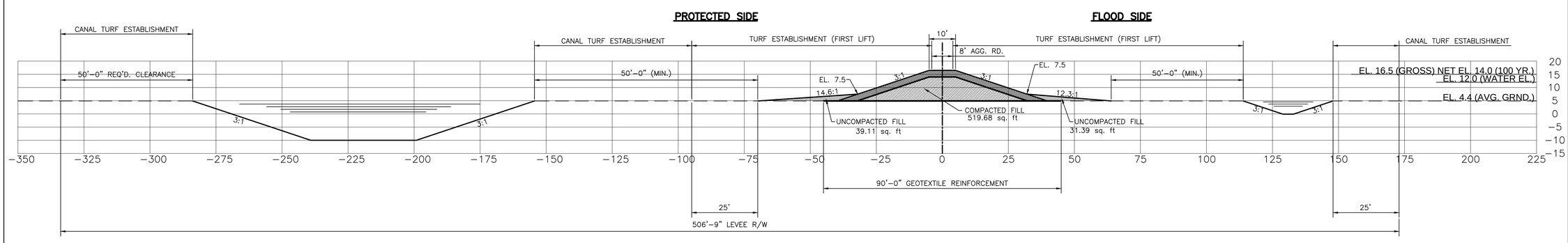
Note: See Sht. C3.0 For Second Lift Section



Levee Section C−2 (Sta. 129+17.02 thru Sta. 178+00.00)

First Lift

Note: See Sht. C3.0 For Second Lift Section



Levee Section C−1 (Sta. 100+00 thru Sta. 129+17.02)

First Lift

Note: See Sht. C3.0 For Second Lift Section

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C2.0

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	10 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

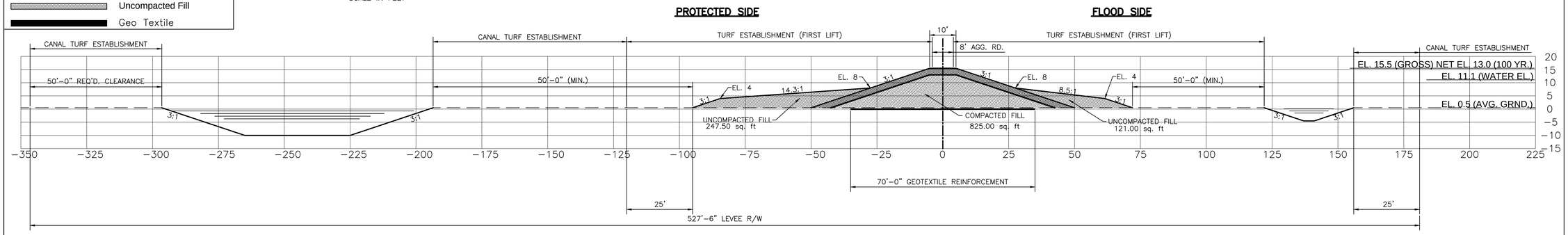
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

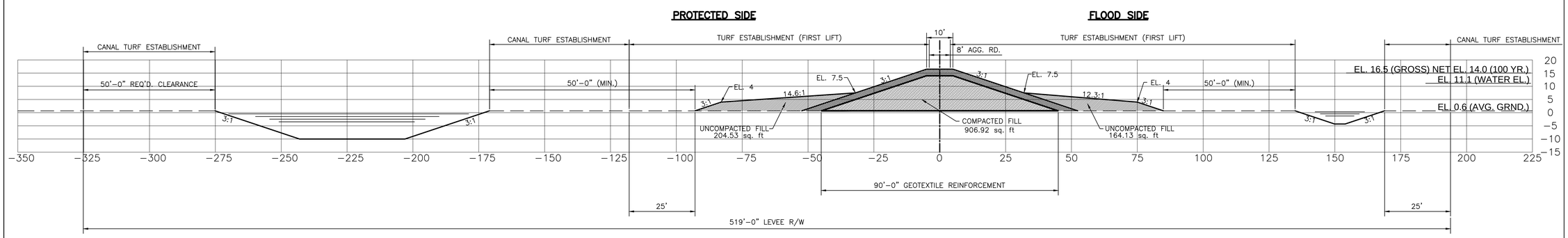
20 0 20 40
SCALE IN FEET



Levee Section C−6 (Sta. 304+61.43 thru Sta. 354+14.27)

First Lift

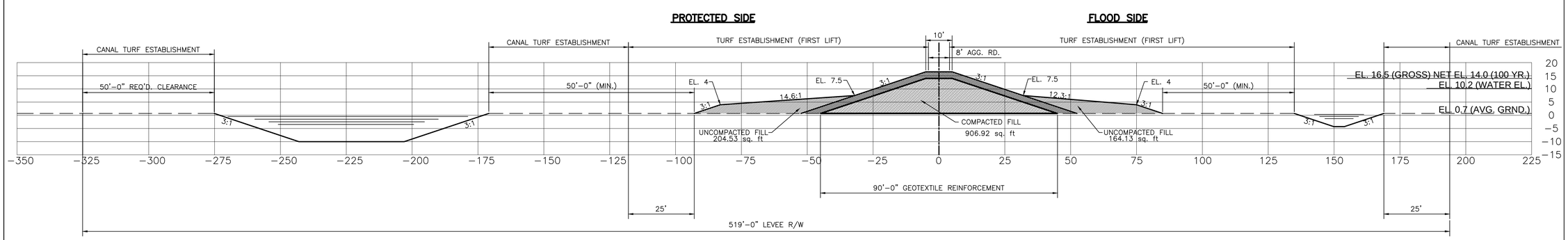
Note: See Sht. C3.1 For Second Lift Section



Levee Section C−5 (Sta. 278+67.81 thru Sta. 304+61.43)

First Lift

Note: See Sht. C3.1 For Second Lift Section



Levee Section C−4 (Sta. 228+33.14 thru Sta. 278+67.81)

First Lift

Note: See Sht. C3.1 For Second Lift Section

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C2.1

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 11 OF 45

NO. | DATE | REVISION DESCRIPTION | BY

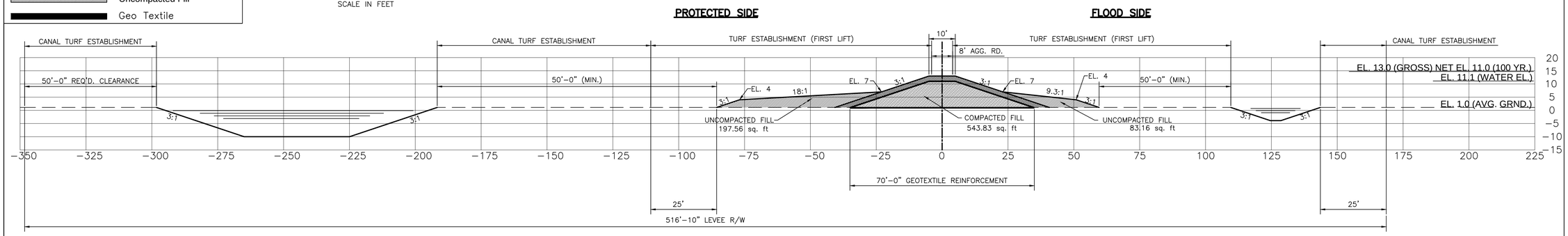
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

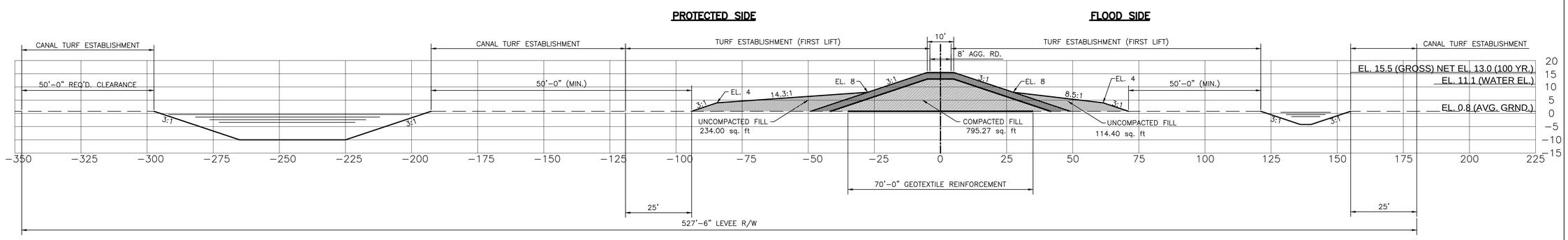
20 0 20 40
SCALE IN FEET



Levee Section C−9 (Sta. 473+00.00 thru Sta. 507+96.35)

First Lift

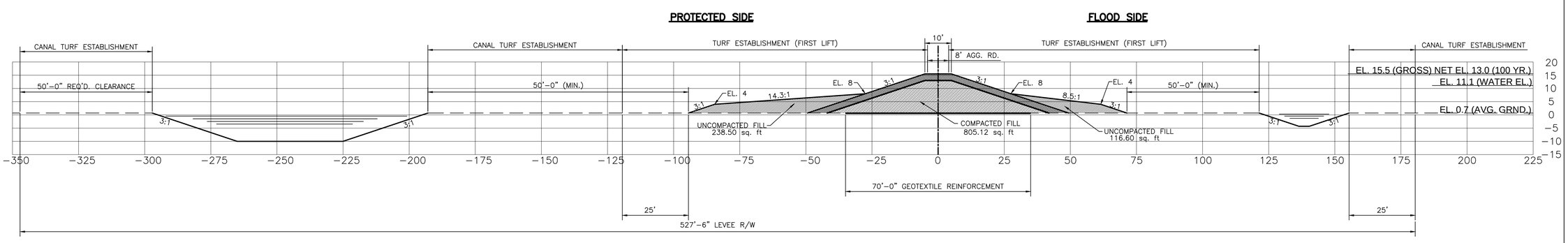
Note: See Sht. C3.2 For Second Lift Section



Levee Section C−8 (Sta. 375+00.00 thru Sta. 473+00.00)

First Lift

Note: See Sht. C3.2 For Second Lift Section



Levee Section C−7 (Sta. 354+14.27 thru Sta. 375+00.00)

First Lift

Note: See Sht. C3.2 For Second Lift Section

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C2.2

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 12 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

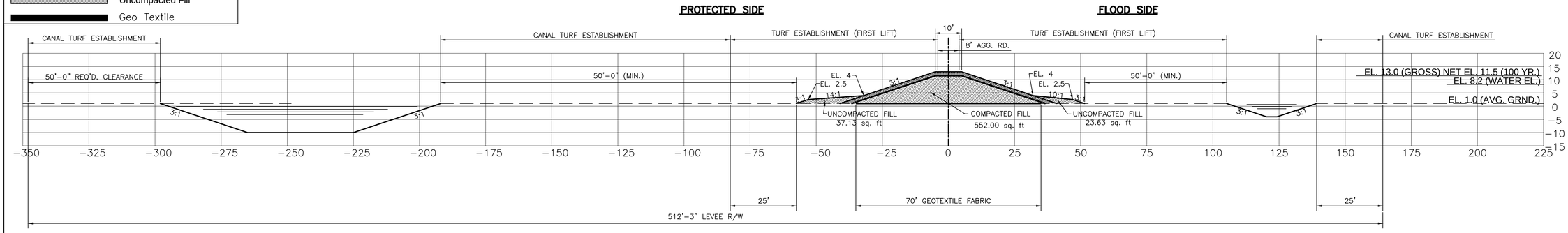
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

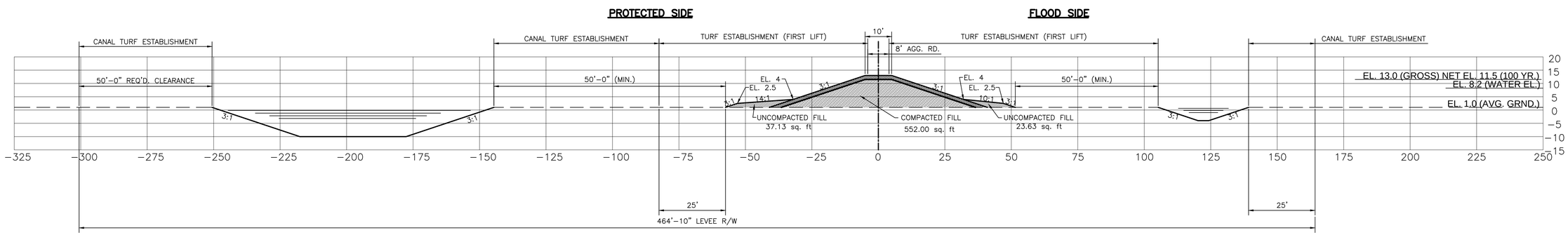
20 0 20 40
SCALE IN FEET



Levee Section C−12 (Sta. 577+89.09 thru Sta. 612+85.46)

First Lift

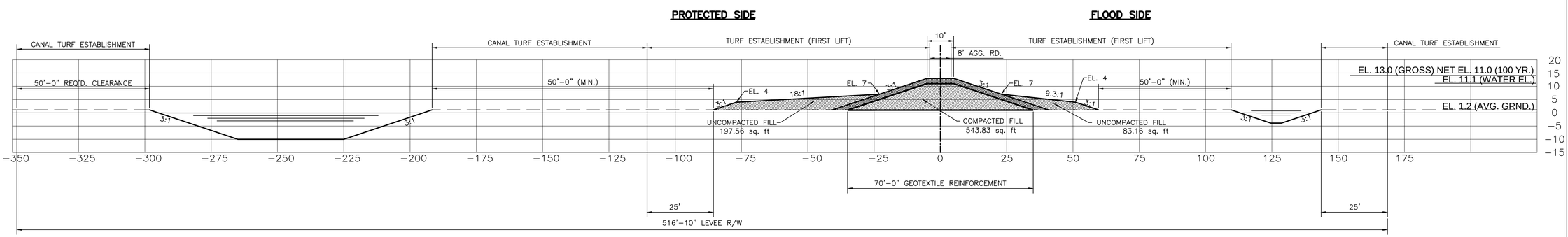
Note: No Second Lift Required



Levee Section C−11 (Sta. 542+92.72 thru Sta. 577+89.09)

First Lift

Note: No Second Lift Required



Levee Section C−10 (Sta. 507+96.35 thru Sta. 542+92.72)

First Lift

Note: See Sht. C3.3 For Second Lift Section

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C2.3

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP	DATE	03/2014
CHECKED	HMP	SHEET	13 OF 45
DETAILED	GAD		
CHECKED	DEB/TNP		

NO.	DATE	REVISION DESCRIPTION	BY

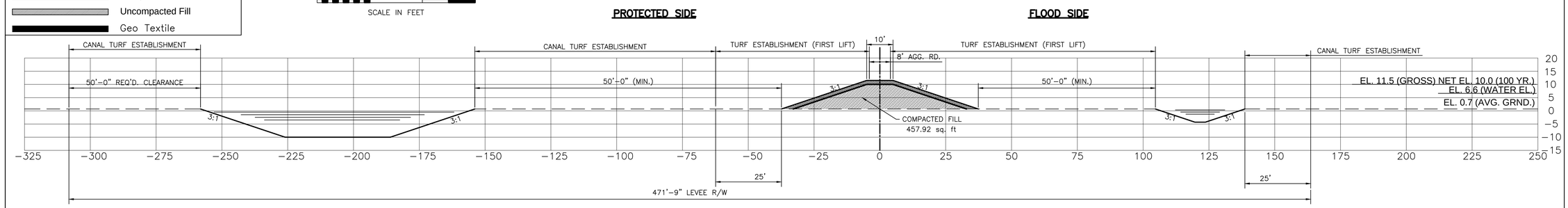
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

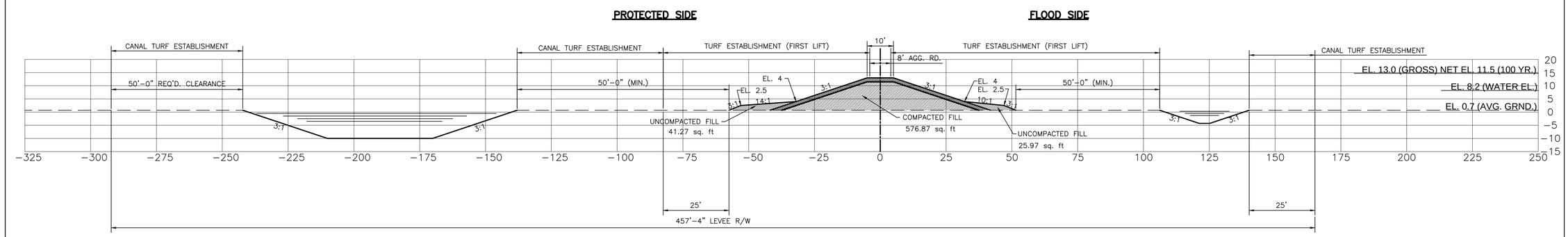
20 0 20 40
SCALE IN FEET



Levee Section C−15 (Sta. 681+62.66 thru Sta. 721+94.13)

First Lift

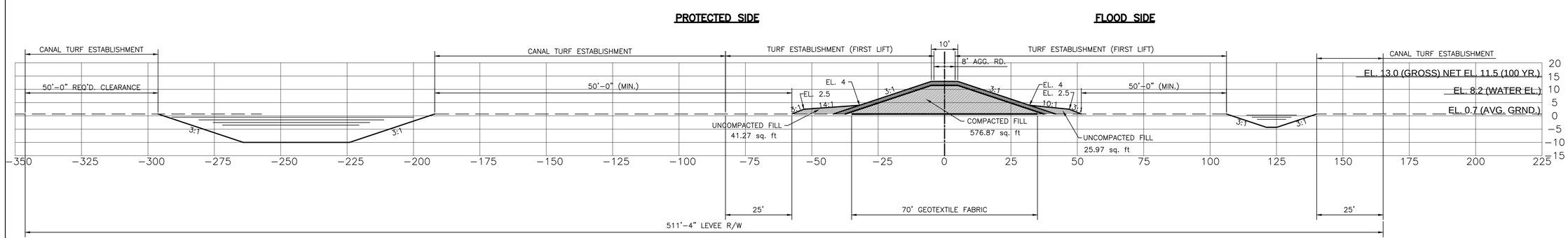
Note: No Second Lift Required



Levee Section C−14 (Sta. 653+16.92 thru Sta. 681+62.66)

First Lift

Note: No Second Lift Required



Levee Section C−13 (Sta. 612+85.46 thru Sta. 653+16.92)

First Lift

Note: See Sht. C3.3 For Second Lift Section

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C2.4

ST. CHARLES / ST. JOHN THE BAPTIST
ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 14 OF 45

NO. | DATE | REVISION DESCRIPTION | BY

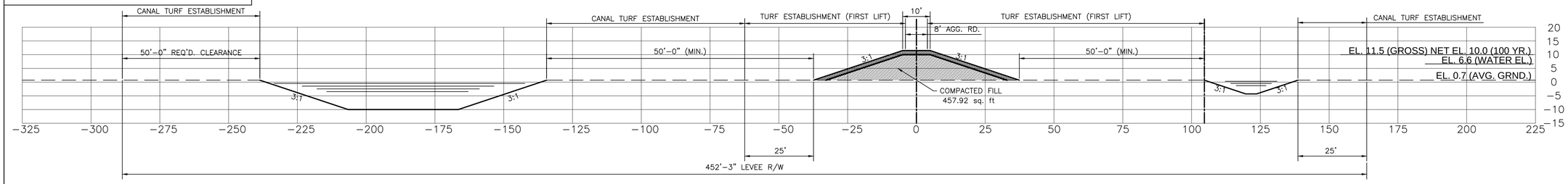
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

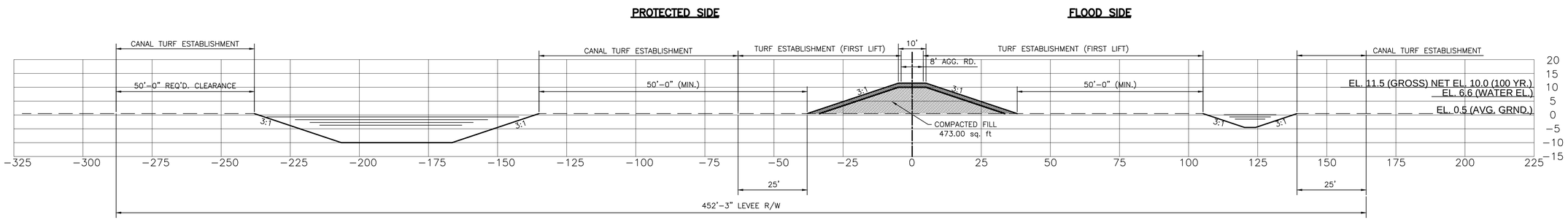
20 0 20 40
SCALE IN FEET



Levee Section C−18 (Sta. 821+54.25 thru Sta. 850+00.00)

First Lift

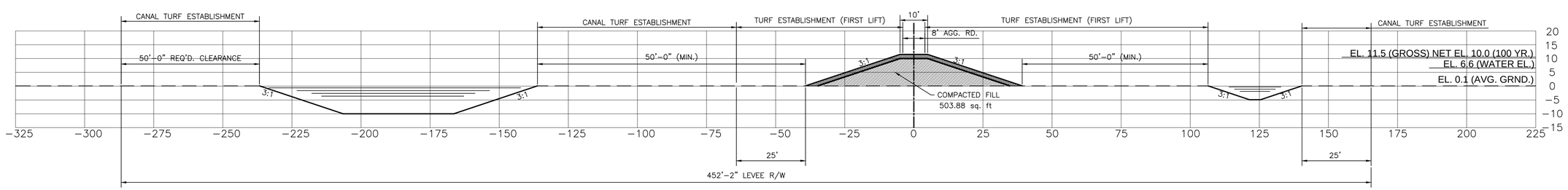
Note: No Second Lift Required



Levee Section C−17 (Sta. 740+91.43 thru Sta. 821+54.25)

First Lift

Note: No Second Lift Required



Levee Section C−16 (Sta. 721+94.13 thru Sta. 740+91.31)

First Lift

Note: No Second Lift Required

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C2.5

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

Alignment C

BKI
MA GSA

DESIGNED DEB/TNP HMP
CHECKED
DETAILED GAD DEB/TNP
CHECKED
DATE 03/2014
SHEET 15 OF 45

NO. | DATE | REVISION DESCRIPTION | BY

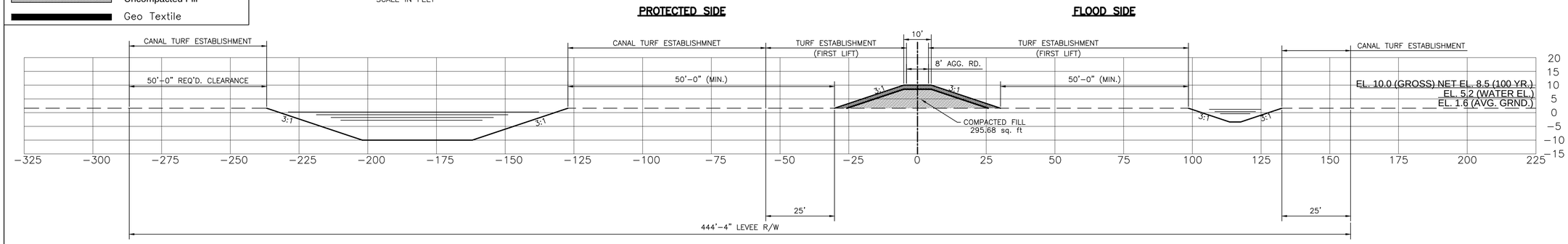
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

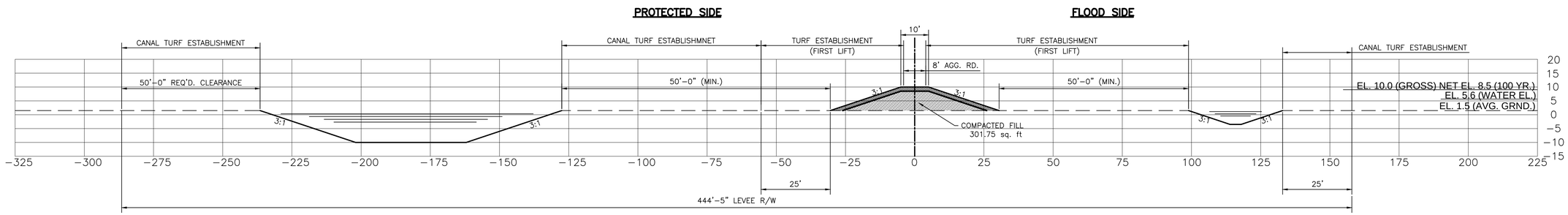
20 0 20 40
SCALE IN FEET



Levee Section C−21 (Sta. 945+00.00 thru Sta. 967+91.21)

First Lift

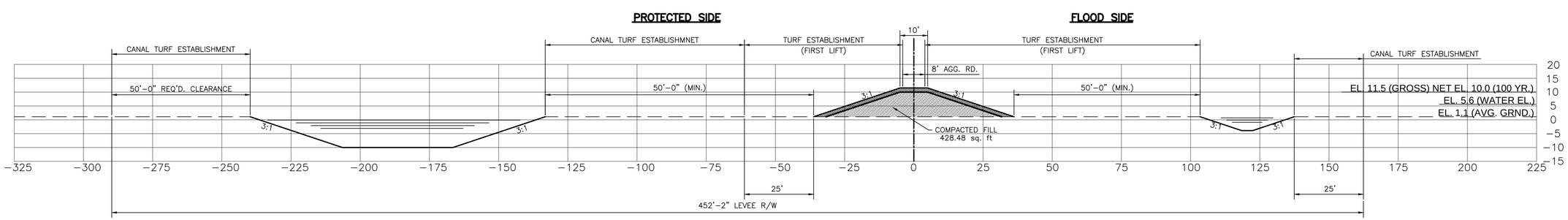
Note: No Second Lift Required



Levee Section C−20 (Sta. 905+00.00 thru Sta. 945+00.00)

First Lift

Note: No Second Lift Required



Levee Section C−19 (Sta. 850+00.00 thru Sta. 905+00.00)

First Lift

Note: No Second Lift Required

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C2.6

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

BOARD OF COMMISSIONERS EAST BANK DISTRICT LAKE PONTCHARTRAIN

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

Alignment C

STATE OF LOUISIANA

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 16 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

Legend

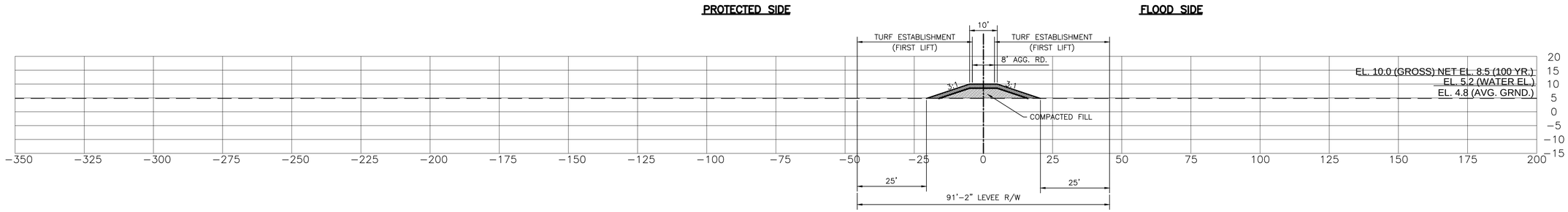
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40

SCALE IN FEET



Levee Section C−22 (Sta. 967+91.21 thru Sta. 1063+87.55)

First Lift

Note: No Second Lift Required

FILE NAME: X.DWG DATE: XREF: NONE

SHEET NUMBER C2.7

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

BOARD OF COMMISSIONERS SOUTHEAST LOUISIANA FLOOD PROTECTION AUTHORITY-EAST

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

STATE OF LOUISIANA

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	17 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

ALIGNMENT C3 – 2nd LIFT (Year 2020)

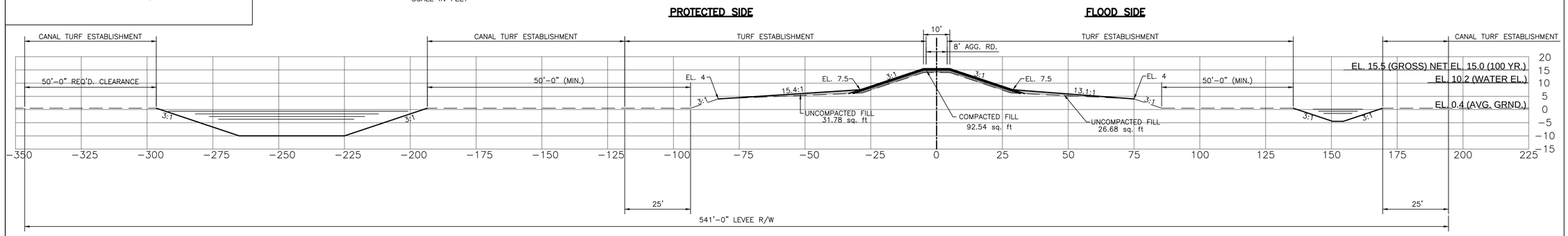
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

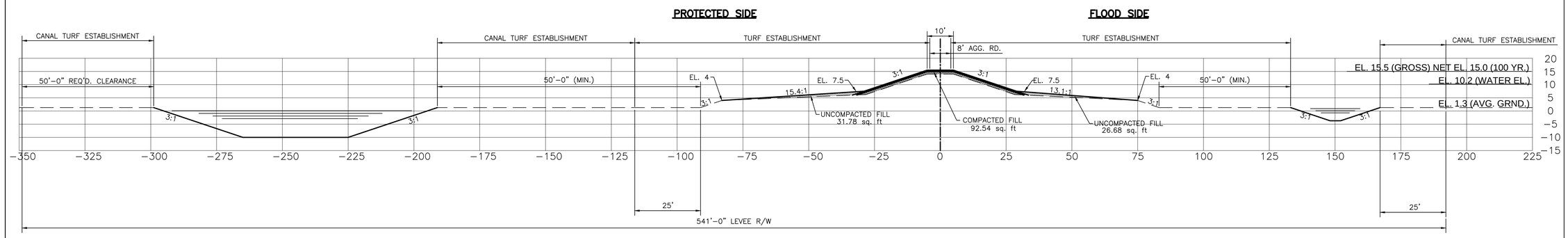
20 0 20 40
SCALE IN FEET



Levee Section C−3 (Sta. 178+00.00 thru Sta. 228+33.14)

First Lift

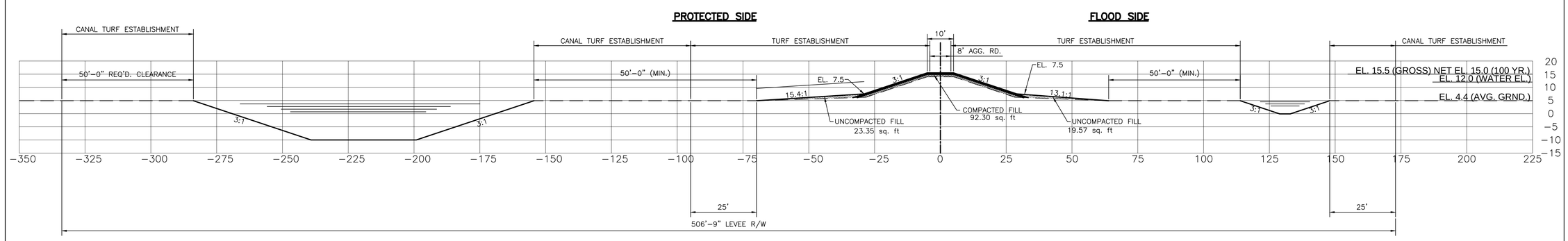
Note: See Sht. C2.0 For First Lift Section



Levee Section C−2 (Sta. 129+17.02 thru Sta. 178+00.00)

First Lift

Note: See Sht. C2.0 For First Lift Section



Levee Section C−1 (Sta. 100+00 thru Sta. 129+17.02)

First Lift

Note: See Sht. C2.0 For First Lift Section

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C3.0

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C

LEVEE PLANS

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	18 OF 45

BY

REVISION DESCRIPTION

NO. DATE

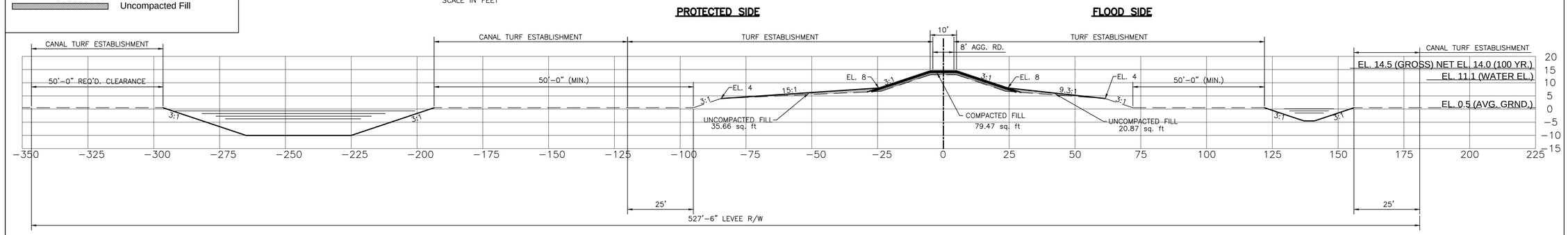
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

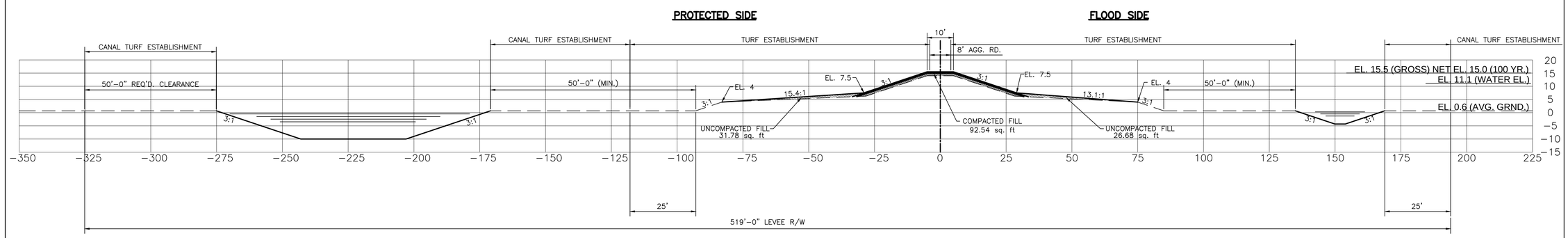
20 0 20 40
SCALE IN FEET



Levee Section C−6 (Sta. 304+61.43 thru Sta. 354+14.27)

First Lift

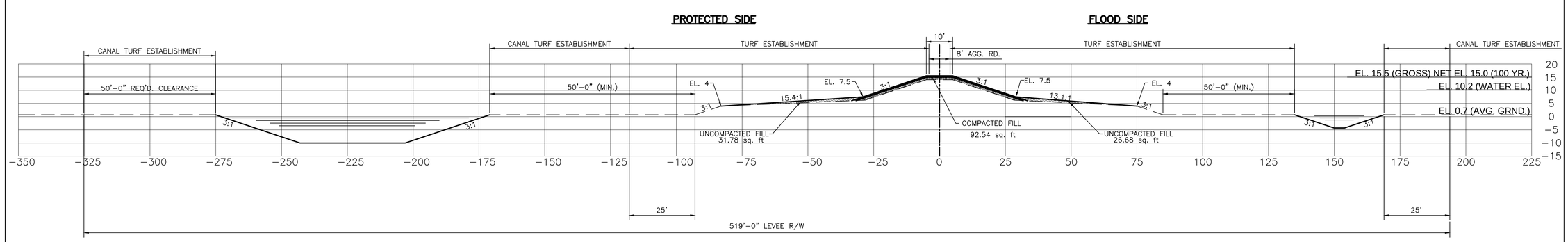
Note: See Sht. C2.1 For First Lift Section



Levee Section C−5 (Sta. 278+67.81 thru Sta. 304+61.43)

First Lift

Note: See Sht. C2.1 For First Lift Section



Levee Section C−4 (Sta. 228+33.14 thru Sta. 278+67.81)

First Lift

Note: See Sht. C2.1 For First Lift Section

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C3.1

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 19 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

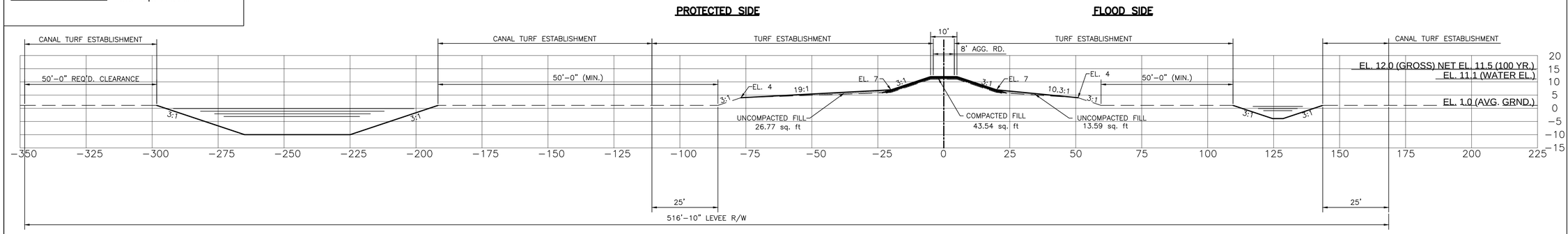
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

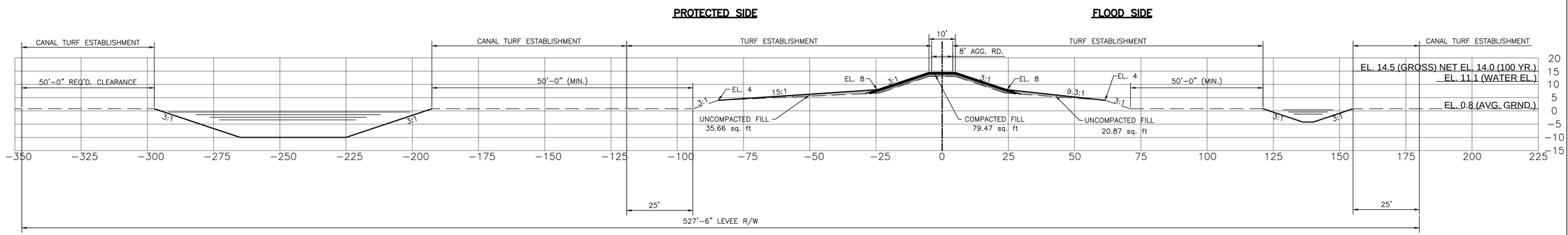
20 0 20 40
SCALE IN FEET



Levee Section C−9 (Sta. 473+00.00 thru Sta. 507+96.35)

First Lift

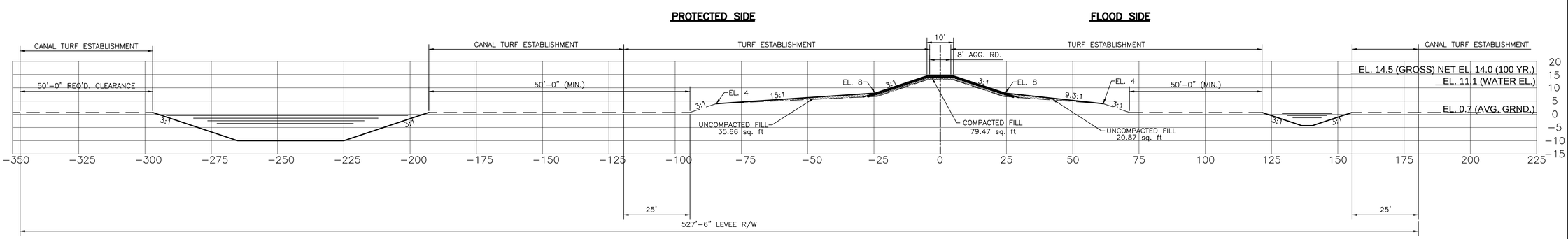
Note: See Sht. C2.2 For First Lift Section



Levee Section C−8 (Sta. 375+00.00 thru Sta. 473+00.00)

First Lift

Note: See Sht. C2.2 For First Lift Section



Levee Section C−7 (Sta. 354+14.27 thru Sta. 375+00.00)

First Lift

Note: See Sht. C2.2 For First Lift Section

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C3.2

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 20 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

Legend

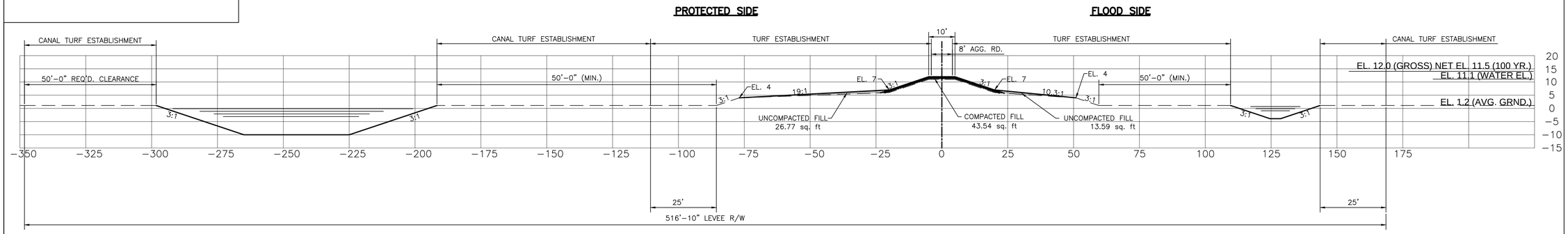
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40

SCALE IN FEET



Levee Section C−10 (Sta. 507+96.35 thru Sta. 542+92.72)

First Lift

Note: See Sht. C2.3 For First Lift Section

FILE NAME: X.DWG DATE: XREF: NONE

NO.	DATE	REVISION DESCRIPTION	BY

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 21 OF 45

BKI
MA GSA

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES
PLD PROJECT
USACE PROJECT

SHEET NUMBER C3.3

ALIGNMENT C4 – 3rd LIFT (Year 2030)

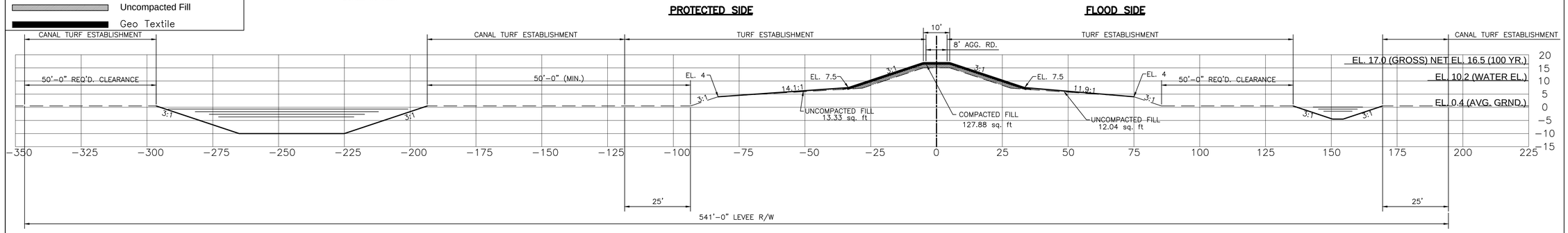
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

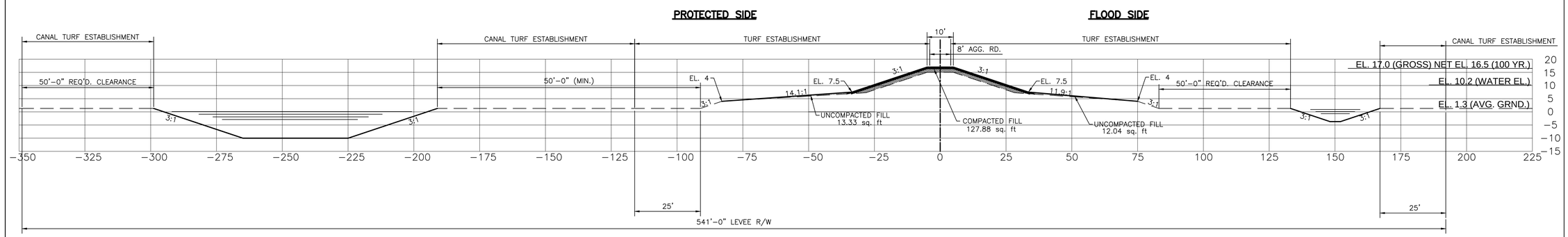
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



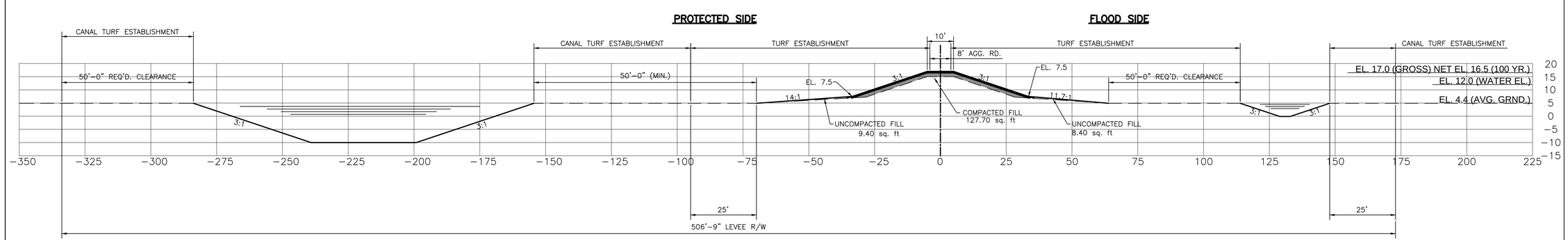
Levee Section C−3 (Sta. 178+00.00 thru Sta. 228+33.14)

First Lift



Levee Section C−2 (Sta. 129+17.02 thru Sta. 178+00.00)

First Lift



Levee Section C−1 (Sta. 100+00 thru Sta. 129+17.02)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C4.0

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C

LEVEE PLANS

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 22 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

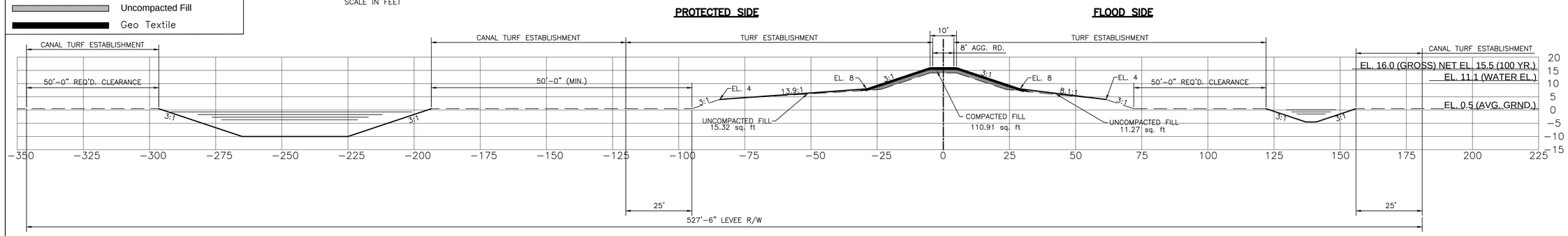
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

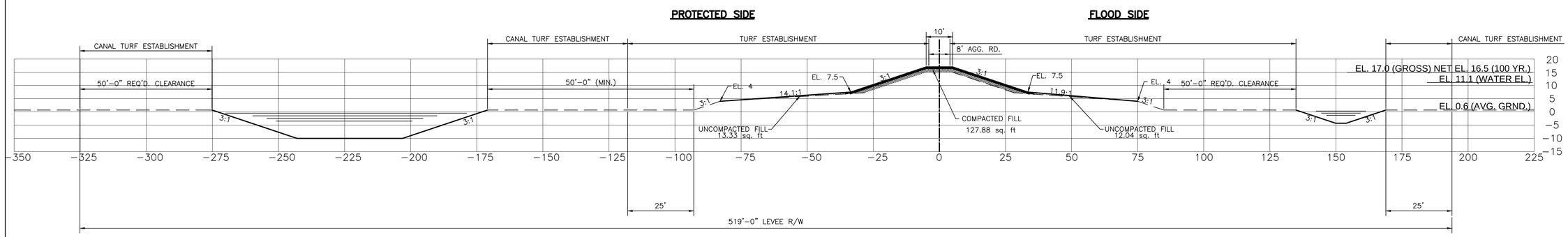
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



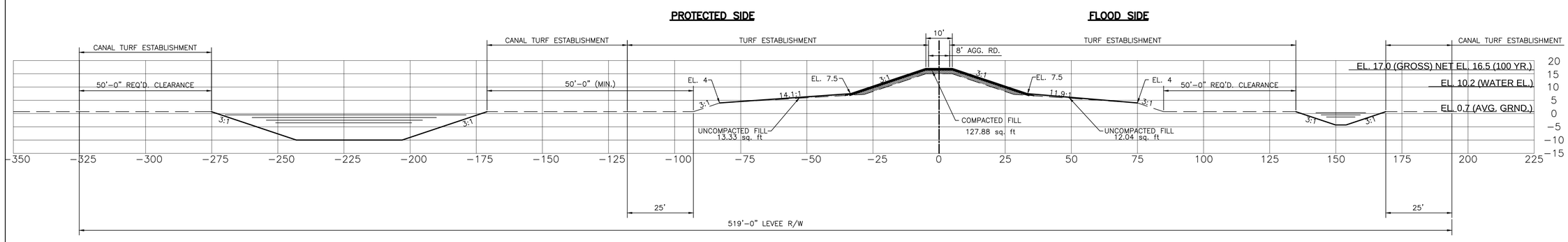
Levee Section C−6 (Sta. 304+61.43 thru Sta. 354+14.27)

First Lift



Levee Section C−5 (Sta. 278+67.81 thru Sta. 304+61.43)

First Lift



Levee Section C−4 (Sta. 228+33.14 thru Sta. 278+67.81)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C4.1

ST. CHARLES / ST. JOHN THE BAPTIST
ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS
Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 23 OF 45

NO. | DATE | REVISION DESCRIPTION | BY

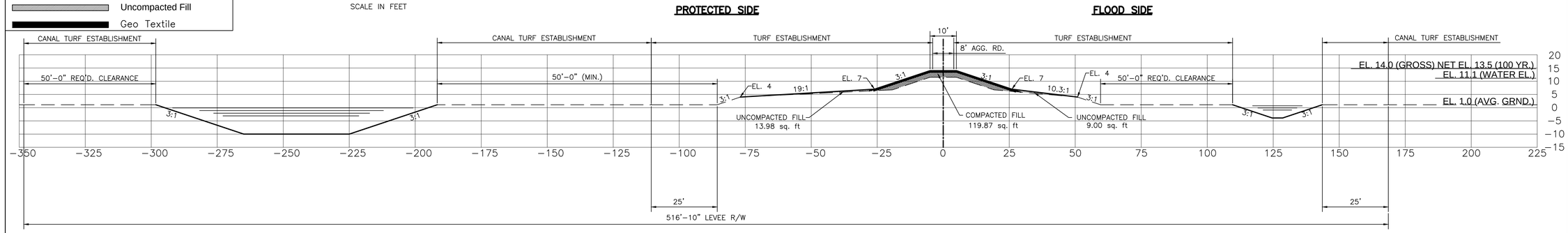
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

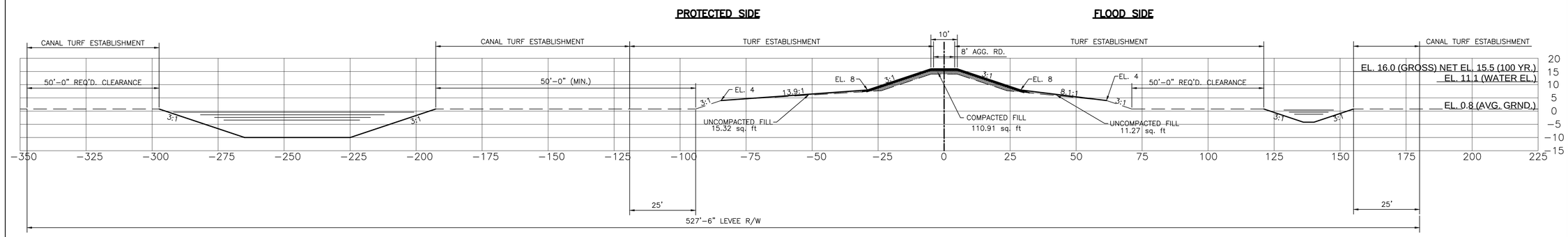
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



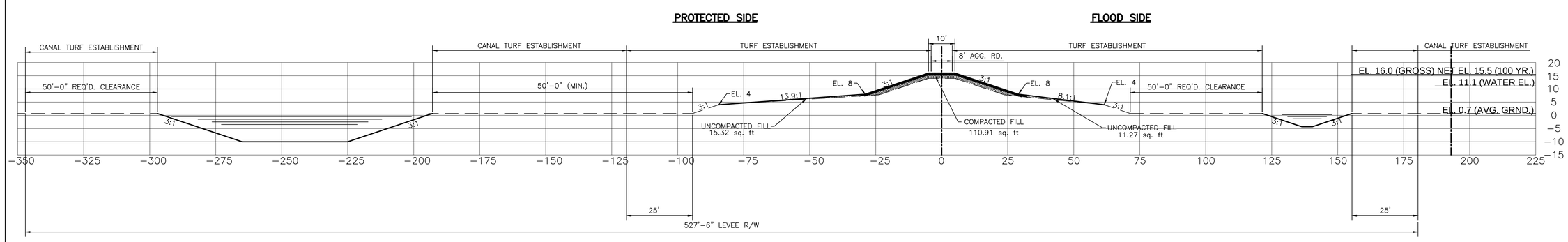
Levee Section C−9 (Sta. 473+00.00 thru Sta. 507+96.35)

First Lift



Levee Section C−8 (Sta. 375+00.00 thru Sta. 473+00.00)

First Lift



Levee Section C−7 (Sta. 354+14.27 thru Sta. 375+00.00)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C4.2

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 24 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

Legend

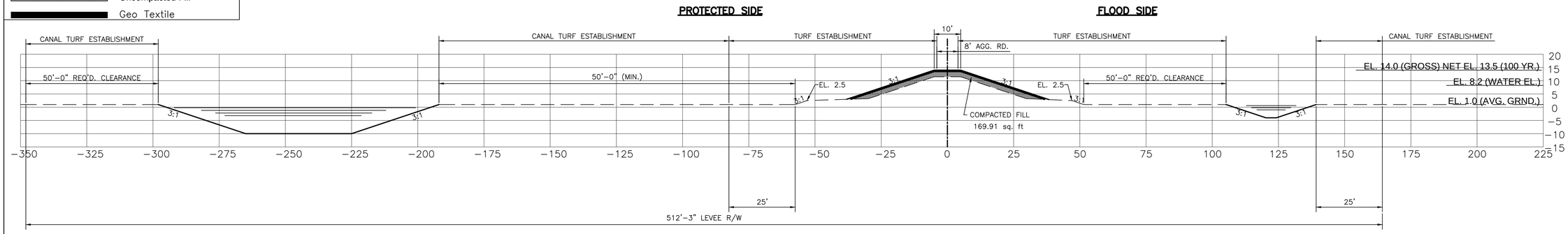
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

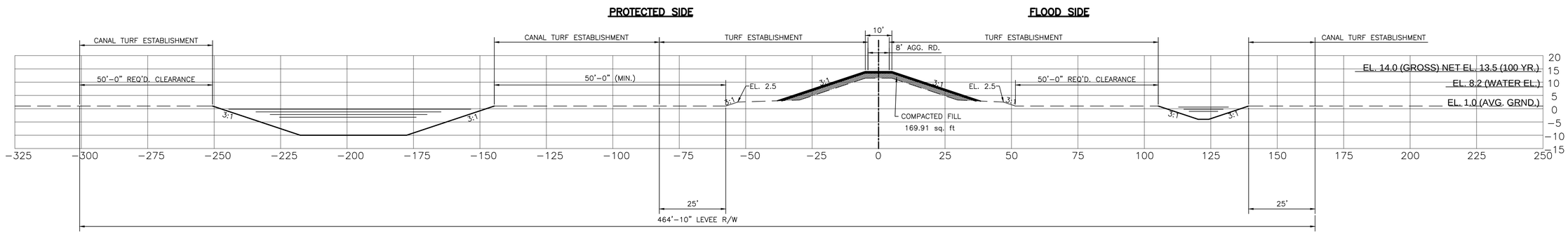
20 0 20 40

SCALE IN FEET



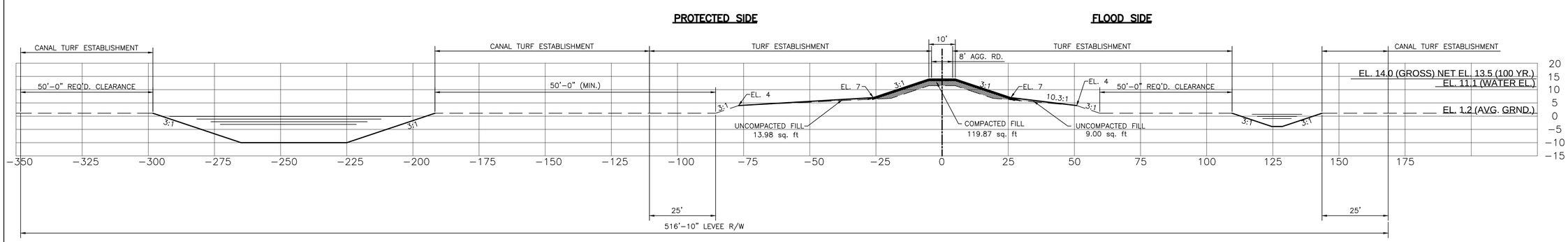
Levee Section C−12 (Sta. 577+89.09 thru Sta. 612+85.46)

First Lift



Levee Section C−11 (Sta. 542+92.72 thru Sta. 577+89.09)

First Lift



Levee Section C−10 (Sta. 507+96.35 thru Sta. 542+92.72)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C4.3

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 25 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

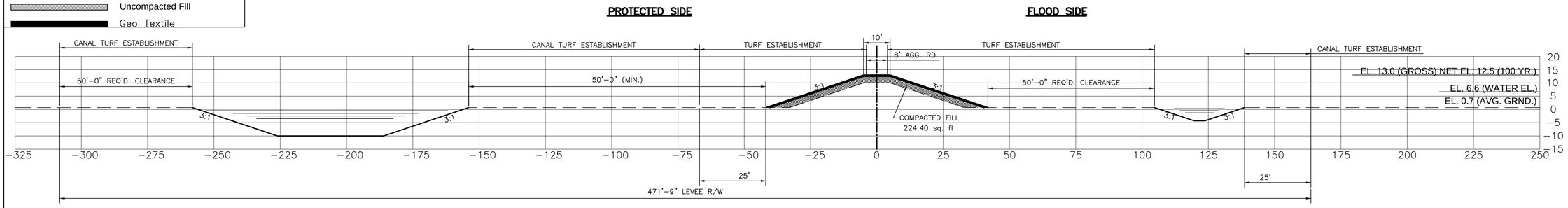
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

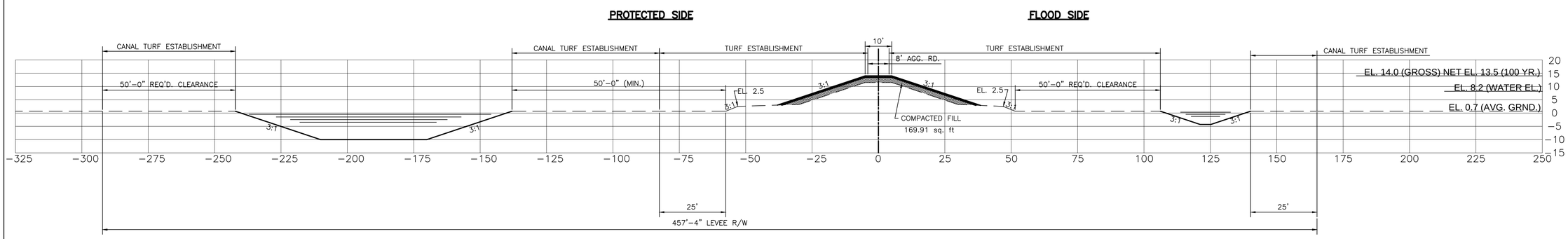
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



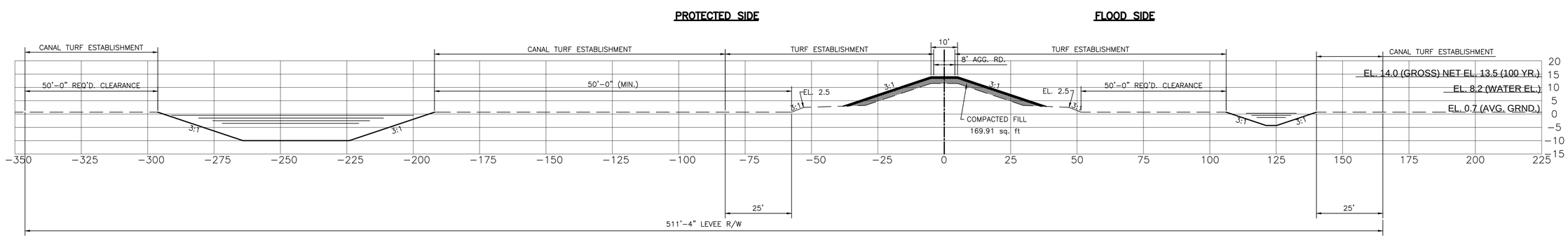
Levee Section C−15 (Sta. 681+62.66 thru Sta. 721+94.13)

First Lift



Levee Section C−14 (Sta. 653+16.92 thru Sta. 681+62.66)

First Lift



Levee Section C−13 (Sta. 612+85.46 thru Sta. 653+16.92)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C4.4

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	26 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

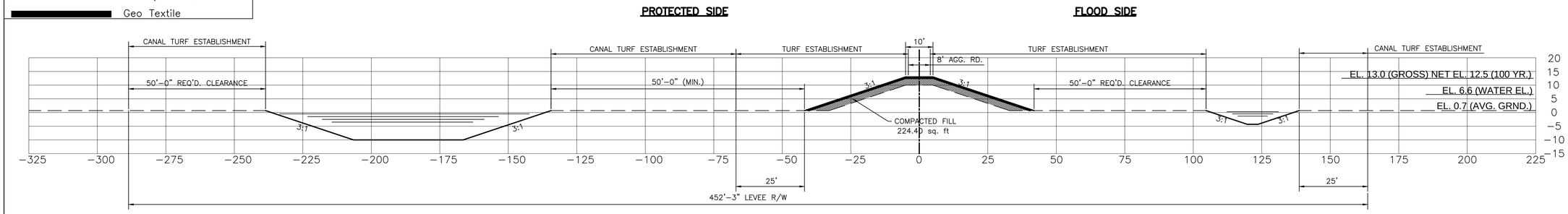
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

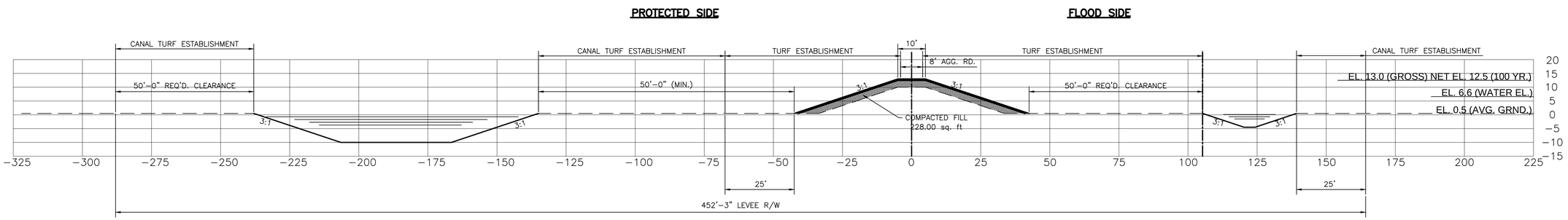
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



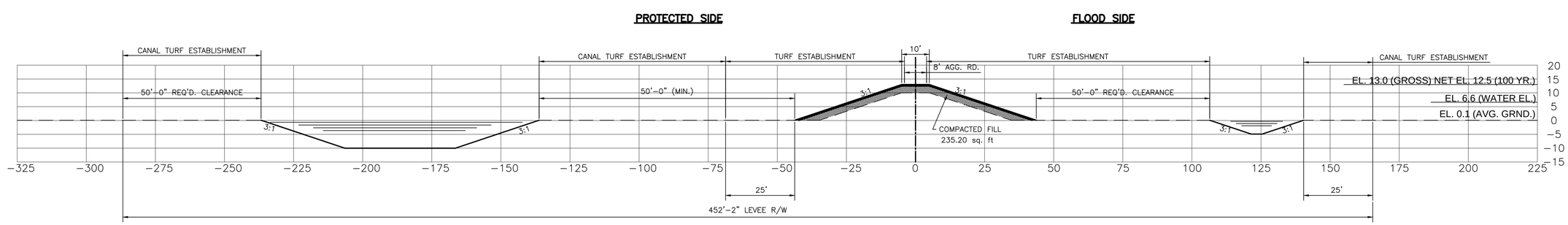
Levee Section C−18 (Sta. 821+54.25 thru Sta. 850+00.00)

First Lift



Levee Section C−17 (Sta. 740+91.43 thru Sta. 821+54.25)

First Lift



Levee Section C−16 (Sta. 721+94.13 thru Sta. 740+91.31)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C4.5

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	27 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

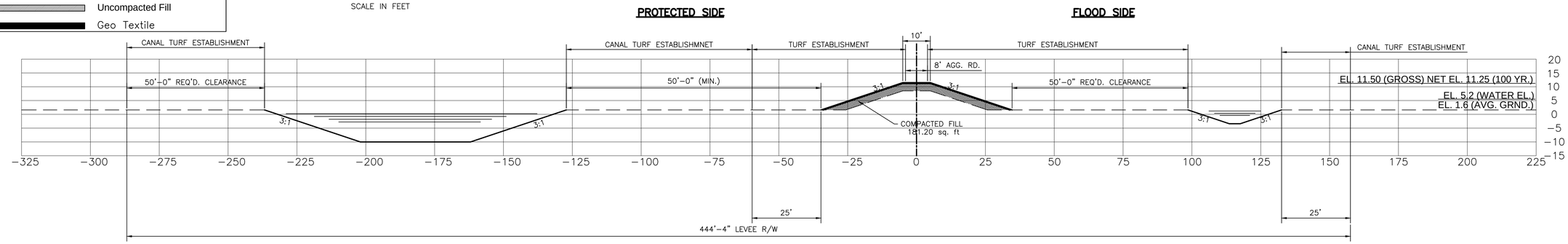
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

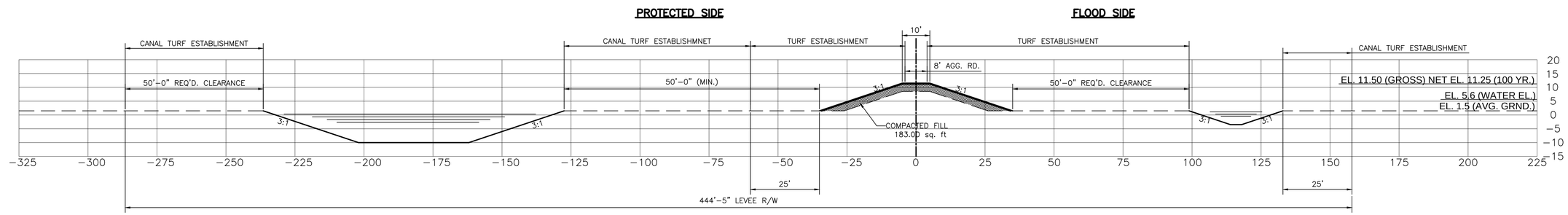
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



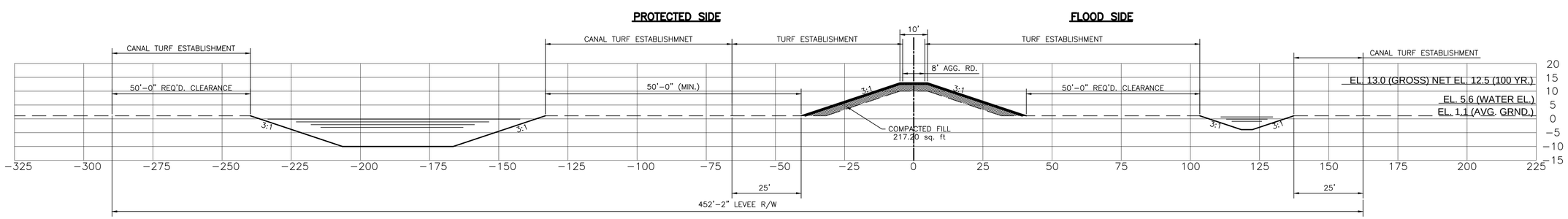
Levee Section C−21 (Sta. 945+00.00 thru Sta. 967+91.21)

First Lift



Levee Section C−20 (Sta. 905+00.00 thru Sta. 945+00.00)

First Lift



Levee Section C−19 (Sta. 850+00.00 thru Sta. 905+00.00)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C4.6

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED / CHECKED	DEB/TNP / HMP
DETAILED / CHECKED	GAD / DEB/TNP
DATE	03/2014
SHEET	28 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

Legend

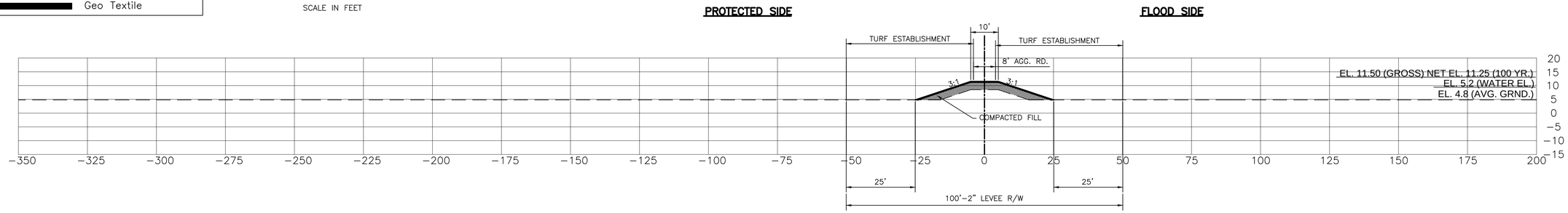
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40

SCALE IN FEET



Levee Section C−22 (Sta. 967+91.21 thru Sta. 1063+87.55)

First Lift

FILE NAME: X.DWG DATE: XREF: NONE

SHEET NUMBER C4.7

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 29 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

ALIGNMENT C5 – 4th LIFT (Year 2045)

Legend

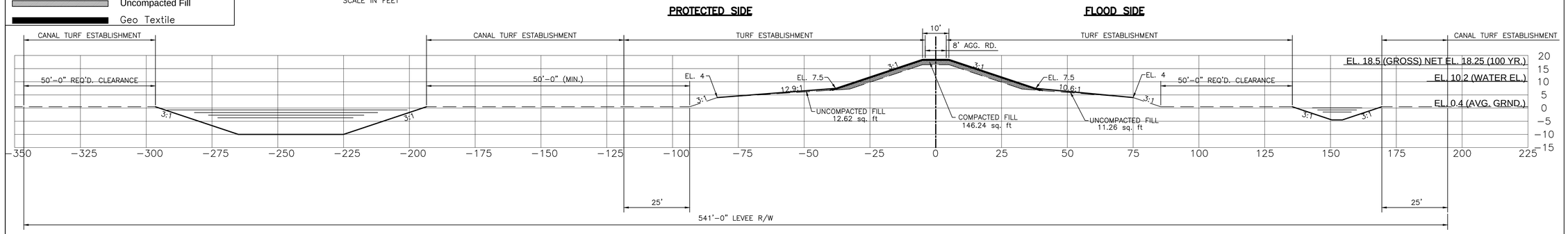
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

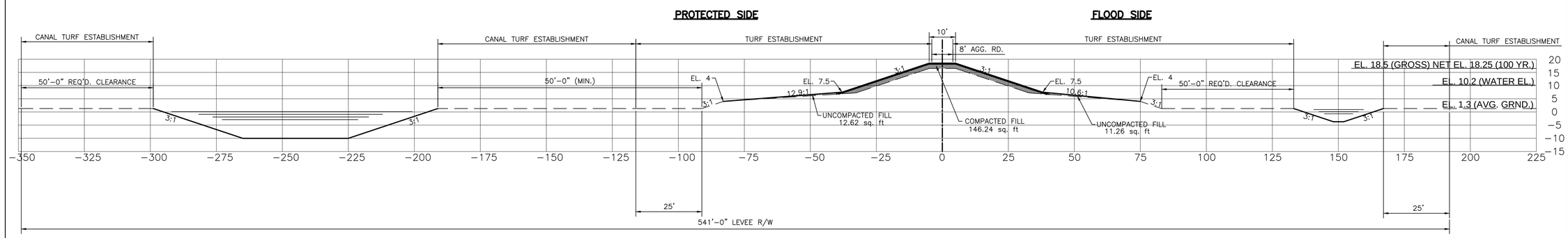
20 0 20 40

SCALE IN FEET



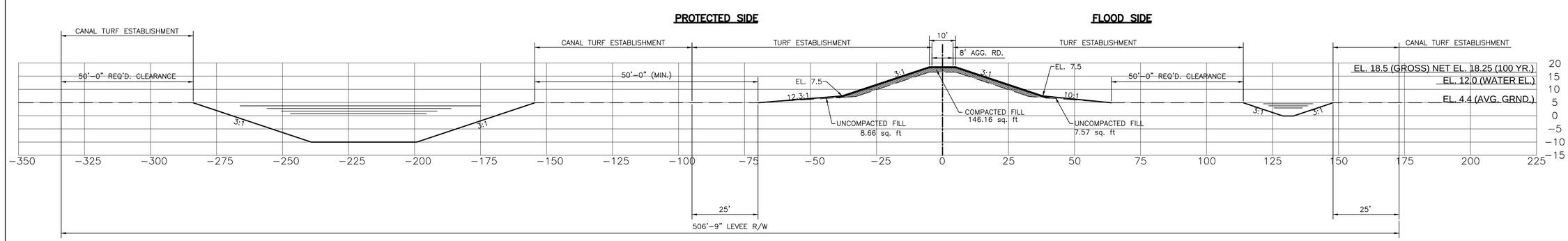
Levee Section C−3 (Sta. 178+00.00 thru Sta. 228+33.14)

First Lift



Levee Section C−2 (Sta. 129+17.02 thru Sta. 178+00.00)

First Lift



Levee Section C−1 (Sta. 100+00 thru Sta. 129+17.02)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C5.0

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP	DETAILED GAD	DATE 03/2014	
CHECKED HMP	CHECKED DEB/TNP	SHEET 30 OF 45	

NO.	DATE	REVISION DESCRIPTION	BY

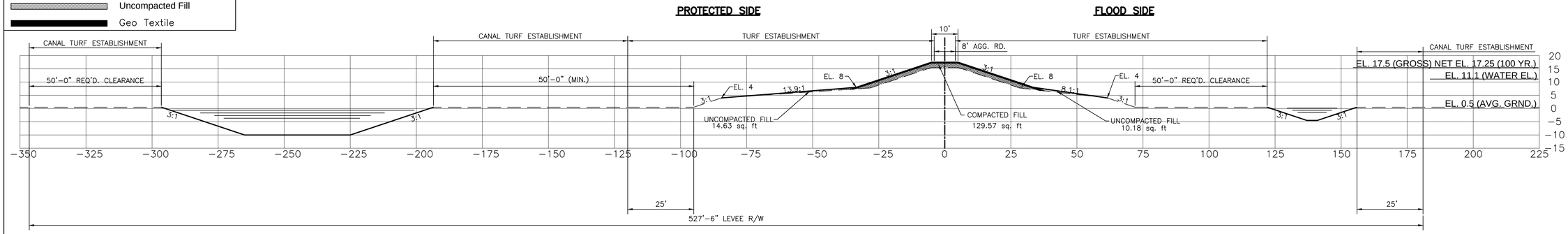
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

20 0 20 40
SCALE IN FEET

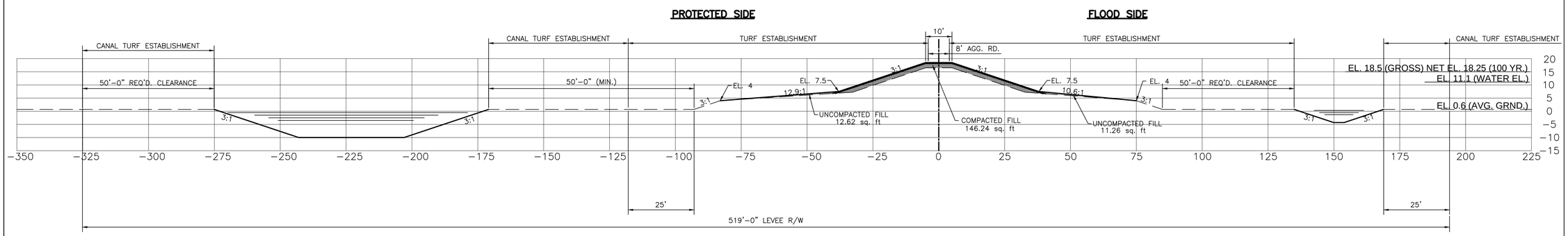
GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88



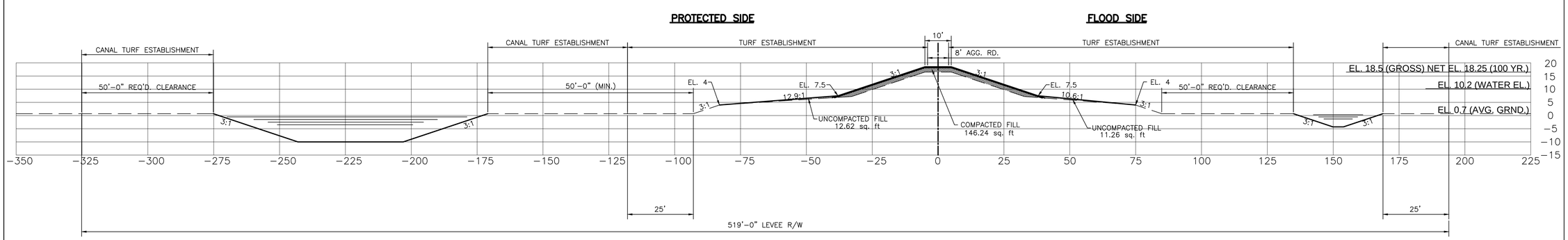
Levee Section C−6 (Sta. 304+61.43 thru Sta. 354+14.27)

First Lift



Levee Section C−5 (Sta. 278+67.81 thru Sta. 304+61.43)

First Lift



Levee Section C−4 (Sta. 228+33.14 thru Sta. 278+67.81)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C5.1

ST. CHARLES / ST. JOHN THE BAPTIST
ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 31 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

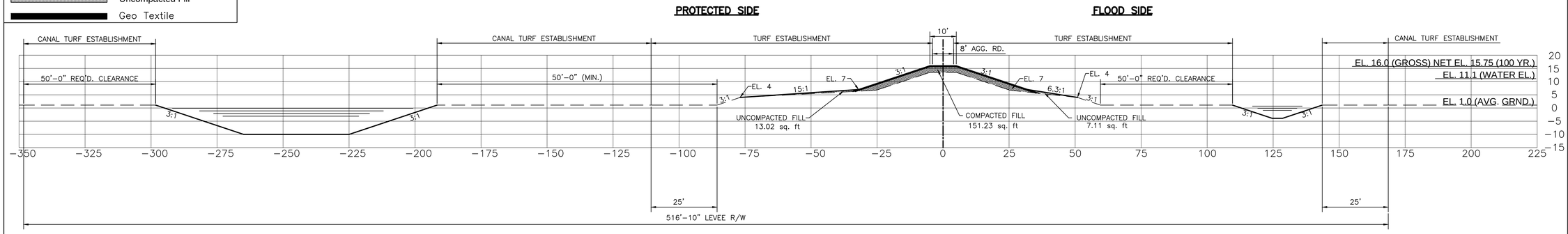
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

20 0 20 40
SCALE IN FEET

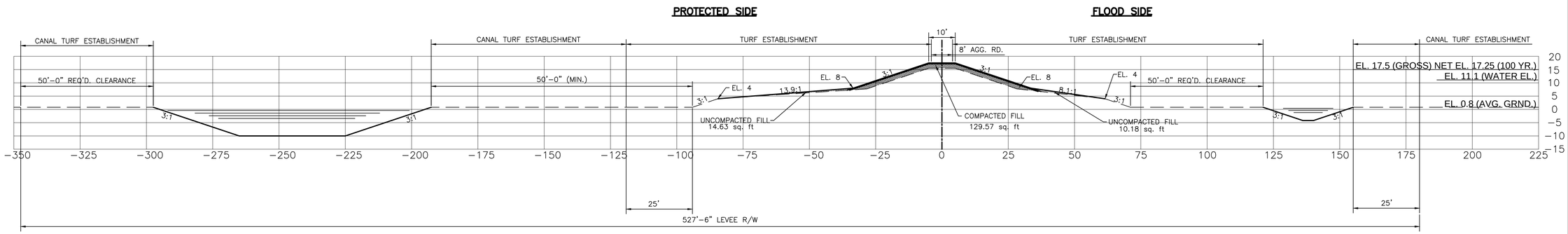
GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88



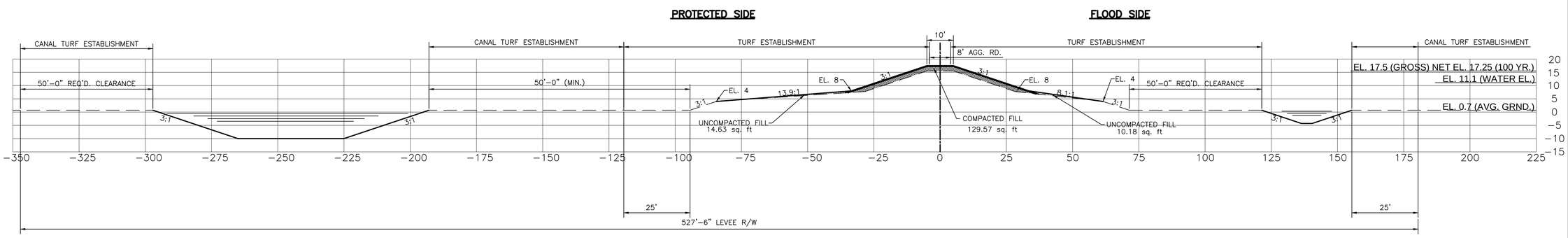
Levee Section C−9 (Sta. 473+00.00 thru Sta. 507+96.35)

First Lift



Levee Section C−8 (Sta. 375+00.00 thru Sta. 473+00.00)

First Lift



Levee Section C−7 (Sta. 354+14.27 thru Sta. 375+00.00)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C5.2

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C
LEVEE PLANS

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 32 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

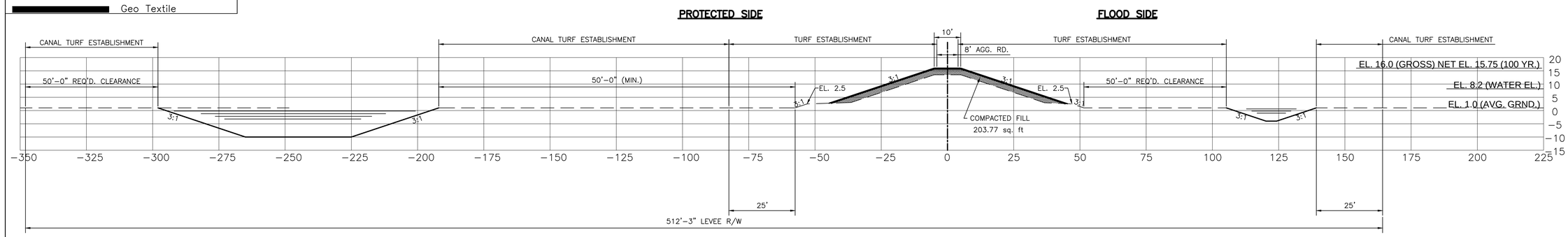
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

20 0 20 40
SCALE IN FEET

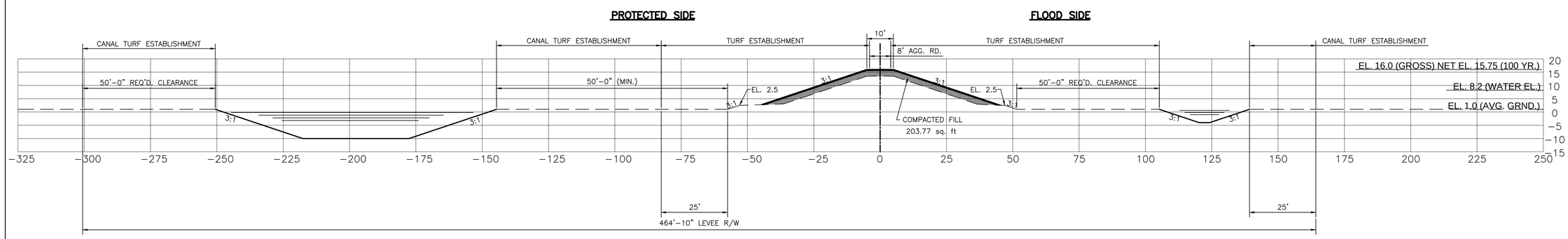
GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88



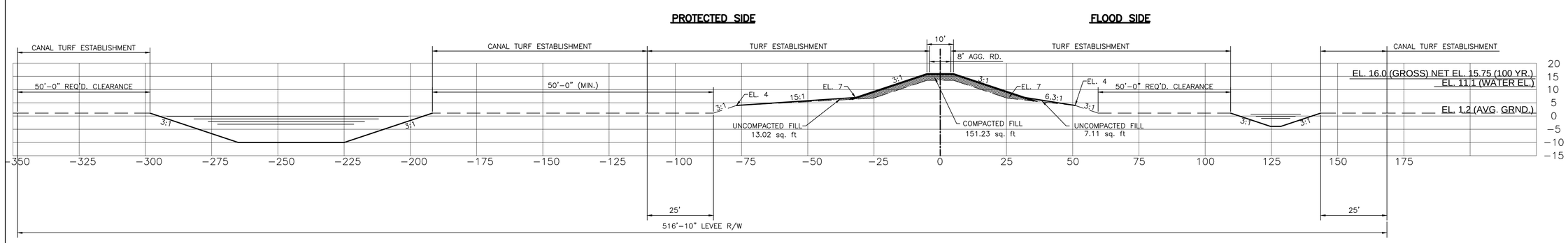
Levee Section C−12 (Sta. 577+89.09 thru Sta. 612+85.46)

First Lift



Levee Section C−11 (Sta. 542+92.72 thru Sta. 577+89.09)

First Lift



Levee Section C−10 (Sta. 507+96.35 thru Sta. 542+92.72)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C5.3

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES
PLD PROJECT
USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 33 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

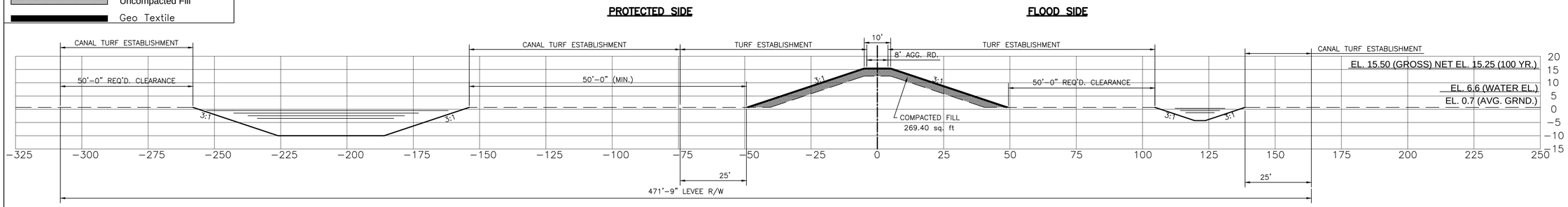
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

20 0 20 40
SCALE IN FEET

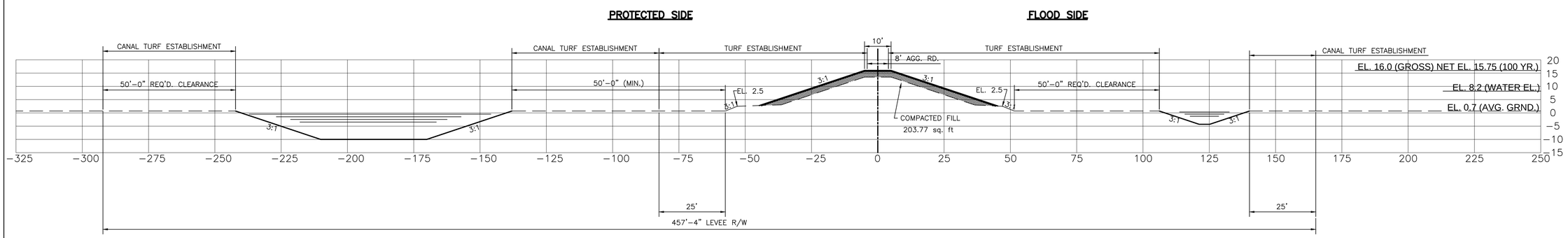
GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88



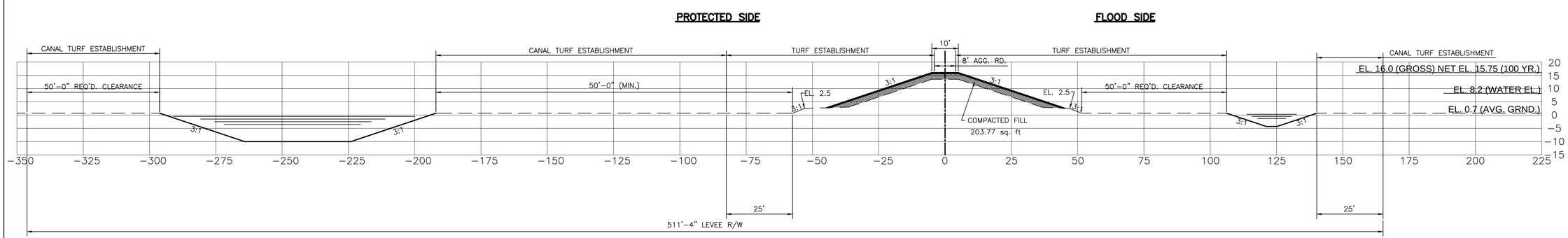
Levee Section C−15 (Sta. 681+62.66 thru Sta. 721+94.13)

First Lift



Levee Section C−14 (Sta. 653+16.92 thru Sta. 681+62.66)

First Lift



Levee Section C−13 (Sta. 612+85.46 thru Sta. 653+16.92)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C5.4

ST. CHARLES / ST. JOHN THE BAPTIST
ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	34 of 45

NO.	DATE	REVISION DESCRIPTION	BY

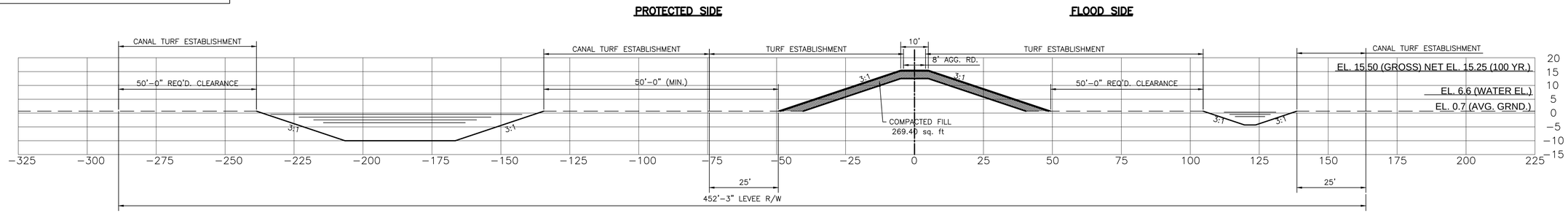
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

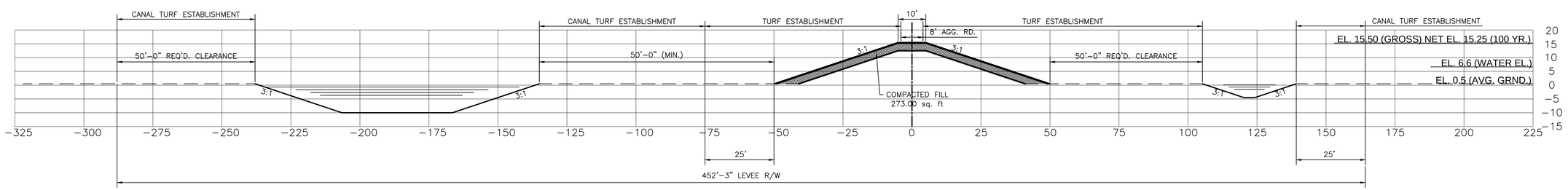
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



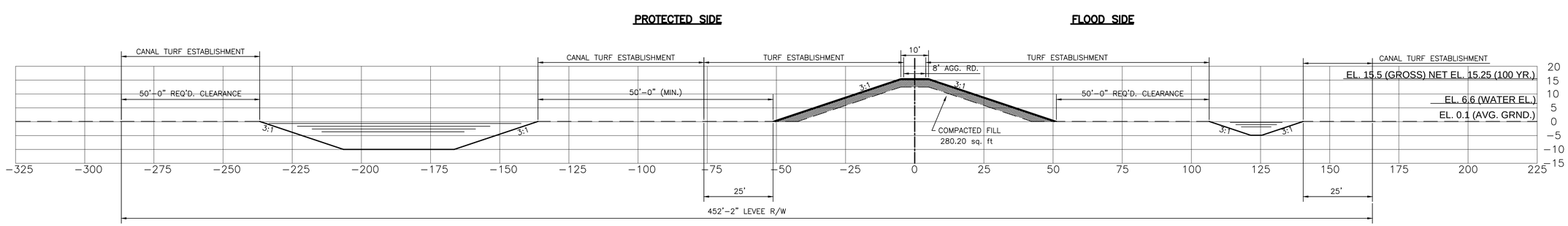
Levee Section C−18 (Sta. 821+54.25 thru Sta. 850+00.00)

First Lift



Levee Section C−17 (Sta. 740+91.43 thru Sta. 821+54.25)

First Lift



Levee Section C−16 (Sta. 721+94.13 thru Sta. 740+91.31)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C5.5

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 35 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

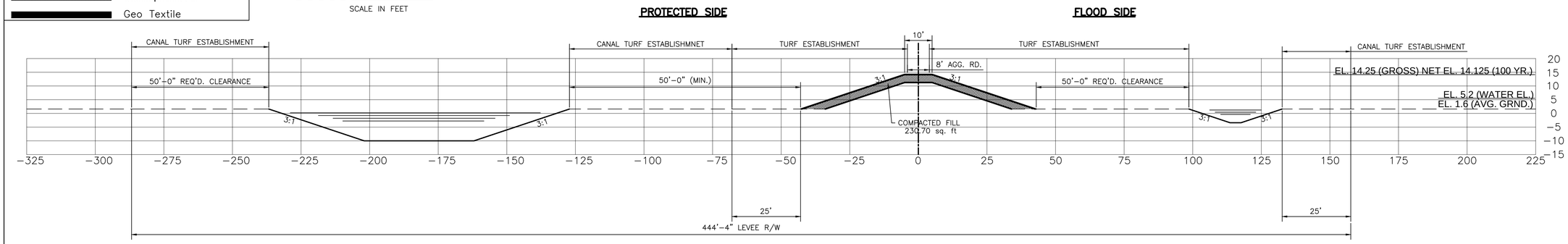
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

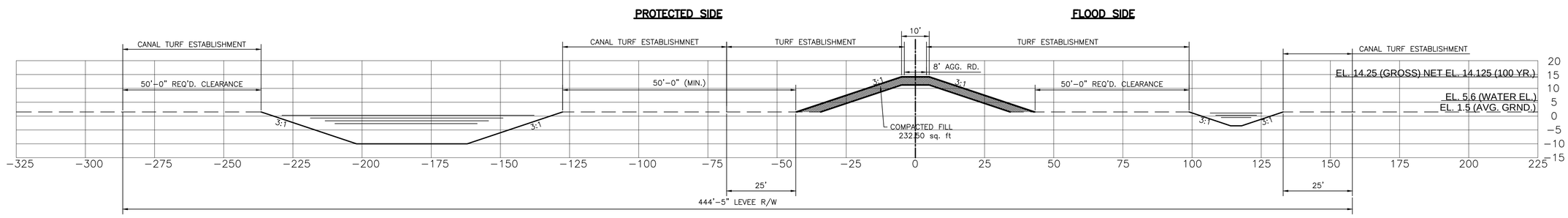
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



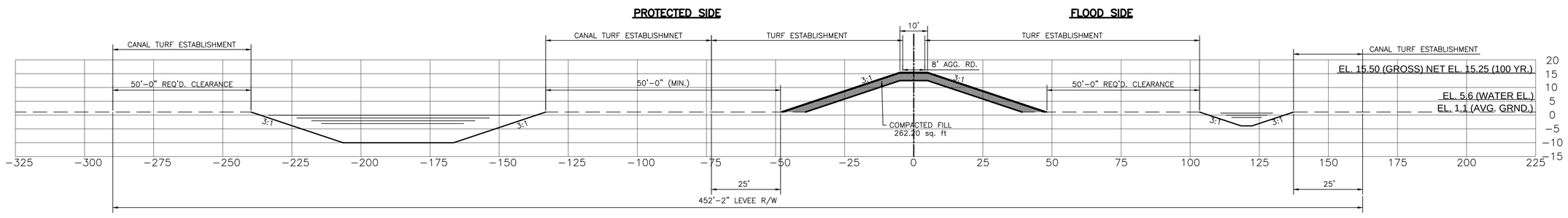
Levee Section C−21 (Sta. 945+00.00 thru Sta. 967+91.21)

First Lift



Levee Section C−20 (Sta. 905+00.00 thru Sta. 945+00.00)

First Lift



Levee Section C−19 (Sta. 850+00.00 thru Sta. 905+00.00)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C5.6

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES
PLD PROJECT
USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 36 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

Legend

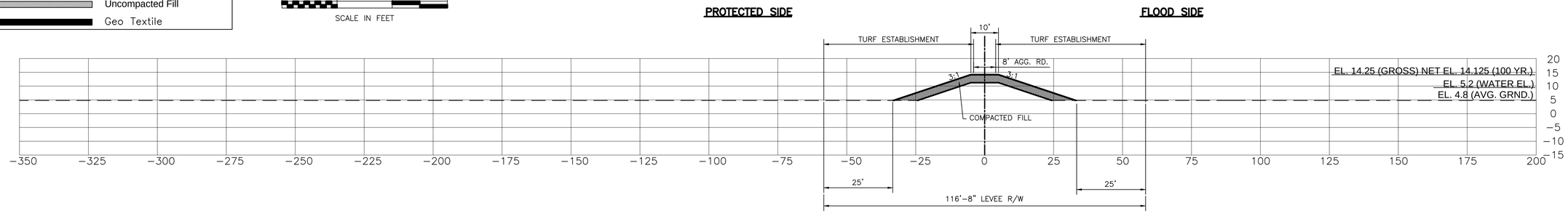
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40

SCALE IN FEET



Levee Section C−22 (Sta. 967+91.21 thru Sta. 1063+87.55)

First Lift

FILE NAME: X.DWG DATE: XREF: NONE

NO.	DATE	REVISION DESCRIPTION	BY

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 37 OF 45

BKI
MA GSA

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

SHEET NUMBER C5.7

ALIGNMENT C6 – 5th LIFT (Year 2060)

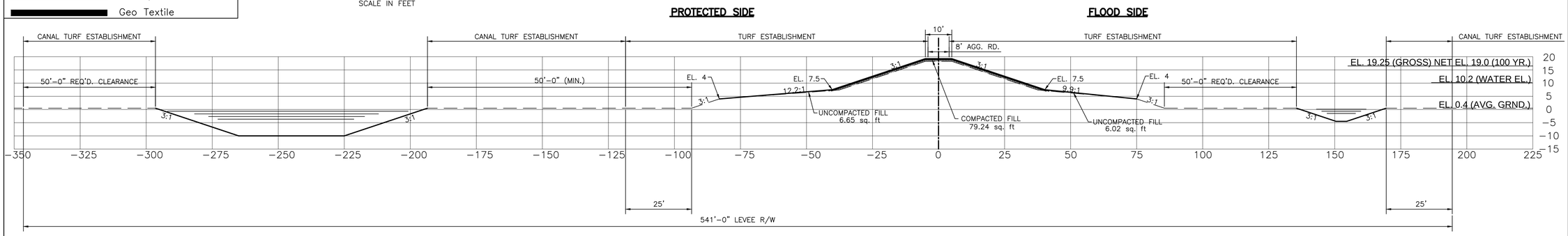
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

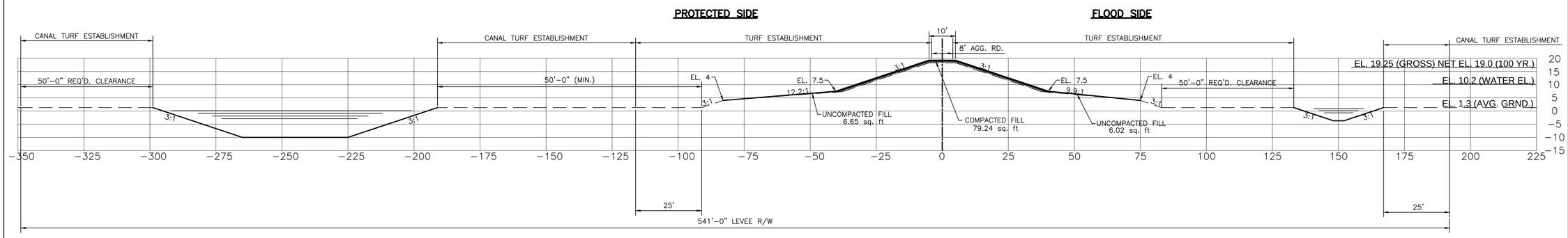
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



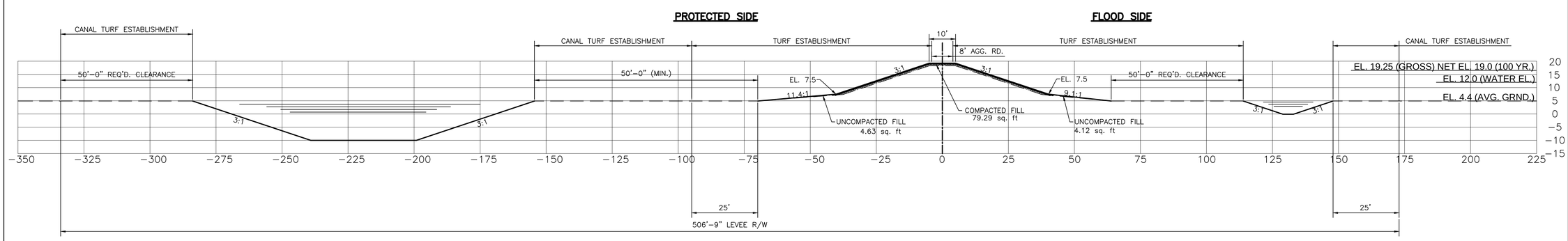
Levee Section C−3 (Sta. 178+00.00 thru Sta. 228+33.14)

First Lift



Levee Section C−2 (Sta. 129+17.02 thru Sta. 178+00.00)

First Lift



Levee Section C−1 (Sta. 100+00 thru Sta. 129+17.02)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C6.0

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C

LEVEE PLANS

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	38 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

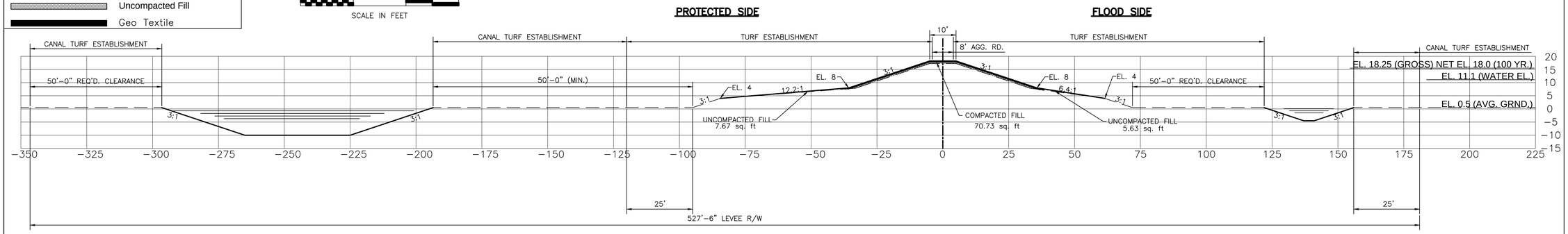
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

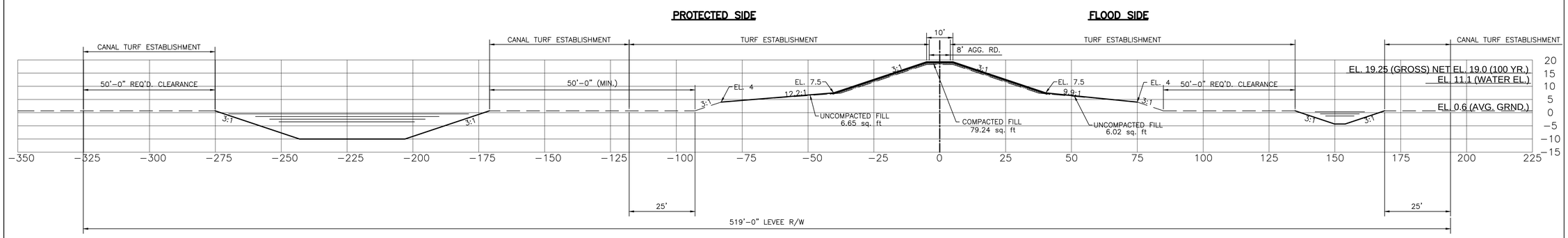
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



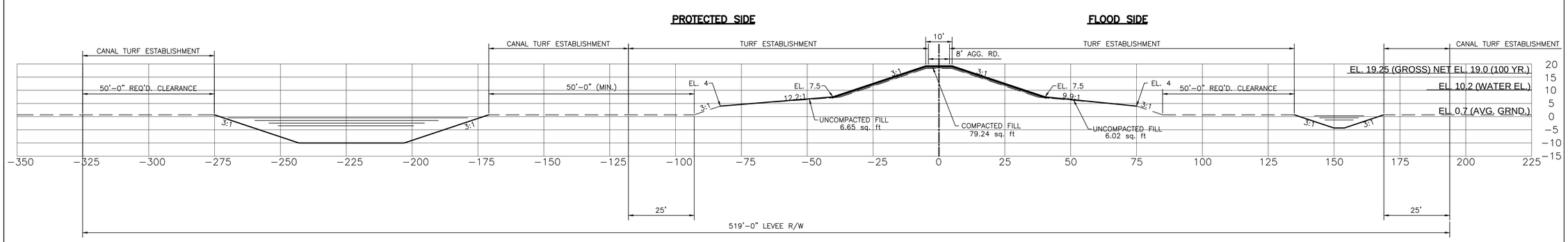
Levee Section C−6 (Sta. 304+61.43 thru Sta. 354+14.27)

First Lift



Levee Section C−5 (Sta. 278+67.81 thru Sta. 304+61.43)

First Lift



Levee Section C−4 (Sta. 228+33.14 thru Sta. 278+67.81)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C6.1

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 39 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

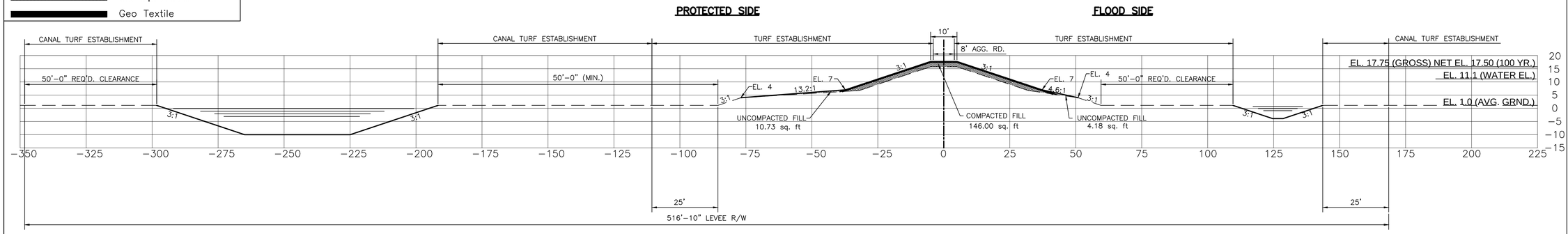
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

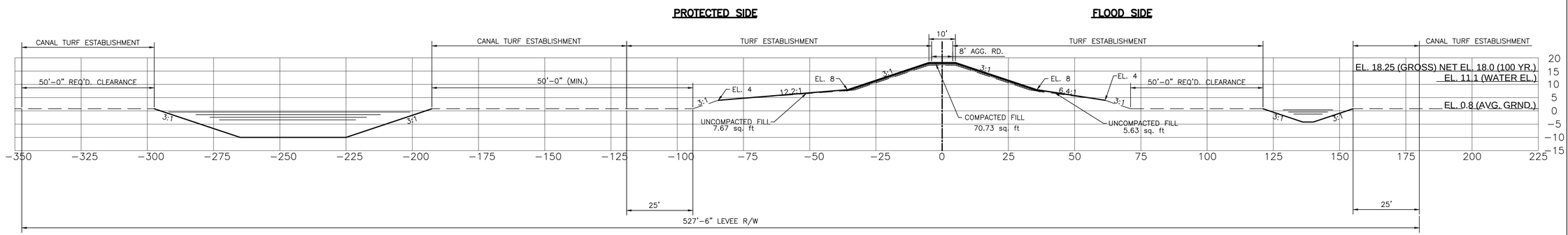
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



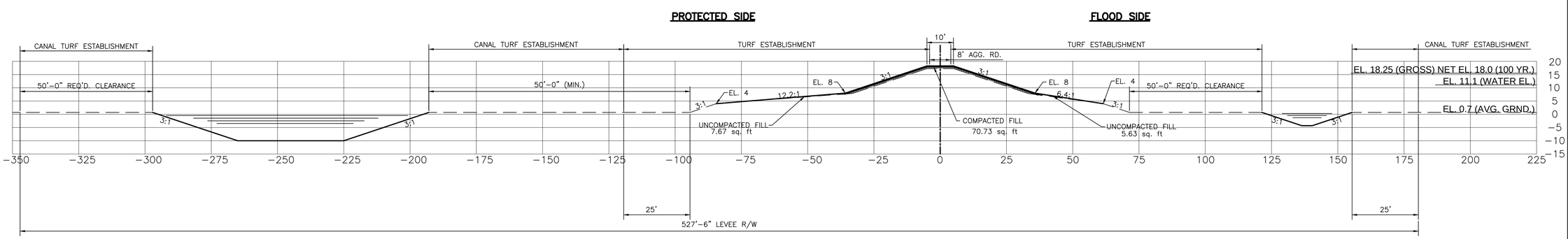
Levee Section C−9 (Sta. 473+00.00 thru Sta. 507+96.35)

First Lift



Levee Section C−8 (Sta. 375+00.00 thru Sta. 473+00.00)

First Lift



Levee Section C−7 (Sta. 354+14.27 thru Sta. 375+00.00)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C6.2

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

Alignment C

LEVEE PLANS

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 40 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

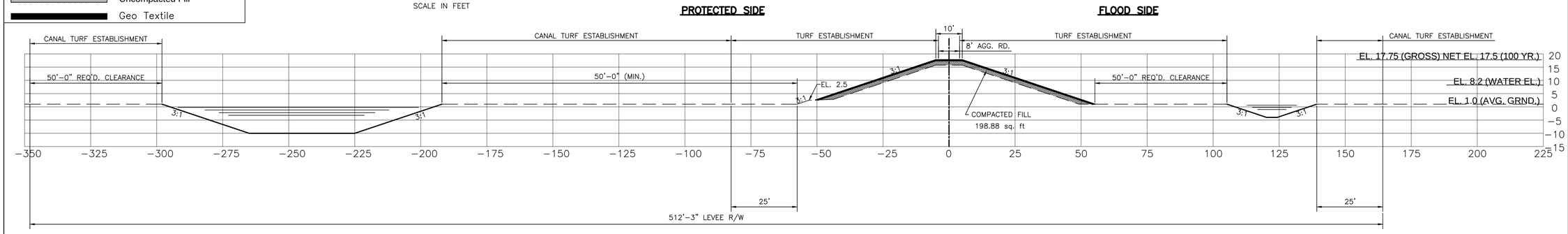
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

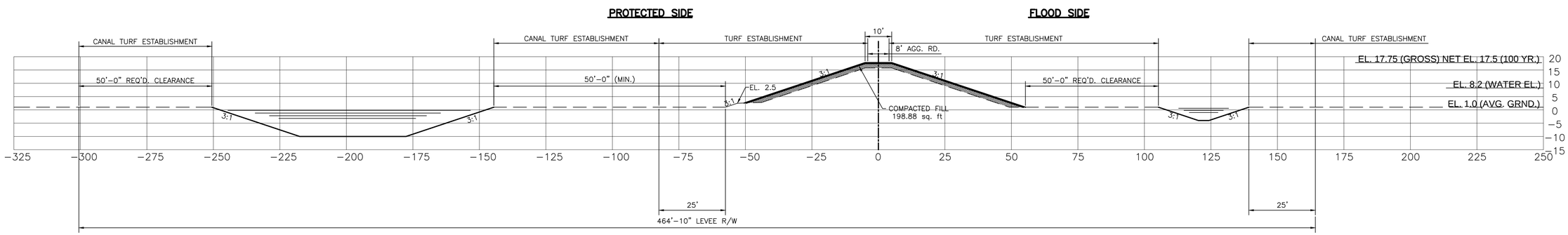
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



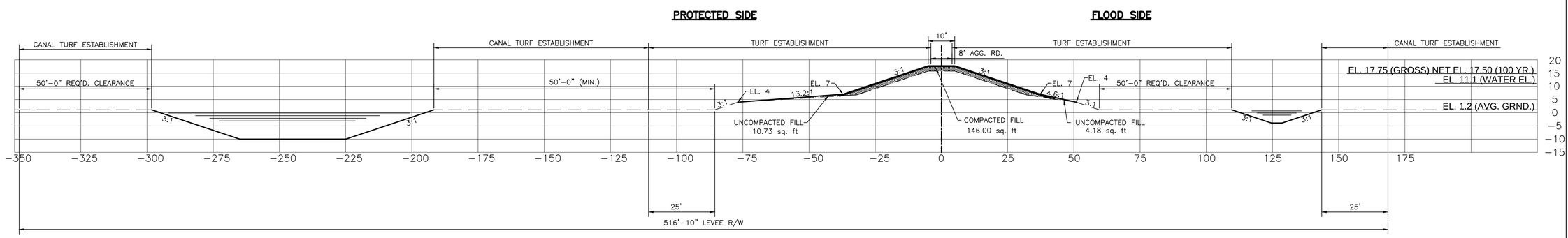
Levee Section C−12 (Sta. 577+89.09 thru Sta. 612+85.46)

First Lift



Levee Section C−11 (Sta. 542+92.72 thru Sta. 577+89.09)

First Lift



Levee Section C−10 (Sta. 507+96.35 thru Sta. 542+92.72)

First Lift

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER C6.3

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	41 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

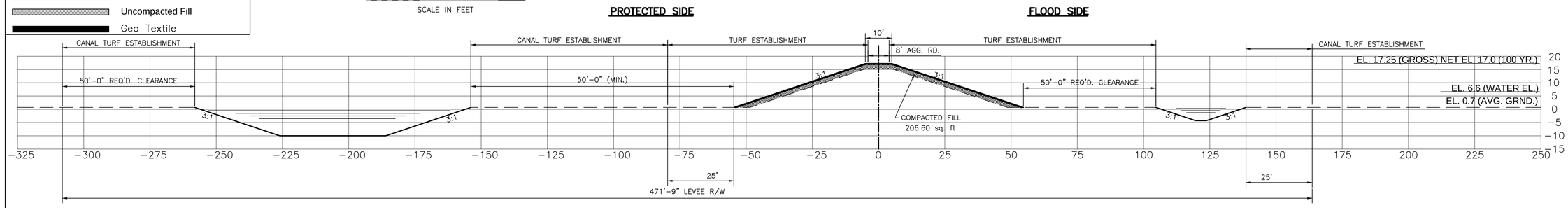
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

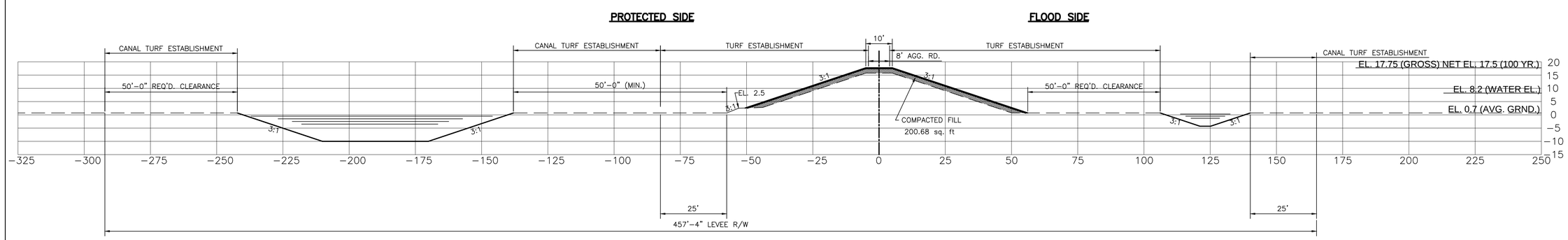
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



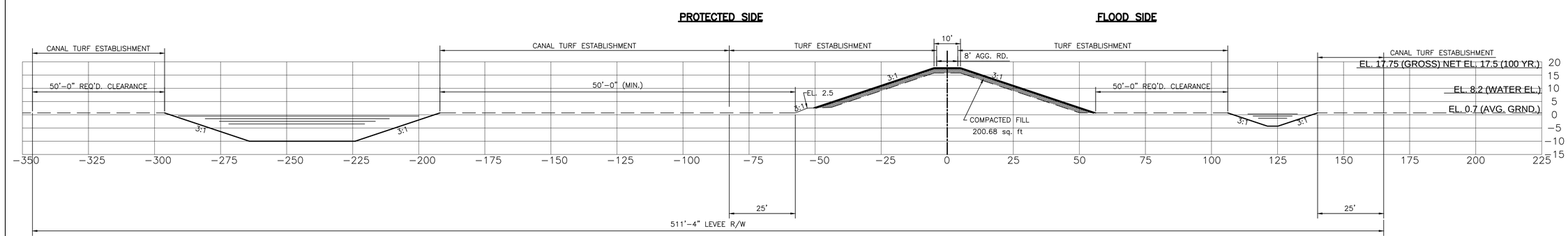
Levee Section C−15 (Sta. 681+62.66 thru Sta. 721+94.13)

First Lift



Levee Section C−14 (Sta. 653+16.92 thru Sta. 681+62.66)

First Lift



Levee Section C−13 (Sta. 612+85.46 thru Sta. 653+16.92)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C6.4

ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	42 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

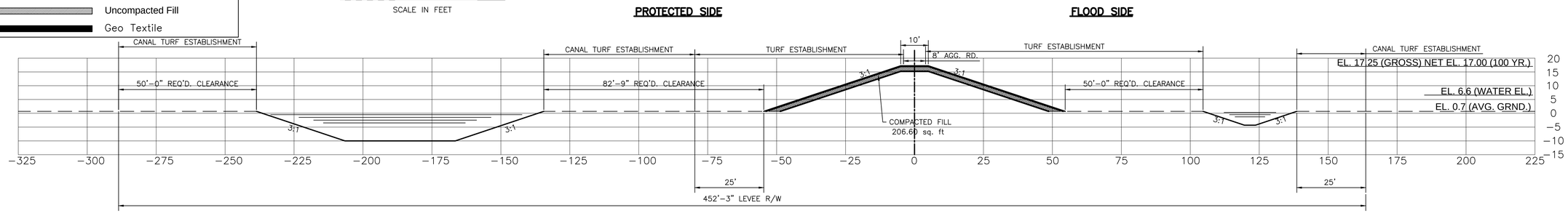
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

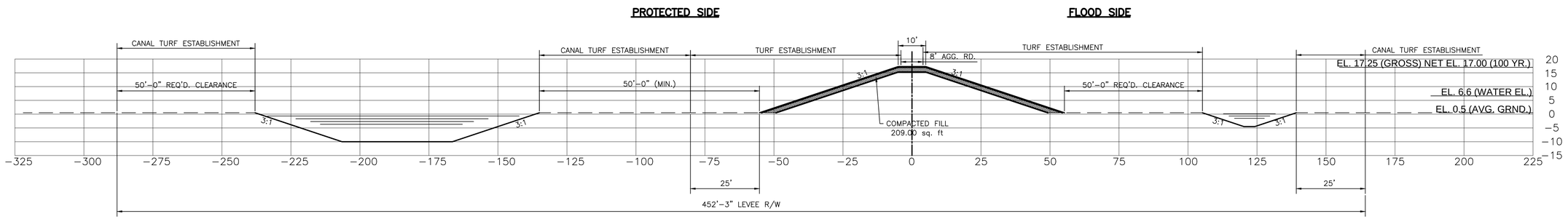
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



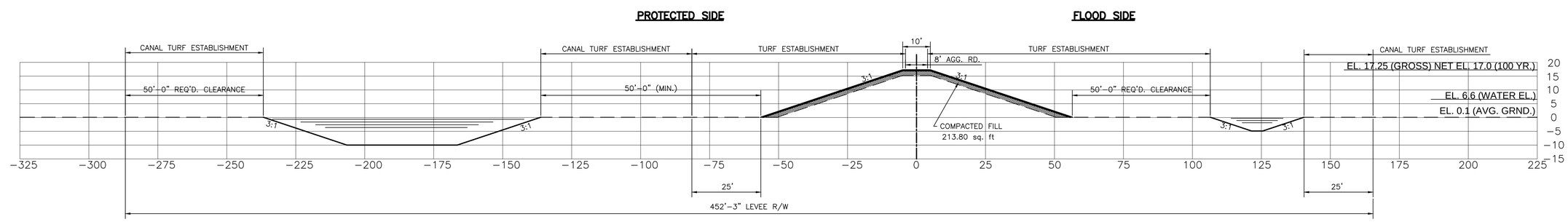
Levee Section C−18 (Sta. 821+54.25 thru Sta. 850+00.00)

First Lift



Levee Section C−17 (Sta. 740+91.43 thru Sta. 821+54.25)

First Lift



Levee Section C−16 (Sta. 721+94.13 thru Sta. 740+91.31)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C6.5

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: Alignment C

BKI
MA GSA

DESIGNED / CHECKED	DEB/TNP / HMP
DETAILED / CHECKED	GAD / DEB/TNP
DATE	03/2014
SHEET	43 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

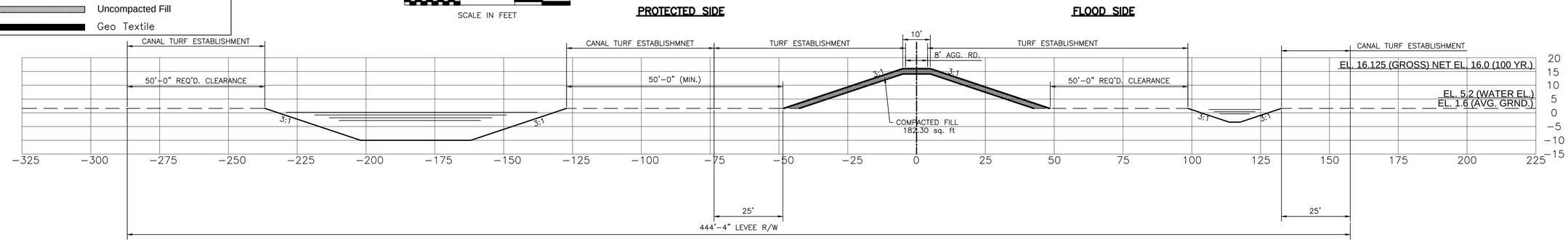
Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

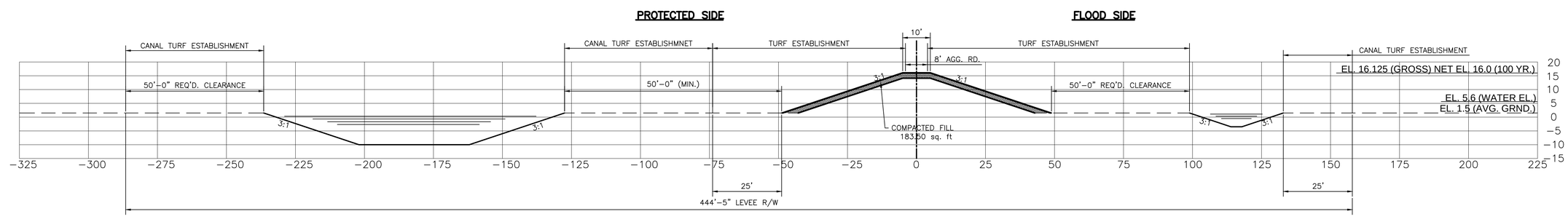
1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40
SCALE IN FEET



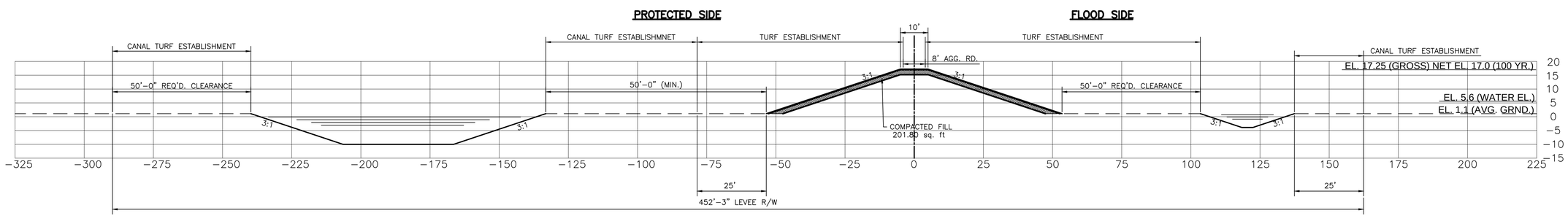
Levee Section C−21 (Sta. 945+00.00 thru Sta. 967+91.21)

First Lift



Levee Section C−20 (Sta. 905+00.00 thru Sta. 945+00.00)

First Lift



Levee Section C−19 (Sta. 850+00.00 thru Sta. 905+00.00)

First Lift

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER C6.6

ST. CHARLES / ST. JOHN THE BAPTIST
ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

Alignment C

BKI
MA GSA

DESIGNED	DEB/TNP
CHECKED	HMP
DETAILED	GAD
CHECKED	DEB/TNP
DATE	03/2014
SHEET	44 OF 45

NO.	DATE	REVISION DESCRIPTION	BY

Legend

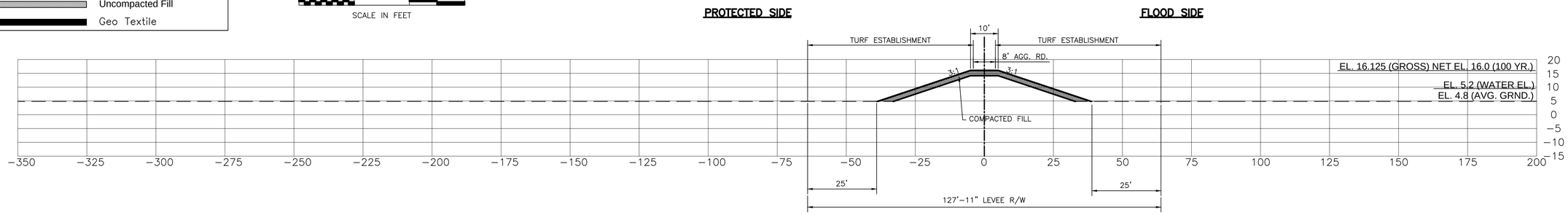
- Center Line of Levee
- Toe of Levee
- Compacted Fill (Overbuild)
- Compacted Fill
- Uncompacted Fill
- Geo Textile

GENERAL NOTES:

1. 3:1 SIDE SLOPES
2. 100% IMPORTED CLAY
3. CONVEYANCE CANAL DEPTH TO −10' NAVD88

20 0 20 40

SCALE IN FEET



Levee Section C−22 (Sta. 967+91.21 thru Sta. 1063+87.55)

First Lift

FILE NAME: X.DWG DATE: XREF: NONE

SHEET NUMBER C6.7

ST. CHARLES / ST. JOHN THE BAPTIST
ST. JAMES / ASCENSION PARISHES

PARISH | PLD PROJECT | USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

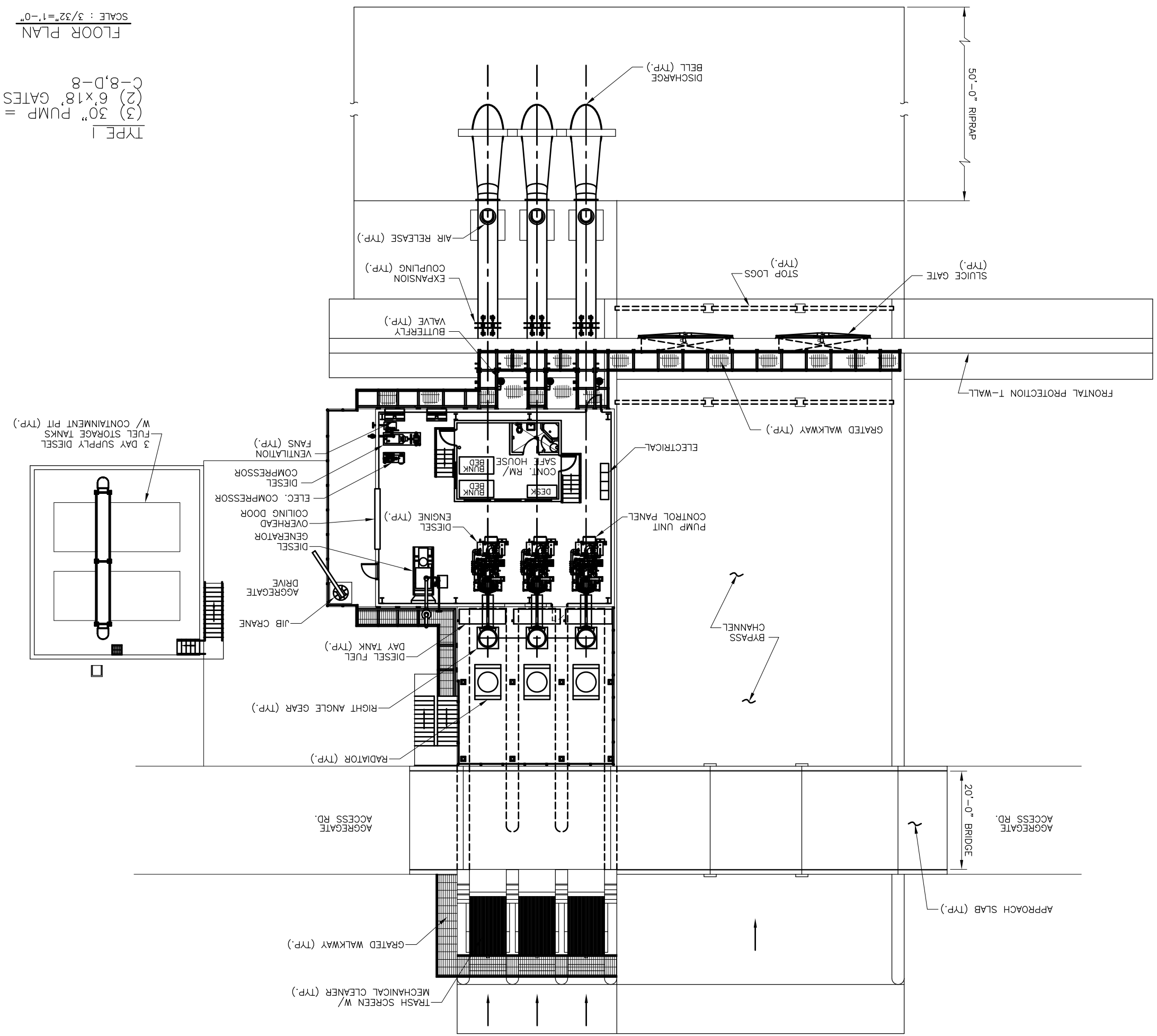
LEVEE PLANS | Alignment C

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 03/2014
SHEET 45 OF 45

NO. | DATE | REVISION DESCRIPTION | BY

PUMP STATION FLOOR PLANS AND ELEVATION VIEWS



TYPE 1
(3) 30" PUMP = 200 CFS
(2) 6'x18' GATES
C-8,D-8

FLOOR PLAN
SCALE : 3/32"=1'-0"

FILE NAME: X.DWG

DATE:

XREF: NONE

NO.	DATE	REVISION DESCRIPTION	BY

DESIGNED HMP DEB/TNP
CHECKED
DETAILED GAD
CHECKED DEB/TNP
DATE 12/2012
SHEET 1 OF 13

BKI
MA GSA

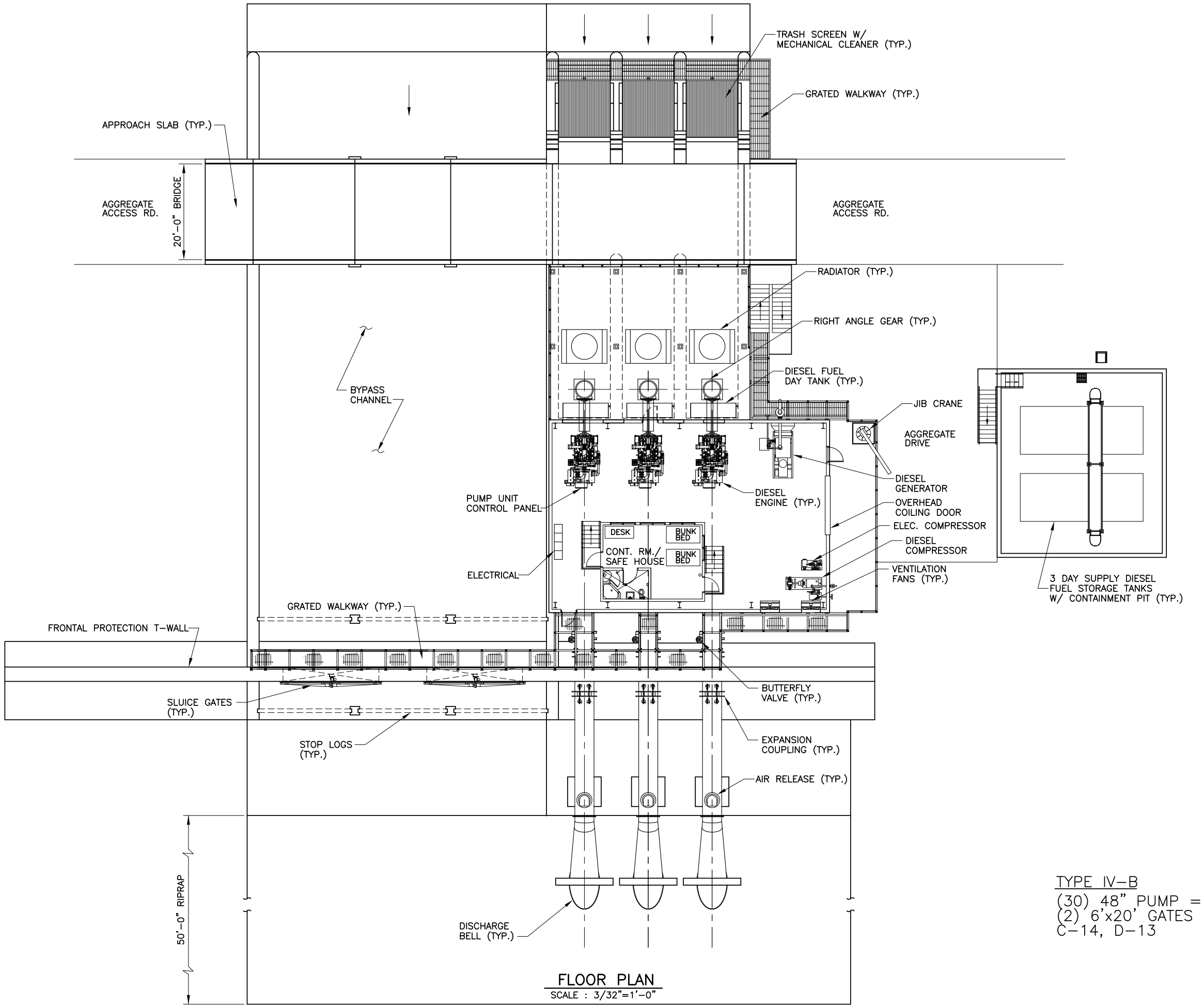
STATE OF LOUISIANA

LEVEE PLANS
FLOOR PLAN

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

USACE PROJECT
FLD PROJECT
PARISH ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES

SHEET NUMBER M1.0



FLOOR PLAN
SCALE : 3/32"=1'-0"

TYPE IV-B
(30) 48" PUMP = 400 CFS
(2) 6'x20' GATES
C-14, D-13

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER	M1.4
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
FLD PROJECT	
USACE PROJECT	

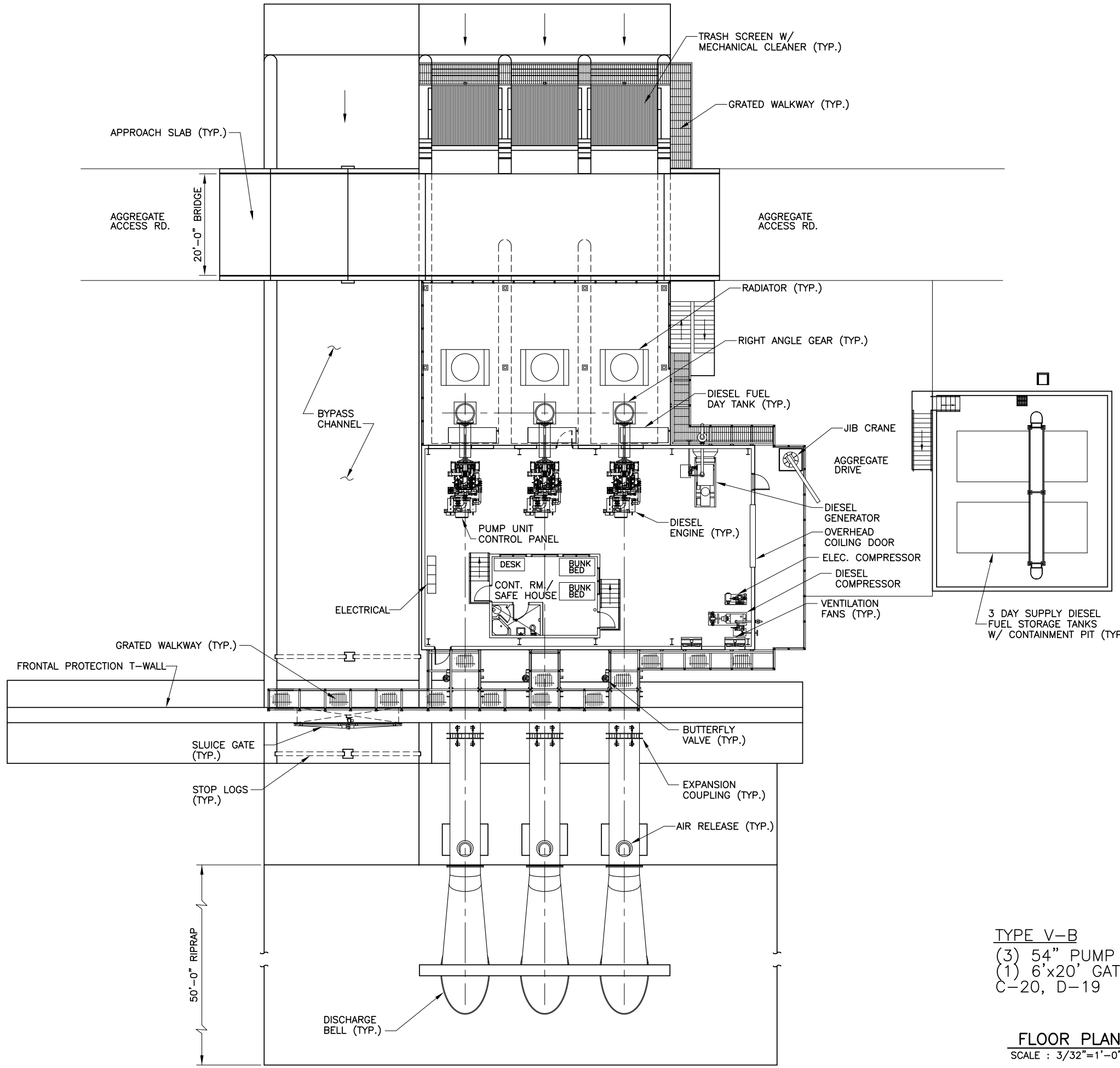
WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: FLOOR PLAN

BKI
MA GSA

DESIGNED	DEB/TNP	DETAILED	GAD
CHECKED	HMP	CHECKED	DEB/TNP
DATE	12/2012	SHEET	5 OF 13

NO.	DATE	REVISION DESCRIPTION	BY



TYPE V-B
(3) 54" PUMP = 460 CFS
(1) 6'x20' GATE
C-20, D-19

FLOOR PLAN
SCALE : 3/32"=1'-0"

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER	M1.6
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
PLD PROJECT	
USACE PROJECT	

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: FLOOR PLAN

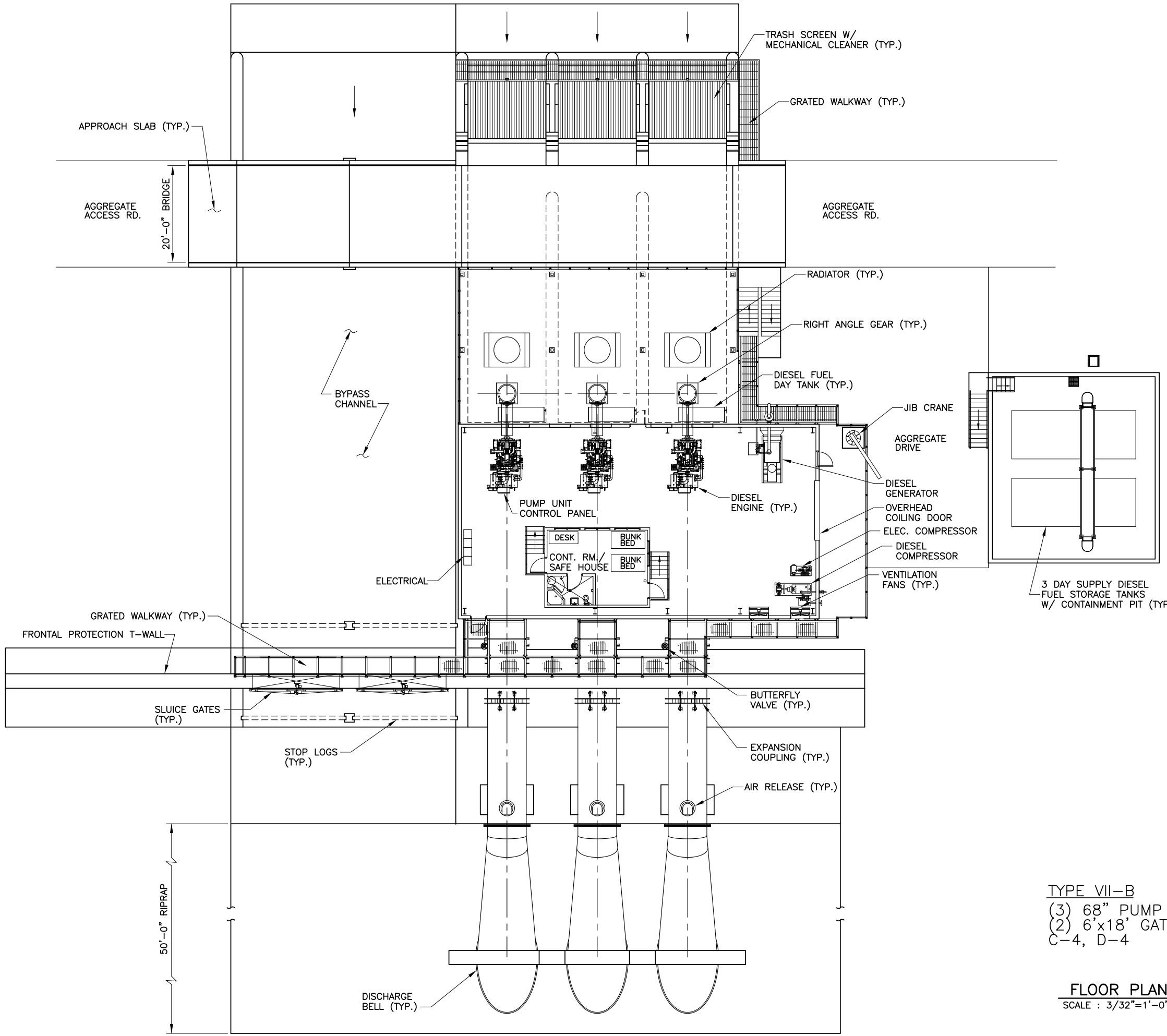
BOARD OF COMMISSIONERS SOUTHEAST LOUISIANA FLOOD PROTECTION AUTHORITY-EAST

STATE OF LOUISIANA

BKI
MA GSA

DESIGNED	DEB/TNP	DETAILED	GAD
CHECKED	HMP	CHECKED	DEB/TNP
DATE	12/2012	SHEET	7 OF 13

NO.	DATE	REVISION DESCRIPTION	BY



TYPE VII-B
(3) 68" PUMP = 1100 CFS
(2) 6'x18' GATES
C-4, D-4

FLOOR PLAN

SCALE : 3/32"=1'-0"

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER	M1.9
PARISH	ST. CHARLES / ST. JOHN THE BAPTIST ST. JAMES / ASCENSION PARISHES
PLD PROJECT	
USACE PROJECT	

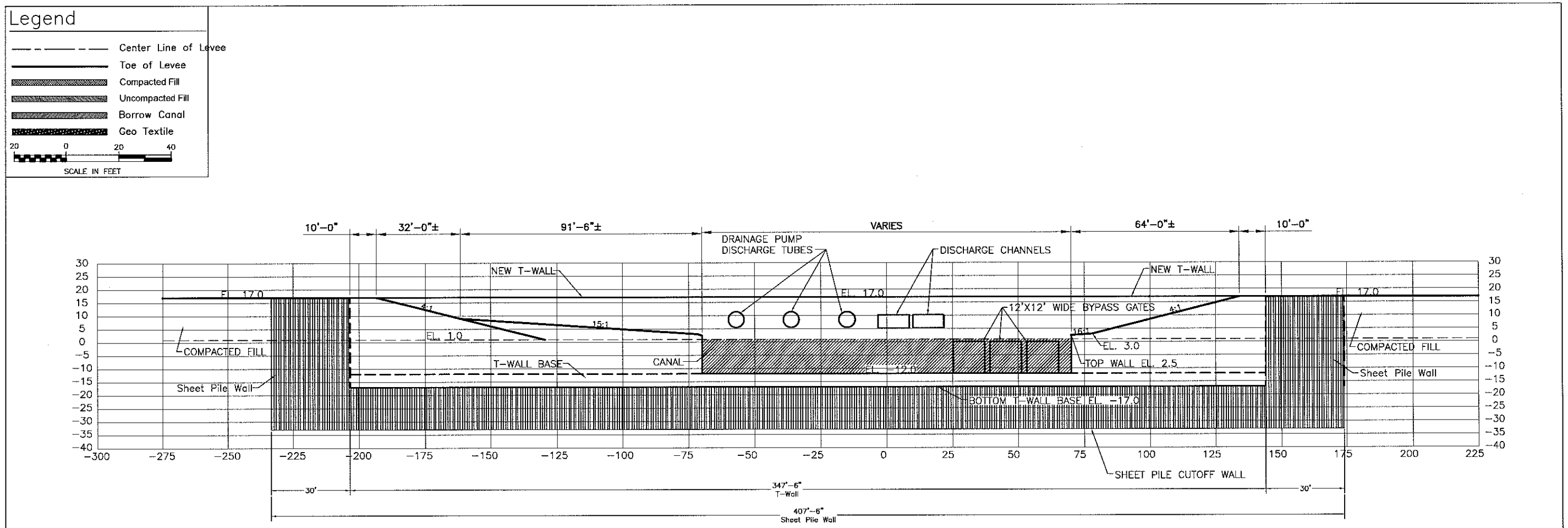
WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LDXE PLANS: FLOOR PLAN

BKI
MA GSA

DESIGNED	DEB/TNP	DETAILED	GAD
CHECKED	HMP	CHECKED	DEB/TNP
DATE	12/2012	SHEET	10 OF 13

NO.	DATE	REVISION DESCRIPTION	BY



ELEVATION OF T-WALL @ PUMP STATION

NOTE:

NUMBER AND SIZE OF PUMP DISCHARGE TUBES, DISCHARGE CHANNELS, AND BYPASS GATES VARIES EACH PUMP STATION LOCATION.

ELEVATION SHOWN FOR TYPICAL FRONTAL PROTECTION T-WALL PLACEMENT. WIDTH VARIES PER PUMP STATION LOCATION.

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER S1.0

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

FLD. PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS

ELEVATION VIEW PUMP STATION

BKI
MA GSA

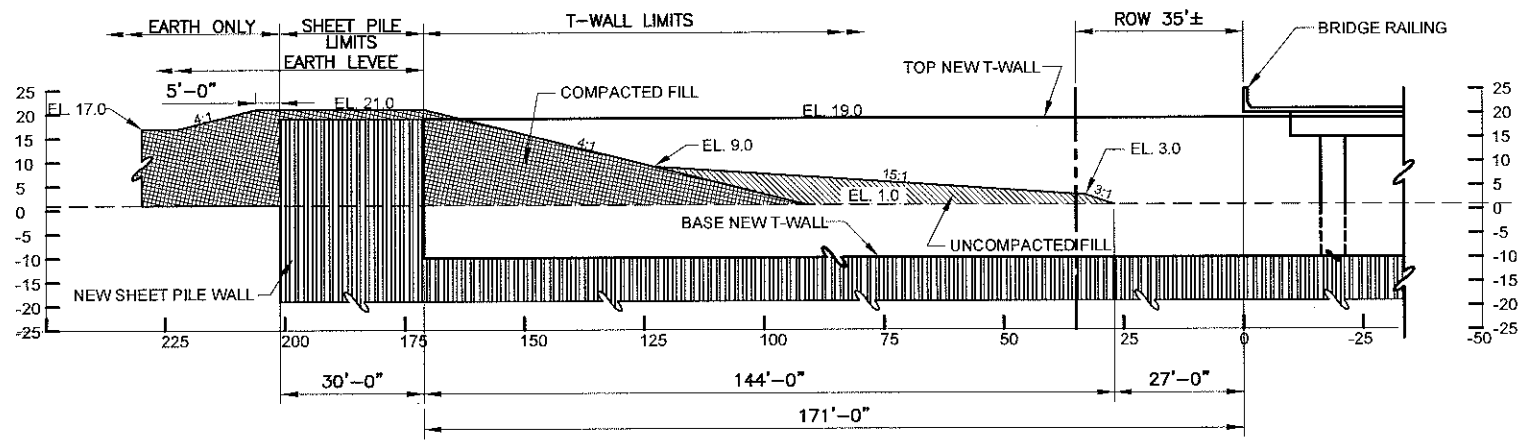
DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 12/2013
SHEET 1 OF 4

NO.	DATE	REVISION DESCRIPTION	BY

Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill
- Uncompacted Fill
- Borrow Canal
- Geo Textile

20 0 20 40
SCALE IN FEET



INTERSTATE T-WALL TYPICAL TRANSITION

NOTE:
LEFT HAND VIEW SHOWN. RIGHT HAND VIEW SYMMETRICAL ABOUT INTERSTATE CENTERLINE (SAME BUT OPPOSITE HAND)

SHEET NUMBER S1.1

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

FLD PROJECT

USACE PROJECT

WEST SHORE - LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: INTERSTATE T-WALL TYPICAL SECTION

BKI
MA GSA

DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 12/2013
SHEET 2 OF 4

NO.	DATE	REVISION DESCRIPTION	BY

XREF: NONE

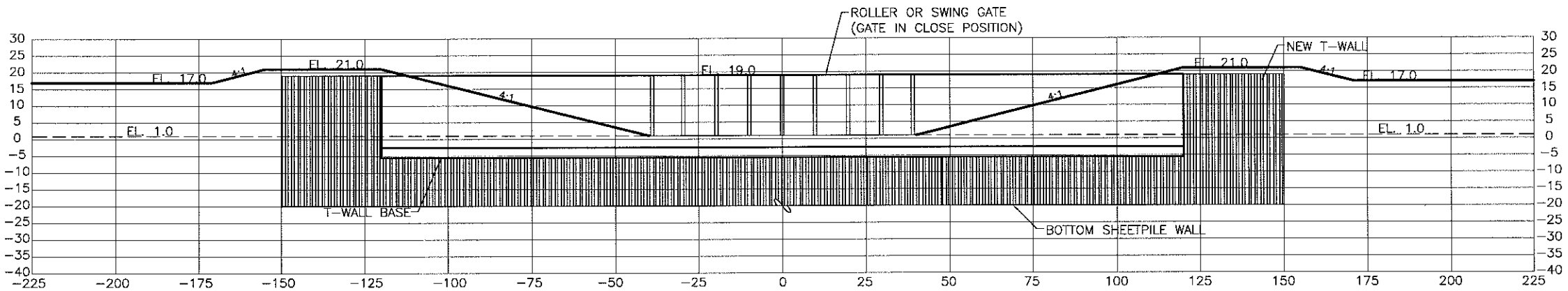
DATE:

FILE NAME: X.DWG

Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill
- Uncompacted Fill
- Borrow Canal
- Geo Textile

20 0 20 40
SCALE IN FEET



ELEVATION VIEW FLOODGATE @ ROADWAY/RAILROAD

NOTE:

GATE WIDTH VARIES FOR INDIVIDUAL CROSSINGS.

XREF: NONE

DATE:

FILE NAME: X.DWG

SHEET NUMBER S1.2

PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES

PLD PROJECT

USACE PROJECT

WEST SHORE – LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION

LEVEE PLANS: FLOODGATE TYPICAL SECTION

BKI
MA GSA

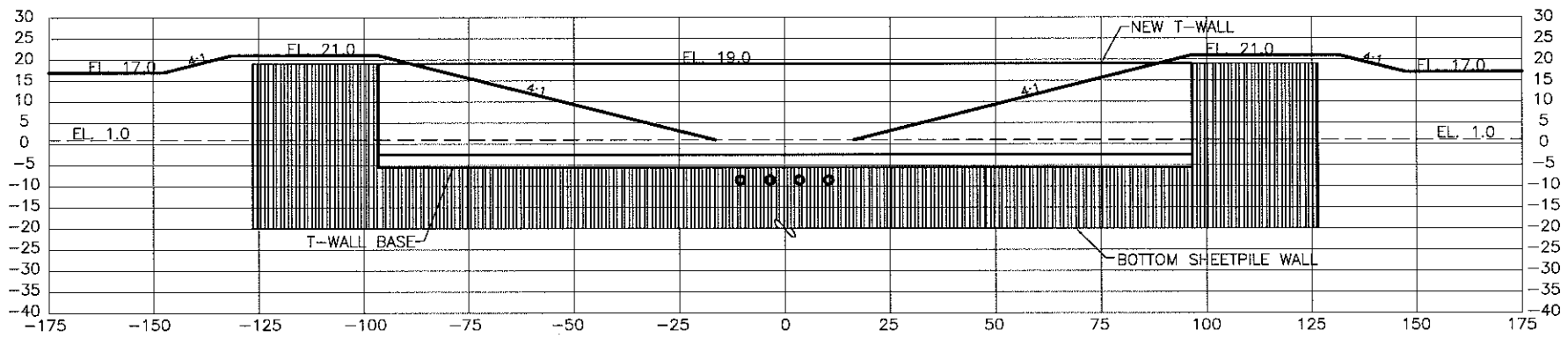
DESIGNED DEB/TNP
CHECKED HMP
DETAILED GAD
CHECKED DEB/TNP
DATE 12/2013
SHEET 3 OF 4

NO.	DATE	REVISION DESCRIPTION	BY

Legend

- Center Line of Levee
- Toe of Levee
- Compacted Fill
- Uncompacted Fill
- Borrow Canal
- Geo Textile

20 0 20 40
SCALE IN FEET



PIPELINE T-WALL CROSSING TYPICAL ELEVATION

NOTE:
NUMBER OF PIPELINES VARY AT INDIVIDUAL CROSSINGS.

XREF: NONE
DATE:
FILE NAME: X.DWG

SHEET NUMBER S1.3
PARISH: ST. CHARLES / ST. JOHN THE BAPTIST / ST. JAMES / ASCENSION PARISHES
FLO PROJECT
USACE PROJECT
WEST SHORE - LAKE PONTCHARTRAIN, LA
HURRICANE PROTECTION PROJECT
PARISHES OF ST. CHARLES, ST. JOHN THE BAPTIST, ST. JAMES, AND ASCENSION
LDWF PLANS
PIPELINE CROSSING TYPICAL SECTION
BKI
MA GSA
DESIGNED DEB/TNP
CHECKED HMP
DETAILED CAD
CHECKED DEB/TNP
DATE 12/2013
SHEET 4 OF 4
NO. DATE REVISION DESCRIPTION BY

WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

REAL ESTATE PLAN
APPENDIX C

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Annex B: Assessment of Non-Federal Sponsor's Acquisition Capability
Annex C: Approval of Non-Material Deviation from Standard Estate Temporary Access Easement & Perpetual Access Easement
Annex D: Approval of Non-Material Deviation from Standard Estate Flood Protection Berm Easement
Annex E: Facility/Utility Relocations
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I. PURPOSE OF THE REAL ESTATE PLAN

This Real Estate Plan (REP) presents the real estate requirements and costs for the Final Integrated Feasibility Report and Environmental Impact Statement for the West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study (WSLP). The information contained herein is tentative in nature and for planning purposes only.

II. PROJECT AUTHORIZATION

Two Congressional resolutions authorize the Study. The first resolution was adopted on July 29, 1971, by the U.S. House of Representatives Committee on Public Works. The resolution reads:

> *"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on Lake Pontchartrain and Vicinity, Louisiana, published as House Document No. 231, 89th Congress, First Session, and other pertinent reports, with a view to determining whether modifications to the recommendations contained therein are advisable at this time, with particular reference to providing additional levees for hurricane protection and flood control in St. John the Baptist Parish and that part of St. Charles Parish west of the Bonnet Carré' Spillway."*

The second resolution was adopted by the U.S. Senate Committee on Public Works on September 20, 1974. The resolution reads:

> *"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on Lake Pontchartrain and Vicinity, Louisiana, published as House Document No. 231, 89th Congress, First Session, and other pertinent reports, with a view to determining whether modifications to the recommendations contained therein are advisable at this time, for hurricane protection and flood control in St. James Parish."*

III. NON-FEDERAL SPONSOR

In 1998, the United States Army Corps of Engineers (USACE) and the Pontchartrain Levee District (PLD) executed a Feasibility Cost Sharing Agreement (FCSA) and Project Study Plan for the Study and was later amended in 2008. PLD has served as the Non-Federal Sponsor (NFS) for the feasibility study conducted under the terms of the FCSA. For purposes of the construction, and operation, maintenance, repair, rehabilitation and replacement (OMRR&R) of the Project, should it be authorized and funded, the Louisiana Coastal Protection and Restoration Authority Board of Louisiana (CPRAB) is required to serve as the NFS.

Pursuant to Louisiana Revised State Statute 49:214.1 (F), the Louisiana Coastal Protection and Restoration Authority of Louisiana was established to serve as the State entity having jurisdiction over flood risk reduction, hurricane storm damage risk reduction and environmental restoration matters in coastal Louisiana. (Note that later enactments by the Louisiana legislature changed CPRA's statutory title to the Louisiana Coastal Protection and Restoration Authority of Louisiana Board (CPRAB). Further references will be to CPRAB, regardless of whether the matter under discussion occurred prior to or

after the date that the Legislature changed the designation to CPRAB.) The Coastal Protection and Restoration Authority (CPRA), formerly entitled the Office of Coastal Protection and Restoration (OCPR) serves, under the guiding authority of CPRAB, as the implementing agency of CPRAB. Among the implementation roles of CPRA is the authority to acquire and hold lands required to implement the mission of CPRAB.

CPRAB is required to provide all lands, easements, and rights-of-way, including those required for relocations, mitigation, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the Project (LERRDs), The Coastal Protection and Restoration Authority (CPRA), is the implementing agency of CPRAB, which has been given the authority to acquire and hold real property interests on behalf of CPRAB.

CPRAB does not have condemnation authority or "quick-take" authority. CPRAB understands that if condemnation should be needed to complete acquisitions for the project, CPRAB will need to partner with a levee district or Parish government which has that authority in order to fulfill its obligation as the NFS. If condemnation authority is required when the Real Estate acquisition process commences, CPRAB will need to enter into a cooperative endeavor agreement or other form of agreement with an entity that has quick-take condemnation authority to have that entity perform any quick-take condemnation measures on behalf of CPRAB that may be necessary for the Project.

Some of the Localized Storm Surge Risk Reduction Project features are voluntary in nature, specifically the home elevations and non-residential flood proofing measures. To participate in this project feature, owners must have clear title. There will be no condemnations for this portion of the Project either for price or to resolve title curative matters.

Assessment of CPRAB's Real Estate Acquisition Capability is attached hereto and incorporated herein by reference as Annex B. CPRAB has been found to be highly capable of performing acquisition of the LERRDS required for the Project.

In accordance with the requirements of ER 405-1-12, Chapter 12, Real Estate Roles & Responsibilities for Civil Works: Cost Shared and Full Federal Projects, CPRAB has been notified in writing of the risks of acquiring LERRDs before execution of the PPA.

IV. PROJECT DESCRIPTION AND LOCATION

The purpose of the study is to assess the need for hurricane and storm damage risk reduction measures in portions of St. Charles, St. John the Baptist, and St. James Parishes, Louisiana.

The recommended structural and Localized Storm Surge Risk Reduction measures of the Project are located within portions of St. Charles, St. John the Baptist, and St. James Parishes, Louisiana, within an area bounded on the east by the Bonnet Carré Spillway upper guide levee, on the north by Lakes Pontchartrain and Maurepas, on the west by the Ascension Parish and St. James Parish line, and on the south by the Mississippi River Levee (MRL) (Figure 1). Additionally, some of the mitigation features are located in Ascension and Livingston Parishes, Louisiana.

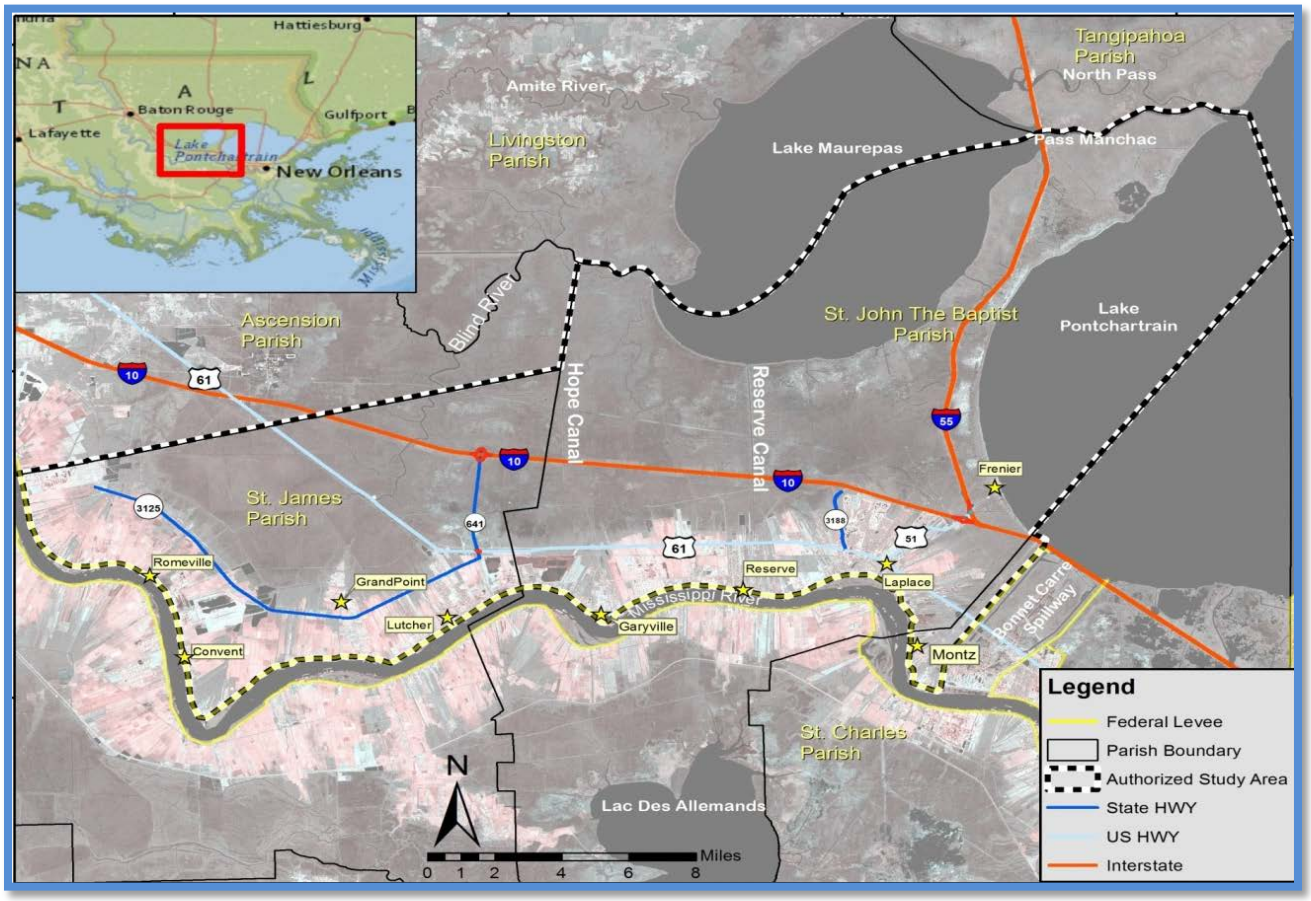


Figure 1: Study Area

The recommended hurricane storm damage risk reduction plan for the WSLP study includes the construction of an 18.27-mile (96,481 feet) levee system around the communities of Montz, Laplace, Reserve and Garyville. The recommended hurricane storm damage risk reduction plan also includes the construction of Localized Storm Surge Risk Reduction components in St. James Parish. The Project mitigation plan contains six components to provide required compensation for habitat impacts (further described in Section A-1 below). An overview of the recommended plan is shown in Annex A. This Report addresses structural and Localized Storm Surge Risk Reduction features of the recommended plan separately below.

A. STRUCTURAL HURRICANE STORM DAMAGE RISK REDUCTION PROJECT FEATURES

The structural hurricane storm damage risk reduction project features of the recommended plan are outlined in Figure 2 below. Additional maps of all features are located in Annex A of this Real Estate Plan.

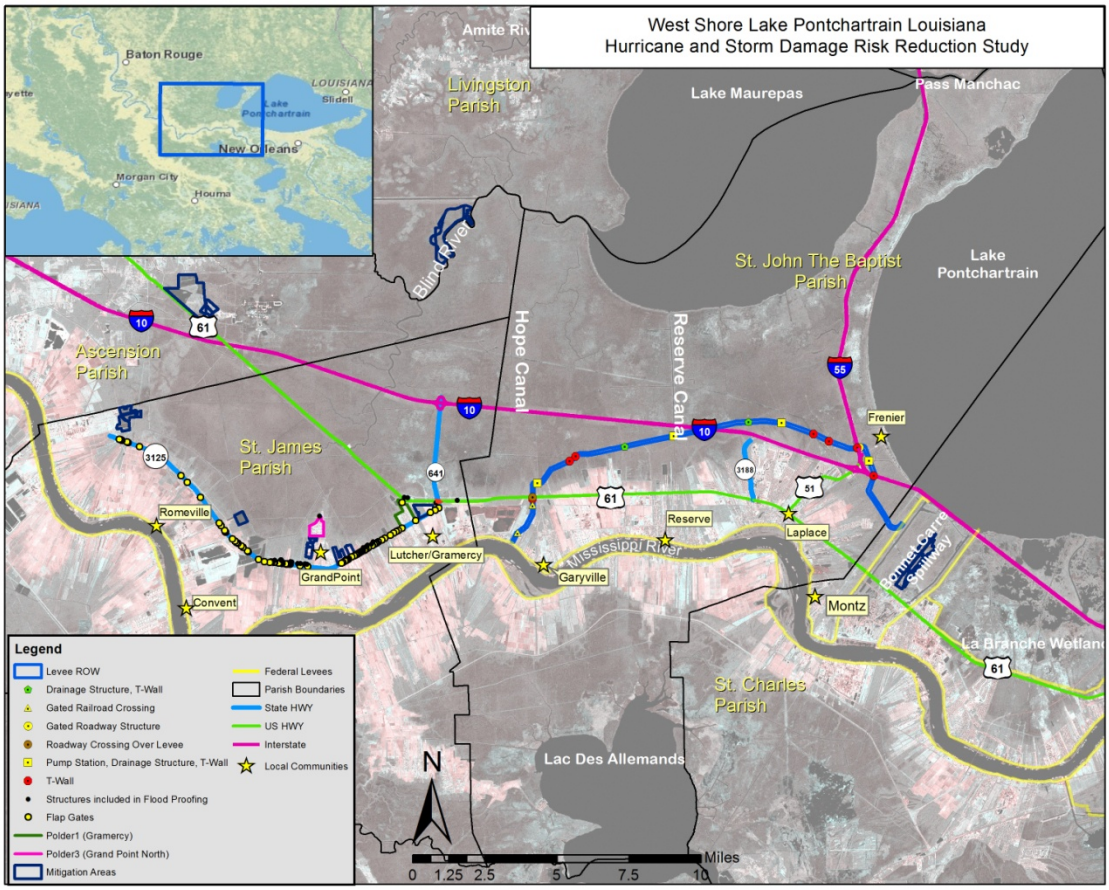


Figure 2: Recommended Plan – Structural Hurricane Storm Damage Risk Reduction Features (See Annex A for larger map)

Levee System

The levee system would begin at the upper guide levee of the Bonnet Carré Spillway, north of an underground utility pipeline right of way and US-61. The levee would head northwest paralleling the pipeline right of way and pass under I-10. Past I-10 the levee would enclose the I-10 and I-55 interchange and cross US-51. It would then track north of I-10 and a pipeline transmission corridor. Past the Belle Terre/I-10 exit, the levee would pass back under I-10 and parallel the pipeline corridor through wetlands until it crosses Hope Canal. The levee would then turn south; cross the pipeline transmission corridor and then extend to the Mississippi River Levee System (MRL).

The system would consist of earthen levees, floodwalls (T-Walls), floodgates, drainage canals, a flood-side ditch for hydraulic connectivity for wetlands north and south of the system, drainage structures and pump stations along the alignment, and mitigation measures (See Figure 5-2, Chapter 5 of the main report). Structures through the levee would be built to the 2070 intermediate RSLR condition, to prevent costly future retrofits required for anticipated changing sea levels.

Starting at the upper guide levee of the Bonnet Carré Spillway and heading west along the levee the project would construct a 646 linear foot (hereafter "LF") T-Wall to pass under the existing I-10

overpass. Past this point, an 1100 c.f.s. pump station with three 68" outfalls would be built at Montz Canal, which is very near the I-55 northbound entrance ramp. The pump station, when the system is closed, would mainly remove rainwater flows from the Woodland, the River Forest, and the Prescott Canals. A 267 LF T-Wall and two 6' x 18' x 27' gated drainage structures would also be constructed at this location. This location and all locations with pump stations or drainage structures would be connected to a flood side ditch and a protected side canal that would parallel the entire levee length. The canals would be used to maintain the existing connection between swamps located inside and outside of the levee system. The protected side canal would also serve as a redundancy connection if one of the pump stations failed during an event.

Past the Montz Canal, at the location of US-51, a 188 LF gated structure would be placed through the levee. Directly west of US-51, a 247 LF T-Wall would cross under I-55. The levee would continue to the west until the levee intercepts the first pipeline crossings near Vicknair Canal. Two sections of T-Walls would be used for these pipeline crossing, a 550 LF T-Wall, and a 623 LF T-Wall. Half of the 35 required pipeline relocations would be at these two locations. For purposes of this report, it is expected that all of the pipeline relocations would be compensable. Relocations are expected to take place in the proposed levee right of way (ROW) or existing pipeline ROW. Determination of the compensability of these relocations will be determined during the engineering and design phase of this project if it is authorized.

Continuing west, the levee would then cross Ridgefield Canal. Ridgefield Canal is located between the I-10 LADOT weigh station and the I-10/LA 3188 exit. A 200 c.f.s. pump station with three 30" outfalls would be built at Ridgefield Canal. The pump station, when the system is closed, would mainly remove rainfall flows from Laplace Plantation, Perriloux, Ridgefield, Tebo and Vicknair canals. A 244 LF T-Wall and with two 6' x 18' x 267' gated drainage structures would also be constructed at this location.

West of the Ridgefield Canal, a 100 LF floodgate would be constructed at the location of the Perriloux Canal to allow rainfall flows to flow through the levee when the system is not closed.

West of the I-10/LA 3188 exit, a 247 LF T-Wall would be constructed to cross back under I-10. The levee would continue to parallel the pipeline corridor through wetlands until it reaches Reserve canal. A 400 c.f.s. pump station with three 48" outfalls would be built at this location. The structure at this location would also include two 6' x 20' x 25' drainage structure with a boat bay and 335 LF of T-Walls. Small boats would still be able to pass through the drainage structure when the system is open.

Continuing west, the levee would then cross Mississippi Bayou. A 6' x 10' x 25' drainage structure with a 267 LF T-Wall would be constructed at this location.

The levee would then continue west toward Hope Canal, until it reaches the next major set of pipeline crossings. All of the remaining major pipeline relocations would be at this location. Two sections of T-Walls would be used for these pipeline crossing, a 400 LF T-Wall, and a 300 LF T-Wall. As with the other pipelines, for purposes of this report, it is expected that the pipeline relocations would be compensable. Relocations are expected to take place in the proposed levee ROW or existing pipeline ROW at this location. Determination of the compensability of these relocations will be determined during the engineering and design phase of this project if it is authorized.

The levee would then continue west until it reaches Hope Canal. A 450 c.f.s pump station with three 54" outfalls would be constructed at this location. Currently the design and cost includes a 6' x 20' x 25' drainage structure and a 247 LF T-Wall, but the Hope Canal location is also the same location of the

State of Louisiana's proposed Mississippi Reintroduction into Maurepas Swamp diversion. The WSLP project has been coordinating activities between the project delivery teams, but for the purposes of the WSLP feasibility design, we do not consider the diversion project as a future landscape feature, since the State has not identified funding and has filed an incomplete permit application to the USACE for construction of the project. The USACE would continue to monitor the status of the diversion project. The team expects that if the diversion project moves forward it would be constructed on the flood side of the levee and would parallel the levee from Hope Canal to the MRL.

When the levee turns south, past Hope Canal to tie into the MRL, the levee would cross US-61, a pipeline ROW, and two railroad tracks. US-61 would be raised to hump over the levee at the crossing point. The pipeline crossing would include a 301 LF T-Wall, while the two railroad crossings would include a 150 LF gate structure and a 50 LF gate structure.

In all, there would be a total of 5,001 LF of T-Walls, 4 pump stations with associated drainage structures, 2 drainage structures, one gated road crossing, and 2 gated railroad crossings.

4.69 miles of the upper guide levee of the Bonnet Carré Spillway from the spillway control structure to the WSLP tie-in point would be included in the WSLP levee system, but there would be no construction activities associated with this Bonnet Carré levee. Existing levee heights are high enough to prevent 1% probability storm surge from entering the WSLP system during storms. The construction of the WSLP tie-in point would be to set to elevation of 15 ft NAVD 88 while the current upper guide levee elevation is 15.5 ft NAVD 88. The upper guide levee heights in the future would be monitored to determine if sections of the Bonnet Carré Spillway levee would need future lifts to prevent overtopping of storm surges into the WSLP system.

The 50 ft and 100 ft right of ways adjacent to the levee footprints would be used for future levee lifts. The levee would be lifted five times over the period of evaluation. The first two lifts would be used to obtain a 1% probability storm level of risk reduction system in 2020. Additional levee lifts to maintain a 1% probability storm level of risk reduction system would take place in years 2030, 2045, and in 2060.

9,000,000 cubic yards (cy) of compacted fill and un-compacted fill would be required to create and maintain the levee over the period of evaluation. A portion of the initial fill material, if suitable, would be obtained from the canals and ditch, approximately 1,678,000 cy. Borings indicate that the top 4 ft of the cross section of these features would not be suitable as levee fill material. The top 4 ft of material; approximately 1,685,000 cy, would be used beneficially at mitigation plan sites. The remaining fill for the levee, approximately 7,322,000 cy, would be obtained from the Bonnet Carré Spillway.

1) LANDS, EASEMENTS & RIGHTS-OF-WAY

The recommended structural plan alignment primarily impacts wetlands. A large portion of the alignment will be located on state-owned lands. An estimated 34 private landowners will be affected by the structural plan features.

The Project Delivery Team (PDT) worked to locate the ROW limits for the proposed levee sections to coincide with existing ROW from highways, pipelines, etc. in order to avoid remainder parcels that were non-functional to the landowners.

The total ROW required for the structural feature will be 1,235 acres (not including temporary access/work area easements as described below). A standard Perpetual Flood Protection Levee Easement will be acquired over 700 acres for the construction of the levee and T-walls, as well as the ROW necessary for the gates and underground piles associated with T-walls. A standard Drainage Ditch Easement will be acquired over 519 acres for two canals. For the pump stations, 9 acres will be acquired in Fee (Excluding Minerals).

Temporary access and work areas would be on existing roadways or developed areas of the project area. A standard Temporary Work Area Easement will be acquired for staging areas located on private lands. Mitigation areas will be acquired in Fee, Excluding Minerals. A non-material deviation will be made to the standard Road Easement to provide for the temporary, non-exclusive rights necessary for temporary access routes (refer to Annex C). For the road on top of the levee, which is for maintenance and not public access, a standard Flood Protection Levee Easement will be acquired.

The levee/floodwall feature of the project encloses a significant acreage of wetlands. These areas are continuously flooded areas. The District performed analysis of the water elevations in these areas, "with" and "without project" (as discussed in Section 4.1.1 of the feasibility report). Results of this analysis indicated that the topographical features of the wetland areas will remain relatively similar after the levee is constructed as they are today. As a result of this analysis, District Real Estate determined that the lands have not been damaged and no real estate rights have been taken from these landowners; therefore, no realty interests need to be acquired over the wetlands.

The District also performed analysis of the potential of adverse impacts associated with the use of the base flood plain, specifically the potential for induced development. Results of this analysis are discussed in Section 6.18 of the feasibility report. Based on this analysis, District Real Estate determined that it is highly unlikely that these areas will be developed in the future. The wetlands will remain inundated due to frequent flooding as a result of rainfall events. The cost of future development is likely to remain high, due to the amount of fill material that would be required in order to raise the elevation of the land to an acceptable level for development. There are existing available upland areas for development that are outside the project area, which could be developed at a much lower cost. In addition, this area would remain jurisdictional wetlands which would require compensatory mitigation for any wetland loss.

Additionally, the NFS has an obligation relating to the operation of the project, specifically in regards to the pump station capacities, to prevent encroachments that would impact the utility of the project. If induced development would change the hydrology of the flood plain, project features such as pump stations could be impacted. The NFS would have an obligation to comply with flood plain management requirements. Filling of wetland areas thru development could impact the function of the pump stations, and the NFS would have a responsibility to ensure that operation of the project features is maintained.

As a result of this analysis, no acquisition of realty interest is proposed over these enclosed wetland areas.

Table 1 below demonstrates the acreage, ownerships affected, and proposed estate for each project feature. The total estimated number of affected private landowners is 34.

Table 1: Acreage

Project Feature	# Acres	# Tracts/Ownerships	Proposed Estate
Access	49	24*	Temporary Access Easement/Perpetual Access Easement
Staging	12	12	Temporary Work Area Easement
Levee/T-wall	700	10	Perpetual Flood Protection Levee Easement
Conveyance Canal	519	10*	Drainage Ditch Easement
Gates	5	5*	Perpetual Flood Protection Levee Easement
Pump Stations	9	9*	Fee, Excluding Minerals
Mitigation	1,682	12	Fee, Excluding Minerals
Borrow	**	10**	Temporary Work Area Easement

**Landowners shown with an asterisk are assumed to be the same landowners that will be affected by the levee/t-wall features. Total estimated landowners affected by the structural features are 34.*
***Refer to discussion of Borrow within LERRDs descriptions below.*

ACCESS

Access for construction of the Project will be directly from the ROW of the Upper Guide Levee, US-51, US-61 and La. Hwy 44. Additional ROW will be required on private lands, affecting an estimated 12 private landowners (these owners are also impacted by the levee construction, staging, and/or mitigation). A Temporary Access Easement will be acquired for this portion of the Project.

Monitoring of some mitigation features may require perpetual access. Access area locations will be refined during PED; at this time, it is assumed that additional right of way will be acquired from 12 owners (these owners are also impacted by the levee construction, staging, and/or mitigation). A Perpetual Access Easement may be acquired for this portion of the Project. These estates are further discussed in Section A-3 below.

STAGING

The majority of staging areas for construction of this Project will be located within the ROW for the levee footprint or existing ROW. Additional ROW will be required within a few reaches. An estimated total of 12 private landowners will be affected. A standard Temporary Work Area Easement will be acquired for the additional ROW required for this portion of the Project.

BORROW

Borrow material for the Project would come from portions of the Bonnet Carré Spillway that area owned in fee by the Federal Government. In addition, suitable material excavated for construction of the drainage canal will be used for levee construction and mitigation. Borrow material for the project which is excavated from the construction of the drainage

canal will require acquisition of a Temporary Work Area Easement for borrow (in addition to the Drainage Ditch Easement). It is unknown at this time how many acres will be utilized for borrow within the drainage canal, or how many landowners will be affected (estimated maximum of 10 landowners).

MITIGATION

Details of the Project mitigation plan are outlined in Appendix A, Annex K of the Final Integrated Feasibility Report and Environmental Impact Statement. The plan contains six components to provide required compensation for habitat impacts. Below is a synopsis of the features; maps of these areas are included in Annex A of this REP:

- The first feature would mitigate for Bottomland Hardwood impacts through the construction of a project in the Bonnet Carré Spillway.
- Five features will collectively mitigate for swamp impacts. These features include purchasing credits from a mitigation bank and constructing five additional restoration projects:

  Blind River Swamp Restoration – Key parts of the restoration plan include planting native swamp canopy and midstory species on 1,040 acres, as well as installation of nutria guards on planted trees to protect against herbivore tree loss. A total of 1,040 acres will be required for this project feature, of which 1,010 acres are located on lands owned by the State of Louisiana and 30 acres are located on privately owned lands. This project feature is located in Livingston Parish. A total of 30 acres will be acquired in Fee (Excluding Minerals) for this feature. For the lands owned by the State of Louisiana, the NFS will provide the interests necessary for the project, and will receive credit for the lands it provides to the project.

  Bonnet Carré Swamp Restoration – This Project feature, located in St. Charles Parish, would create 310 acres of swamp using beneficial placement of dredged material and tree plantings. These lands are owned in fee by the Federal Government, and USACE is the managing agency over these lands.

  Maurepas Crawfish Ponds Swamp Restoration – This Project feature, located in Ascension Parish, would restore 1,161 acres of swamp through land grading and tree plantings. A total of 1,161 acres of privately owned lands will be acquired in Fee (Excluding Minerals) for this feature.

  Lutcher Polder Farmland Swamp Restoration – This Project feature, located in St. James Parish, would restore 348 acres of swamp through land grading and tree plantings. A total of 348 acres of privately owned lands will be acquired in Fee (Excluding Minerals) for this feature.

2) NON-FEDERAL SPONSOR OWNED LERRDs

CPRAB, a state agency, is required to provide all lands, easements, and rights-of-way, relocations, disposal and borrow areas (LERRDs), including those required for mitigation, and the disposal of dredged or excavated material. Portions of the levee footprint and

potential mitigation sites lie within lands owned by the State of Louisiana under the jurisdiction of various State agencies. The CPRAB will provide the necessary interests for the project, and will receive credit for the lands it provides to the project. CPRAB will be required to obtain the necessary agreements from any non-federal government entity, and provide Right of Entry to the Government.

3) ESTATES

The following standard estates will be required for the Project:

FEE EXCLUDING MINERALS (With Restriction on Use of the Surface)

The fee simple title to the land, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; excepting and excluding all oil and gas, in and under said land and all appurtenant rights for the exploration, development, production and removal of said oil and gas, but without the right to enter upon or over the surface of said land for the for the purpose of exploration, development, production and removal therefrom of said oil and gas.

This estate will be acquired for areas where pump stations will be constructed, as well as for areas to be acquired for mitigation. The District is of the opinion that this estate provides all the rights necessary for the project as well as protects the integrity of the project features. There are no active oil and gas wells within the project area, but it is unknown whether there are marketable minerals under the surface of the impacted properties. The District recognizes that if oil or gas were discovered, there is a possibility that the owner could develop those minerals through directional drilling. The District consulted with Louisiana Geological Survey regarding the feasibility of this process and potential impact to the surface of the project area. Because of depths involved in the drilling process (approximately 5,000 feet below the surface), directional drilling for minerals beneath the surface will have no impact on the surface. For a project of this size, directional drilling would be feasible. Given the acreages of the mitigation sites proposed for the project, the District verified that drilling to targets laterally can be achieved from up to 6 miles away. Extraction of minerals by existing conventional means would not impact the integrity of the project features.

Furthermore, the District believes that landowners may be less willing to sell the property if the mineral rights are acquired by the NFS. This in turn would require acquisition through condemnation which would increase the cost of the project. For planning purposes, we assume that the additional cost would be approximately $10,000 in labor for each tract that requires condemnation, to include title, curative work, preparation of condemnation assembly and assistance to Justice Department once the condemnation case is filed.

The risks to the project of not acquiring minerals are negligible; therefore, it is in the best interest of the Government to acquire Fee Excluding Minerals (with Restriction on Use of the Surface).

FLOOD PROTECTION LEVEE EASEMENT

A perpetual and assignable right and easement in (the land described in Schedule A) (Tracts Nos, ____, ____ and ____) to construct, maintain, repair, operate, patrol and replace a flood protection (levee) (floodwall)(gate closure) (sandbag closure), including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

This estate will be acquired for areas where the levee, floodwall, gates, and the underground piles will be constructed. The underground piles are considered an appurtenance of the floodwall. This easement prohibits any use of the surface or subsurface which interferes with the project.

DRAINAGE DITCH EASEMENT

A perpetual and assignable easement and right-of-way in, over and across (the land described in Schedule A) (Tracts Nos. ____, ____ and _____) to construct, maintain, repair, operate, patrol and replace a drainage ditch, reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

A drainage ditch will be constructed adjacent to the levee in order to provide drainage to protected areas. Portions of the excavated material will be used to construct the levee and the mitigation sites.

TEMPORARY WORK AREA EASEMENT

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____), for a period not to exceed _____, beginning with date possession of the land is granted to the Coastal Protection and Restoration Authority Board (CPRAB), for use by the CPRAB and the United States of America, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

This estate will be acquired over areas to be used for staging.

TEMPORARY ACCESS EASEMENT (Non-Material Deviation from Standard Estate)

A non-exclusive and assignable temporary easement for a period not to exceed _____years beginning with date possession of the land is granted to the Coastal Protection and Restoration Authority Board (CPRAB), for use by the CPRAB and the United States of America, its representatives, agents, and contractors as an access route and/or right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____); together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way, reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired, including the right to cross over the right-of-way as access to their adjoining land; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

This estate will be acquired over existing privately owned roads that are used for access to the project during construction. The estate with approval signatures by the Chief of Real Estate for the Temporary Access Easement (Non-Material Deviation from Standard Estate) is attached as Annex C.

PERPETUAL ACCESS EASEMENT (Non-Material Deviation from Standard Estate)

A perpetual non-exclusive and assignable easement for use by the Coastal Protection and Restoration Authority Board (CPRAB) and the United States of America, its representatives, agents, and contractors as an access route and/or right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____); together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way, reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired, including the right to cross over the right-of-way as access to their adjoining land; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

This estate will be acquired over certain existing privately owned roads to allow for access to the project for operation and maintenance. The estate with approval signatures by the Chief of Real Estate for the Perpetual Access Easement (Non-Material Deviation from Standard Estate) is included within Annex C.

B. LOCALIZED STORM SURGE RISK REDUCTION PROJECT FEATURES

The Localized Storm Surge Risk Reduction Project features are outlined in Figure 3 below. Additional maps of all features are located in Annex A of this Real Estate Plan.

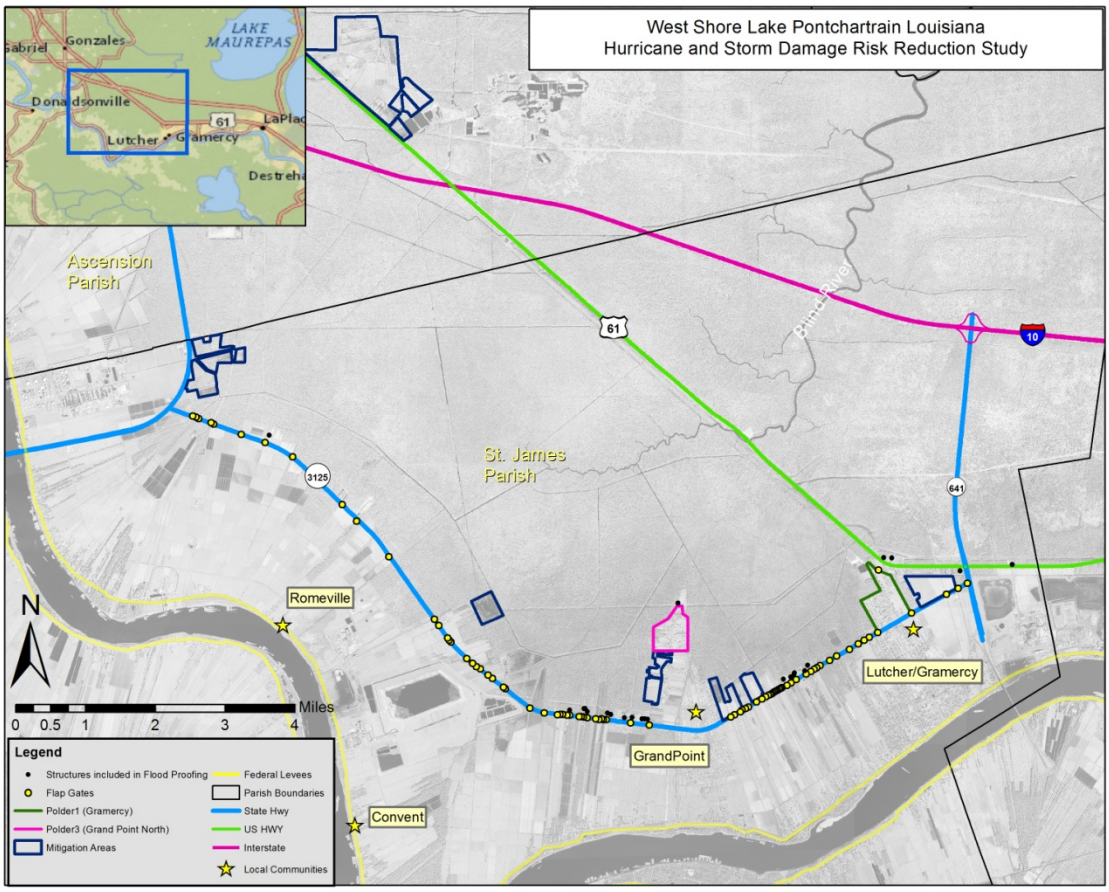


Figure 3: Recommended Plan – Localized Storm Surge Risk Reduction Features
(See Annex A for larger map)

<u>Polder 1 (Gramercy Berm):</u>

In the Gramercy area, north of Hwy 3125, a 10,100 LF berm would be built to provide risk reduction to 275 structures, herein referred to as "**Polder 1 (Gramercy Berm)**." The berm would be constructed to a +6.5' NAVD 88 elevation. The berm in 2020 would provide risk reduction above the 1% AEP storm stages. Storm stages in St. James Parish are below +6.5' NAVD 88 elevation in 2020. As discussed in Chapter 3, in the future, the berm's effectiveness depends on the actual rate of RSLR.

The berm would parallel both sides of Hwy 20, and parallel the railroad track along US-61 (Airline Highway). To the south, the berm would tie into Hwy 3125 to close off the system. Hwy 3125 is key feature for all of the Localized Storm Surge Risk Reduction features. The entire roadway is above a 6.5 ' NAVD 88 elevation and will be used as a tie in point for the berm. The design of the berm is based on a

4' wide crown and 3:1 side slopes. Using local LIDAR data it was assumed that the existing ground elevation under the berm would be at an elevation of approximately 4.3 ft NAVDD88. Using this assumption, the proposed berm would have an average height of 2.2 ft with an average width of 18 ft, and require 237,000 cy of compacted fill for construction. The berm would also include two floodgates to allow existing drainage to flow through the berm when not under surge events. A pump system to operate and remove rainwaters during tropical/hurricane storm events will be included in the features. The pump system will be approximately 217 cfs. The berm would be placed in a location so as not to interfere with existing local drainage.
In reviewing the berm footprint, there is a risk of affecting approximately 0.29 acres of forested wetlands. Attempts would be made to avoid these areas during construction. Due to the current uncertainty in avoiding these areas, we have included cost for mitigating for these forested wetlands in the total construction cost.

Polder 3 (Grand Point North):

Polder 3 (Grand Point North) would provide risk reduction to 71 structures. The berm would be a complete ring around the structures in the northern portion of Grand Point, near the Grandpoint Boat Launch. The berm would be 10,400 LF, and would include a 4' wide crown and 3:1 side slopes. The berm would be constructed to a 6.5' NAVD 88 elevation. Initially, in 2020 the berm would provide risk reduction above the 1% AEP storm stages. Storm stages St. James Parish are below a 6.5‘ NAVD 88 elevation in 2020. Future level of risk reduction is dependent on the actual rate of RSLR.

Using local LIDAR data it was assumed that the existing ground elevation under the berm would be approximately 4‘ NAVD 88. Using this assumption, the proposed berm would have an average height of 2.5 ft with an average width of 20 ft, and require 286,800 cy of compacted fill for construction. The berm would also include one floodgate to allow existing drainage to flow through the berm when not under surge events. A pump system to operate and remove rain waters during tropical/hurricane storm events will be included in the features. The pump system will be approximately 140 cfs. The berm would be placed in a location so as not to interfere with existing local drainage. The berm would also be placed very near the edge of the property owners’ parcels where feasible. This would minimize the loss of use of any property.

In reviewing, the berm footprint there is a risk of affecting approximately 0.81 acres of forested wetlands. Attempts would be made to avoid these areas during construction. Due to the current uncertainty in avoiding these areas, we have included cost for mitigating for these forested wetlands in the total construction cost.

Hurricane Storm Damage Risk Reduction Under LA Highway 3125:

In addition to the berms north of Hwy 3125, the recommended plan is to use 13 miles of Hwy 3125 and its existing foundation as a Localized Storm Surge Risk Reduction feature. The roadway elevation is above a 6.5' NAVD 88 elevation. Currently, the 1% AEP storm stages in 2020 flow through the culverts under the roadway in the opposite direction from natural drainage. By closing off the culverts with one-way flap gates and a drainage canal with a floodgate during surge events, the plan would provide risk reduction to 19,500 acres and 4,295 structures south of Hwy 3125. Although there are a limited number of structures that are impacted by the 1% AEP storm surge stages, this closure reduces the risk of a large portion of the parish’s critical sugarcane crops from flooding from this type of storm surge event. If in the future, the Parish makes improvements to Hwy 3125, any additional height added to the entire

highway could add to the structures risk reduction level behind the highway. Due to the fact that the roadway is being used as hurricane storm damage risk reduction feature the NFS will be required to maintain the system's initial level of risk reduction. This includes the berm tie in points to the roadway and 13 miles of the roadway. If the roadway requires maintenance and would be degraded below its original elevation, the work should take place outside of hurricane season. If it is not possible to workout side of hurricane season, interim storm surge risk measures should be set up to maintain the original level of risk reduction provided by the roadway.

The recommended plan includes 145 flap gated closures, two floodgates and two small berms (Noranda and Uncle Sam). The Noranda berm ties the highway into high ground east of Gramercy. The Uncle Sam berm divides the developed area behind Hwy 3125 from an area that is primarily agricultural land. By dividing these two areas, the local community can focus its reduction effort in the future. Future improvements could be focused on sections of the highway that have structures behind the highway, approximately 7 miles vs. 13 miles. The area west of the Uncle Sam berm includes an area of 8,175 acres, but only includes one structure that has a first floor elevation below the 1% the AEP storm stages. The total length of the berms is approximately 645 LF.

Due to the nature of the flooding south of Hwy 3125, it is assumed that the 19,500 acres would have ample storage capacity to hold any rainfall during the surge events. Even if some acres of crops are flooded from rainfall, it would be much less than if the surge was allowed to flow under Hwy 3125.

Remaining Structures in St. James Parish:

The recommended plan addresses the flooding of structures located outside of the polders north of Hwy 3125. Eighty structures were evaluated outside of the berms. Only 23 of the 80 structures have a first floor elevation less than the 1% AEP storm stages in 2020. Based on this evaluation the recommended plan includes 14 residential structures that would be raised to the stage associated with the 2070 1% (100-year) AEP event; 4 non-residential structures would be flood proofed to 3 feet above the ground elevation; and smaller berms would be constructed for 5 light industrial/warehouse facilities. The 14 residential structures are being raised to the 2070 height because it is more cost effective to raise a home once.

1) LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS, & DISPOSALS

Polders 1 and 3 will primarily impact developed residential lands, affecting an estimated 106 landowners. It is the intent of the Project to place the berms as close as possible to property lines in order to minimize possible severance damages to properties. No relocation of utility lines will be necessary for this portion of the work because utilities are located along the public streets. The polder entitled "Hurricane Storm Damage Risk Reduction Under LA Highway 3125" includes 145 flap gate culvert closures, 2 flood gates, and 2 small berms (Noranda and Uncle Sam). The flap gates and flood gates will be constructed on lands owned by the State of Louisiana. Noranda will be constructed on lands owned in part by the State of Louisiana, as well as 1 private landowner. Uncle Sam will be constructed on primarily agricultural lands, and will affect 1 private landowner.

Because Polder 1 ties in to La. Highway 3125 (refer to "Hurricane Storm Damage Risk Reduction Under LA Highway 3125" in the project description above), the District

acknowledges that there is a need for a real estate instrument which would ensure the roadway elevation is maintained in place, regardless of whether there is a continuing need for the Highway. Additionally, the real estate instrument should ensure that the State (LADOTD) does not degrade the Highway below 6.5 foot elevation. In the event that there is a temporary degradation for maintenance or rebuilding of the Highway, this should not be done during hurricane season, or must be done in a limited manner, so that the Highway could be raised during a storm event.

This instrument would be signed by the NFS, and the Louisiana Department of Transportation. Further, the instrument will include specific language agreeing to this requirement. At the time of this report, the District had not conducted discussions with the NFS or LADOTD regarding this issue. Therefore, District Office of Counsel was not able to develop the language that would be required in the instrument. The District recognizes that design of this feature must be coordinated with the NFS and with LADOTD. Discussions will occur during PED once there is more detail available regarding the design. At that time, Office of Counsel will also develop the language of the instrument to be signed by both parties and will coordinate such with the Real Estate and Office of Counsel vertical team. A Request for Approval of a Non-Standard Estate will be submitted to CEHQ-RE for approval.

Additionally, there are approximately 23 structures remaining outside of the Localized Storm Surge Risk Reduction features with a first floor elevation less than the 6.5 foot NAVD 88 elevation. These structures will be flood proofed to the stage associated with the 2020 100-year event. The recommended plan includes 14 residential structures to be elevated so that the lowest habitable finished floor is at least <u>one foot</u> above the Base Flood Elevation and to the stage associated with the 2070 1% (100-year) ACE event; 4 non-residential structures would be flood proofed to 3 feet above the ground elevation; and smaller berms would be constructed for 5 light industrial/warehouse facilities.

Table 2 below demonstrates the acreage, ownerships affected, and proposed estate for each Localized Storm Surge Risk Reduction Project feature. The total estimated number of affected private landowners is 131.

Table 2: Localized Storm Surge Risk Reduction Features

Project Feature	# Acres	# Tracts/ Ownerships	Proposed Estate
Polder 1	4.17	57	Perpetual Berm Easement*
Polder 3	4.78	49	Perpetual Berm Easement*
Flood Control Under 3125:			
Flap Gates/Flood Gates	27.90	NFS Owned	**
Noranda	.22	1	Perpetual Berm Easement*
Uncle Sam	.07	1	Perpetual Berm Easement*
Residential Elevations		14	Flood Proofing Agreement
Commercial Flood Proofing		9	Flood Proofing Agreement

**This is a non-material deviation from the standard perpetual Flood Protection Levee Easement. Refer to Annex F. Refer to Section B-3 below for further discussion.*
***Refer to discussion in Section B(1) above regarding specific language needed in the instrument to be signed between the NFS and LADOTD.*

ACCESS

Access for construction of the Localized Storm Surge Risk Reduction features will be directly from the adjacent public ROW and within ROW acquired for construction of the Project features. No private lands will be required for access.

STAGING

Staging areas for construction of the Localized Storm Surge Risk Reduction Project features will be located within the ROW for the Project footprint. No additional ROW will be required.

BORROW

All borrow material for this feature of the Project would come from the Bonnet Carré Spillway, which is owned in fee by the Federal Government.

MITIGATION

Mitigation for construction of the Localized Storm Surge Risk Reduction Project features is included within the Project mitigation plan, as described in Section A-1 and in Appendix A, Annex K of the Final Integrated Feasibility Report and Environmental Impact Statement. In Polder 1, there is a risk of affecting approximately 0.29 acres of forested wetlands. Attempts will be made to avoid these areas during construction. Due to the current uncertainty in avoiding these areas, we have included cost for mitigating for these forested wetlands in the total construction cost.

In reviewing Polder 3, the footprint of the berm, there is a risk of affecting approximately 0.81 acres of forested wetlands. Attempts will be made to avoid these areas during

construction. Due to the current uncertainty in avoiding these areas, we have included cost for mitigating for these forested wetlands in the total construction cost.

2) NON-FEDERAL SPONSOR OWNED LERRDs

Portions of the Localized Storm Surge Risk Reduction footprint and potential mitigation sites lie within lands owned by the State of Louisiana. The Non Federal Sponsor will provide the necessary interests for the project, and will receive credit for the lands it provides to the project.

3) ESTATES

Flood Protection Berm Easement *(Non-Material Deviation from Standard Estate)*

The Localized Storm Surge Risk Reduction Project features include construction of several berms to provide risk reduction to residential structures in St. James Parish. Typically, a berm is constructed as a part of a levee, and the standard perpetual Flood Protection Levee Easement is acquired for both the levee and the berm.

Due to the nature of the berms proposed for this Project, the District has prepared a Non-Material Deviation to the standard perpetual Flood Protection Levee Easement, replacing the word "levee" with the word "berm". A copy of the approved Non-Material Deviation to Standard Estate is included in Annex D.

The language of the Flood Protection Berm Easement is as follows:

> *A perpetual and assignable right and easement in (the land described in Schedule A) (Tracts Nos, ____, ____ and ____) to construct, maintain, repair, operate, patrol and replace a flood protection berm, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.*

It is noted that the Flood Protection Berm easement is proposed for the berms, but does not include the areas of the project feature located on Highway 3125. A separate instrument will be acquired for those features, as discussed in Section B-1 above.

4) LOCALIZED STORM SURGE RISK REDUCTION FEATURE IMPLEMENTATION PLAN – FLOOD PROOFING OF RESIDENTIAL STRUCTURES (ELEVATION) AND FLOOD PROOFING OF NON-RESIDENTIAL STRUCTURES (BERMS)

The Localized Storm Surge Risk Reduction Project features include 23 structures in the Project area. CPRAB will be the implementing agency for the elevations and commercial flood proofing measures.

District Real Estate performed a preliminary review of structures in the Project area. Based on this information, it is assumed that all of the structures eligible for elevation will be structurally sufficient to withstand elevation. Further, the District performed an analysis comparing the preliminary costs of structure elevation with preliminary depreciated value of

the structures and for each structure the lower cost was structure elevation. Therefore, for this Project it is not anticipated that there will be any property buy-outs.

Property owner participation in the Localized Surge Risk Reduction mearsures will be completely voluntary. The owners will be required to submit an application for residential structure elevation or commercial flood proofing, which must be signed by all owners of the property that would be impacted by the estate acquired in the Flood Proofing Agreement (including the Covenant Running With the Land). In order for an owner to participate in the residential elevation or the commercial flood proofing, the owner must have legal possession of the property without title defect. Title will be researched by the implementing agency. If a property is mortgaged, the owner must obtain approval from the mortgagor to participate in the structure elevation or floodproofing. The implementing agency will also conduct an appraisal as well as a site inspection to complete a Phase I HTRW/Asbestos investigation, and determine the condition and suitability of the structure for elevation or flood proofing. Landowners will obtain bids from qualified licensed contractors for the work to be performed. A Flood Proofing Agreement, which will include a Covenant Running With the Land, will be executed between the property owner, 3rd party interests impacted by the Covenant, and the NFS. The implementing agency will obtain subordinations from 3rd party interests impacted by the restrictions of the covenant. It is expected that occupants will need to temporarily relocate from their residences while the structure is being elevated. A complete implementation plan will be formulated during PED.

Flood Proofing Agreement

The District, under advisement from CEMVD and CEHQ, will modify a sample Flood Proofing Agreement that has been used by an implementing entity in conjunction with another Corps project, to include provisions applicable to the West Shore Lake Pontchartrain Project. Other Flood Proofing Agreements have been used for projects at the Nashville District, Omaha District and Mobile District.

The terms and conditions of the Flood Proofing Agreement will contain provisions that represent an interest in real property. In addition to provisions relating to the actual flood proofing action and construction, the agreement will include provisions regarding the right of NFS to access the property, to survey, investigate HTRW, inspect and monitor the property. Additionally, the agreement will include a covenant running with the land. The covenant will represent an interest in real property that will ensure that the flood proofed structures remain at the prescribed elevation and to ensure that all future construction or modifications to the flood proofed structure or elsewhere on the lands containing the flood proofed structures are performed in accordance with the project requirements. The Flood Proofing Agreement will be developed, in coordination with CEMVD and CEHQ, during PED to establish the program requirements and to conform to the scope of work that is determined for elevation of residential structures and flood-proofing measures for non-residential and light industrial structures. The individual property owners electing to participate in flood proofing of individual structures will enter into the agreement with the NFS. The Agreement, inclusive of the covenant running with the land, will be recorded in the Conveyance Records of the Parish where the property is located. At this time, it does not appear that any additional real estate interest will be acquired; however, that determination will be finalized during PED.

V. INDUCED FLOODING

Pump stations will be used to maintain existing drainage patterns in that portion of the Project area that is located on the protected side of the structural levee/floodwall system. Operation of these pump stations will be limited to such operations as are necessary to avoid Project construction-induced flooding on the protected side of the structural levee/floodwall system.

Modeling results indicated that the impacts to surrounding communities would be similar with and without the WSLP Project features and the magnitude in changes in water level are less than model precision.

There is a margin of error in both the economic model and the storm surge modeling (ADCIRC) which is recognized by team hydrologists and economists. In general, the potential impacts to communities outside of the proposed levee alignment would be similar with and without Alignment C. The ADCIRC modeling will be refined during PED to determine whether or not there will be induced flooding and to precisely estimate its magnitude. At feasibility level of design, the model uncertainty and inclusion of Localized Storm Surge Risk Reduction features adequately addresses the limited potential for induced damages. Therefore, a Takings Analysis has not been prepared for the Project.

VI. EXISTING FEDERAL PROJECTS WITHIN THE LER REQUIRED FOR THE PROJECT

Mississippi River & Tributaries Project

The levee feature of the project will tie into the Mississippi River Levee, which is a part of the Mississippi River and Tributaries Project, which was authorized by the Federal Flood Control Act of 1928. The Pontchartrain Levee District holds easements for the existing Right of Way that are equivalent to a levee easement. The Pontchartrain Levee District holds sufficient rights for the needs of the project, and will provide Right of Entry to CPRAB over this portion of the project.

Bonnet Carré Spillway

Portions of the structural project features as well as mitigation project features lie within the boundaries of the Bonnet Carré Spillway, on lands that are owned by the United States and are managed by USACE. This is further discussed in Section VII below.

VII. FEDERALLY OWNED LANDS WITHIN THE LER FOR THE PROJECT

The levee feature of the project will tie into the Bonnet Carré guide levee, and some project mitigation features lie within the Bonnet Carré Spillway. In addition, borrow material for the Project would come from the Bonnet Carré Spillway. The lands within the Spillway that are required for the Project are owned in fee by the Federal Government. USACE is the managing agency over this land.
CPRAB will be responsible for Operation & Maintenance of the mitigation features which lie within the Bonnet Carré Spillway. The Government will provide an outgrant to perform Operation & Maintenance of the mitigation site.

VIII. NAVIGATION SERVITUDE

The navigation servitude is the dominant right of the Government under the Commerce Clause of the U.S. Constitution to use, control and regulate the navigable waters of the United States and submerged lands thereunder.

The Project does not require LERRDs within any navigable watercourses. Therefore, the Federal Navigational Servitude will not be invoked for this Project.

IX. BASELINE COST ESTIMATES/CHART OF ACCOUNTS (COAs)

The Chart of Accounts includes lands required for the project (shown in the 01 – Lands and Damages account), as well as lands required for mitigation (shown in the 06 – Wildlife and Fisheries account). The Chart of Accounts also provides Relocations costs, which are the responsibility of the NFS (shown in the 02 – Relocations account).

The estimated total cost for Real Estate Acquisition is $27,679,000. This includes $5,481,000 for the structural features, $3,521,000 for Localized Storm Surge Risk Reduction features, $18,132,000 for mitigation and $545,000 for administrative costs associated with the flood proofing measures.

The costs for structural features include land payments as well as administrative costs and incremental costs associated with acquiring the real estate interests, as well as costs for potential condemnations. Costs for the Localized Storm Surge Risk Reduction features include land payments as well as administrative costs and incremental costs associated with acquiring the real estate interests, as well as costs for potential condemnations associated with acquisition of rights for the berms.

Costs for the Localized Storm Surge Risk Reduction flood proofing measures include administrative costs associated with implementation of the recommended plan. This would include such items as procurement of title, title review, preparation, execution, and recordation of the Flood Proofing Agreement (which includes a covenant running with the land), issuance of payment to the owner/contractor, and subsequent inspections to ensure the work was performed in accordance with the Flood Proofing Agreement. Administrative costs for these real estate tasks (to be performed by the NFS) were estimated at $10,000 for each structure, plus a contingency.

Because real estate costs did not exceed 10% of total project costs, a gross appraisal was not prepared for this Project. LERRDs costs are based on cost estimates prepared by the Appraisal Branch in June 2014.

Relocations costs are reflected in the 02-Relocations account. Refer to the section entitled "Facility/Utility Relocations" for information regarding the costs associated with these relocations.

					AMOUNT (ROUNDED)	CONTINGENCY (ROUNDED)	PROJECT COST
			CONTINGENCY	PROJECT COST			
01	**LANDS AND DAMAGES**				**7,453,000**	**2,094,000**	**9,547,000**
STRUCTURAL FEATURES					4,232,000	1,249,000	5,481,000
Assumes 22 landowners affected							
01B	**ACQUISITIONS**						
01B20	BY NON-FEDERAL SPONSOR (NFS)	187,000	46,750	233,750			
01B40	REVIEW OF NFS	99,000	24,750	123,750			
01C	**CONDEMNATIONS**						
01C20	BY NFS	55,000	13,750	68,750			
01E	**APPRAISAL**						
01E30	BY NFS	44,000	11,000	55,000			
01E50	REVIEW OF NFS	22,000	5,500	27,500			
01F	**PL 91-646 ASSISTANCE**						
01F20	BY NFS	0	0	0			
01R	**REAL ESTATE PAYMENTS**						
01R1	**LAND PAYMENTS**						
01R1B	BY NFS	3,825,000	1,147,500	4,972,500			
01R2	**PL 91-646 ASSISTANCE PAYMENTS**						
01R2B	BY NFS	0	0	0			
LOCALIZED RISK REDUCTION FEATURES					2,785,000	736,000	3,521,000
Assumes 108 landowners affected; does not include home elevations							
01B	**ACQUISITIONS**						
01B20	BY NON-FEDERAL SPONSOR (NFS)	918,000	229,500	1,147,500			
01B40	REVIEW OF NFS	486,000	121,500	607,500			
01C	**CONDEMNATIONS**						
01C20	BY NFS	270,000	67,500	337,500			
01E	**APPRAISAL**						
01E30	BY NFS	216,000	54,000	270,000			
01E50	REVIEW OF NFS	108,000	27,000	135,000			
01F	**PL 91-646 ASSISTANCE**						
01F20	BY NFS	0	0	0			
01R1	**LAND PAYMENTS**						
01R1B	BY NFS	787,000	236,100	1,023,100			
01R2	**PL 91-646 ASSISTANCE PAYMENTS**						
01R2B	BY NFS	0	0	0			
LOCALIZED RISK REDUCTION HOME ELEVATIONS					436,000	109,000	545,000
Assumes 23 landowners affected; includes administrative costs only							
01B	**ACQUISITIONS**						
01B20	BY NON-FEDERAL SPONSOR (NFS)	345,000	86,250	431,250			
01B40	REVIEW OF NFS	91,000	22,750	113,750			
02	**RELOCATIONS**						
					14,768,000	**4,430,000**	**19,198,000**
02	**RELOCATIONS**	14,768,000	4,430,000	19,198,000			
06	**WILDLIFE & FISHERIES**						
MITIGATION					**13,957,000**	**4,175,000**	**18,132,000**
Assumes 12 landowners affected							
01B	**ACQUISITIONS**						
01B20	BY NON-FEDERAL SPONSOR (NFS)	102,000	25,500	127,500			
01B40	REVIEW OF NFS	54,000	13,500	67,500			
01C	**CONDEMNATIONS**						
01C20	BY NFS	60,000	15,000	75,000			
01E	**APPRAISAL**						
01E30	BY NFS	24,000	6,000	30,000			
01E50	REVIEW OF NFS	12,000	3,000	15,000			
01F	**PL 91-646 ASSISTANCE**						
01F20	BY NFS	0	0	0			
01R1	**LAND PAYMENTS**						
01R1B	BY NFS	13,705,000	4,111,500	17,816,500			
01R2	**PL 91-646 ASSISTANCE PAYMENTS**						
01R2B	BY NFS	0	0	0			

X. UNIFORM RELOCATION ASSISTANCE (PL 91-646, Title II as amended)

No relocation assistance benefits are anticipated for the structural features of the Project. No families or businesses will be displaced as a result of the structural project features.

Because participation in the Localized Storm Surge Risk Reduction project flood proofing feature is voluntary, the owner-occupants are not eligible for relocation assistance benefits, in accordance with the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs (URA), as promulgated by 49 CFR Part 24, paragraphs 24.2(a)(9)(ii)(D), (E), (H), 24.101(a)(2), and applicable sections in Appendix A. However, if the owner of a leased residential property participates in the structure elevation, the tenant is considered displaced and is eligible for relocation assistance.

Below is an excerpt of the applicable portions of 49 CFR Part 24 as they relate to owner-occupants:

49 CFR Part 24:

> (1) Subpart A, paragraph 24.2(a)(9)(ii)(E), Persons Not Displaced definition, states that an owner-occupant who moves as a result of an acquisition of real property that will not be acquired if an agreement cannot be reached, or as a result of rehabilitation of the real property, is not a displaced person. However, the displacement of a tenant as a direct result of any acquisition, rehabilitation or demolition for a Federal or Federally-assisted project is subject to the URA as a displaced person; and (H) states that an owner-occupant who conveys his or her property...after being informed in writing that if a mutually satisfactory agreement on terms of the conveyance cannot be reached, the Agency will not acquire the property. In such cases, however, any resulting displacement of a tenant is subject to the URA as a displaced person; and
>
> (2) Subpart B, paragraphs 24.101(a)(2), (b)(1)(iii), & (b)(2)(i), Applicability of Acquisition Requirements, states that if the agency will not acquire a property because negotiations fail to result in an agreement, the owner of such property is not a displaced person and as such, is not entitled to relocation assistance benefits. However, tenants on such properties may be eligible for relocation assistance benefits.
>
> (*Note the above paragraph is intended to stress that if an agency will not use condemnation as an acquisition tool, then an owner-occupant is not considered a displaced person; conversely, even if an agency does not utilize condemnation as an acquisition tool, tenants may be considered displaced persons. It is understood that if an owner does not participate in the program, then a tenant would not be displaced and would not qualify for relocation assistance.)*

XI. TIMBER/MINERAL/ROW CROP ACTIVITY

The Louisiana Department of Natural Resources provides a Strategic Online Natural Resources Information System (SONRIS), which contains up-to-date information on oil & gas activity in the state of Louisiana. Review of this information indicated that although there are oil and gas wells within the

study area, there are no active wells within the recommended plan alignment. This information will be reviewed and confirmed following feasibility level design.

With the exception of the acquisition of the standard Fee Excluding Minerals Estate (With Restrictions on the Use of the Surface) which has the potential to impact mineral rights over certain lands, the other estates have no impact on mineral rights and USACE will not acquire mineral rights to any of the LERRDs required for the Project. Over lands where the fee estate is being acquired, mineral rights will be subordinated. Mineral right owners can still explore for minerals through directional drilling.

There are approximately 404 acres of agricultural land impacted by the Project. Property owners will be allowed to harvest crops prior to acquisition. In the event that Project schedules do not allow for such, the contributory value of the in crops will be included in the estimate of property value in the appraisal. Any timber present within required right of way is included in the overall appraised value of the land.

XII. OYSTER LEASES

There are no oyster leases located within the Project study area.

XIII. ZONING ORDINANCES

There will be certain building restrictions in areas where structure elevation and/or flood proofing measures are proposed. The NFS will be required to publicize floodplain information for project area and will be required to provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with risk reduction levels provided by the Project. Additionally, the NFS will be required to prevent obstructions or encroachments on the Project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on *Project* lands, easements, and rights-of-way or the addition of facilities which might reduce the level of risk reduction of the Project. Additionally, local Parish building code enforcement agencies would ensure compliance with the purpose and objectives of the Localized Storm Surge Risk Reduction component of the Project by requiring compliance with the flood proofing covenants contained in Project Flood Proofing Agreements with regard to future construction of additions, modifications, repair and replacement of existing Project flood proofed structures.

XIV. ACQUISITION SCHEDULE

<u>Structural Project Features – Acquisition Schedule</u>

The following acquisition schedule is based on the premise that the Project will impact approximately 34 private landowners for the levee alignment. It is assumed that this portion of the Project will be constructed in sections. A detailed acquisition schedule will be refined during PED, once the 95% plans and specifications are prepared for each section of the project. The schedule will begin once a Right of Entry request has been received by Real Estate. The schedule below provides the total amount of time to complete the acquisition of real estate rights for mitigation and for the construction of the levee alignment and other Project features. It is possible that some of the tasks listed below could be concurrent. For the purposes of this Report, these tasks are presented as being consecutively performed (with the exception of closings and condemnations), and the durations below represent the approximate total time of acquisition.

1)	TOD, Mapping	3 months
2)	Obtain Title & Appraisals	6 months
3)	Negotiations	2 years
4)	Closing	1 year
5)	Eminent Domain Proceedings	6 years

Localized Storm Surge Risk Reduction Project Features – Acquisition Schedule

The following schedule is based on the premise that the Localized Storm Surge Risk Reduction Project features (excluding flood proofing measures) will affect approximately 108 private landowners.

It is assumed that the Localized Storm Surge Risk Reduction features will be constructed in sections. A detailed acquisition schedule will be refined during PED, once the 95% plans and specifications are prepared for each section of the Project. The schedule will begin once a Right of Entry request has been received by Real Estate. The schedule below provides the total amount of time to complete the acquisition of real estate rights for construction of the Localized Storm Surge Risk Reduction Project features. It is possible that some of the tasks listed below could be concurrent. For the purposes of this Report, these tasks are presented as being consecutively implemented (with the exception of closings and condemnations), and the durations below represent the approximate total time of acquisition.

1)	TOD, Mapping	2 years
2)	Obtain Title & Appraisals	2 years
3)	Negotiations	4 years
4)	Closing	2 years
5)	Eminent Domain Proceedings	6 years

Localized Storm Surge Risk Reduction (Structure Elevation and Flood Proofing Measures) – Acquisition Schedule

There will be an acquisition of an interest in real estate contained within the flood proofing agreements for the flood proofing measures proposed to address individual residential and non-residential structures. This interest in real estate will represent a covenant running with the land. An Agreement will be executed between the NFS and approximately 23 landowners and will be recorded in the Conveyance Records of the Parish in which the structure is located. The following schedule represents the estimated duration of tasks relating to construction of the elevations/commercial flood proofing measures:

Applications for structure elevation or commercial flood proofing	3 months
Title research	3 months
Appraisals	3 months
HTRW Site Inspections	3 months
Landowner/Contractor Negotiations	6 months
Negotiation of Flood Proofing Agreement	6 months
Execution of Flood Proofing Agreement	2 months
Filing Flood Proofing Agreement	2 months

XV. FACILITY/UTILITY RELOCATIONS

Relocation data is collected and detailed by the USACE New Orleans District, Engineering Division, Design Services Branch Relocations Team. There are an estimated 36 pipelines that will require relocation in the implementation of the recommended plan. These pipelines will be relocated within existing Right-of-Way or levee Right-of-Way. A preliminary list of pipeline relocations is included as Table 3 below (for reference, map of relocations is located in Annex E). "ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REPORT THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES."

The estimated cost of pipeline relocations is $19,198,000. These costs are 100% borne by the Non-Federal Sponsor. Real Estate Guidance issued for 3x3x3 studies indicates that if the costs of relocation of facilities and utilities is less than 30% of project costs, a preliminary compensable interest report need not be prepared. Because the estimated cost of relocations does not exceed 30% of total project cost, an Attorney's Preliminary Opinion of Compensable Interest was not prepared for this project.

Table 3 below contains a list of the pipeline relocations and anticipated construction costs. These costs are reflected as relocations (02-Relocations) within the project cost certification. This information will be reviewed during PED, and a Final Attorney's Opinion of Compensability will be prepared prior to execution of the PPA. Until that opinion is prepared, the compensability of the facility/utility is unknown.

Table 3: Pipeline Relocations

West Shore Lake Pontchartrain, LA Hurricane Protection Project

Alignment C (Pipeline Avoidance) Pipeline Crossings
30% Contingency

COMPANY	PRODUCT	SIZE	MII COSTS
MARATHON ASHLAND PIPELINE LLC	CRUDE OIL	30"	$727,289
SHELL PIPELINE COMPANY	REFINED PRODUCTS LINE	24"	$696,083
	GAS	24"	$696,223
ST. JOHN THE BAPTIST PARISH POTABLE WATER	TRANSMISSION LINE	24"	$696,083
SHELL PIPELINE COMPANY LP	AREA WIDE MAINTENANCE	24"	$696,223
MARATHON ASHLAND PIPELINE LLC	PETROLEUM PRODUCT	20"	$636,218
WILPRISE PIPELINE COMPANY	PIPELINE	12.75"	$463,882
SOUTHERN STATES PIPELINE COMPANY	GAS	12.75"	$463,882
WILPRISE PIPELINE COMPANY	NATURAL GAS LIQUID	12"	$463,882
SHELL PIPELINE COMPANY LP	PIPELINE AREA WIDE MAINTENANCE	12"	$463,882
WILPRISE PIPELINE COMPANY	NATURAL GAS LIQUID	12"	$672,761
WILPRISE PIPELINE COMPANY	PIPELINE	12"	$672,761
AIR PRODUCTS	HYDROGEN DUPONT MAINLINE	12"	$672,761
GULF LIQUIDS NEW RIVER	PIPELINE	12"	$672,761
GULF INTERSTATE / BIG THREE INDUSTRIES	NITROGEN	12"	$672,761
GULF INTERSTATE / BIG THREE INDUSTRIES	OXYGEN	12"	$672,761
WILPRISE PIPELINE COMPANY	PIPELINE	12"	$672,761
GULF LIQUIDS NEW RIVER	PIPELINE	12"	$672,761
TEXACO PIPELINE LLC.	EXISTING PIPELINE MAINTENANCE	8"	$448,377
BRIDGELINE GAS DISTRIBUTION LLC	SURVEY LINE	8"	$448,377
ENTERPRISE PIPELINE COMPANY	PROPANE	8"	$448,377
SORRENTO PIPELINE COMPANY	PIPELINE	8"	$448,377
ENTERPRISE - WILPRISE	NGL PROPANE	6.629"	$433,219
BRIDGELINE GAS DISTRIBUTION LLC	BUTANE	6"	$433,219
WILPRISE PIPELINE COMPANY	PIPELINE MAINTENANCE - CLEAR ROW	6"	$433,219
WILPRISE PIPELINE COMPANY	PIPELINE MAINTENANCE - CLEAR ROW	6"	$433,219
BRIDGELINE GAS DISTRIBUTION LLC	BUTANE	6"	$433,219
NICOR EXPLORATION GAS	GAS	6"	$433,219
CHEVRON TEXACO	AREA WIDE FLOWLINE MAINTENANCE & REPAIR (SS01)	6"	$433,219
BRIDGELINE GAS DISTRIBUTION LLC	PROPANE	6"	$433,219
SHELL PIPELINE COMPANY LP	FLOWLINE INSPECT / REPAIR	6"	$433,219
ENTERPRISE PIPELINE COMPANY	LIQUIFIED PETROLEUM GASES (PROPANE)	6"	$433,219
LIG	GAS	4"	$421,624
SHELL OIL COMPANY	EPSILON ETHYLENE CONNECTION	4"	$421,624
SHELL PIPELINE COMPANY LP	EXISTING PIPELINE MAINTENANCE	4"	$421,624
I.P. PETROLEUM COMPANY	PIPELINE	4"	$421,624
		TOTAL	$19,197,927

A separate Relocations Report, containing relocations costs, will be submitted as a reference to the Engineering Appendix. Maps of potential relocations can be referenced in that appendix. Those relocation costs represent a preliminary level of design and will be further refined during the development of the project P&S.

The NFS will perform these relocations as a part of its responsibility under the project authority. The conclusions contained herein are preliminary only. The USACE will make a final determination of the relocations necessary for the construction, operation or maintenance of the project after further analysis, and completion and approval of the Final Attorney's Opinion of Compensability for each of the impacted utilities and facilities.

XVI. HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW)

A Phase I Environmental Site Assessment was conducted in February, 2014. The assessment cautioned that oil and gas pipelines must be observed to avoid damaging any pipelines traversing the Project area, but found no leaks or other problems associated with these facilities. The assessment found that there is a low probability of encountering HTRW, and recommended no further investigation.

For the non-structural home elevations, an HTRW assessment will be performed on each individual structure prior to elevation. If the findings indicate that there are HTRW issues, the NFS and homeowner will be required to remediate prior to commencement of construction. The costs of remediation will not be a Federal responsibility, and will not be creditable to the NFS.

XVII. LANDOWNER CONCERNS

The overall Project has received support from the community; however, the attitudes of the landowners who will be directly affected by its construction is not known. Public comments have reflected dissatisfaction with the selection of Alignment C (and were more in favor of Alignment D), and have indicated that landowners in St. James Parish are dissatisfied with the recommendation of Localized Storm Surge Risk Reduction project features in that area. The NFS is confident that it will be able to acquire the LERRDS required for the project.

XVIII. NFS RISK NOTIFICATION

In accordance with the requirements of ER 405-1-12, Chapter 12, Real Estate Roles & Responsibilities for Civil Works: Cost Shared and Full Federal Projects, CPRAB has been notified in writing of the risks of acquiring LERRDs before execution of the PPA. A copy of the letter sent to the Sponsor is included in Annex F.

Prepared By:

Karen E. Vance

_____

Karen E. Vance
Realty Specialist, Planning & Appraisal Branch
Real Estate Region South Division
November 19, 2014

Recommended for Approval By:

Judith Y. Gutierrez

_____

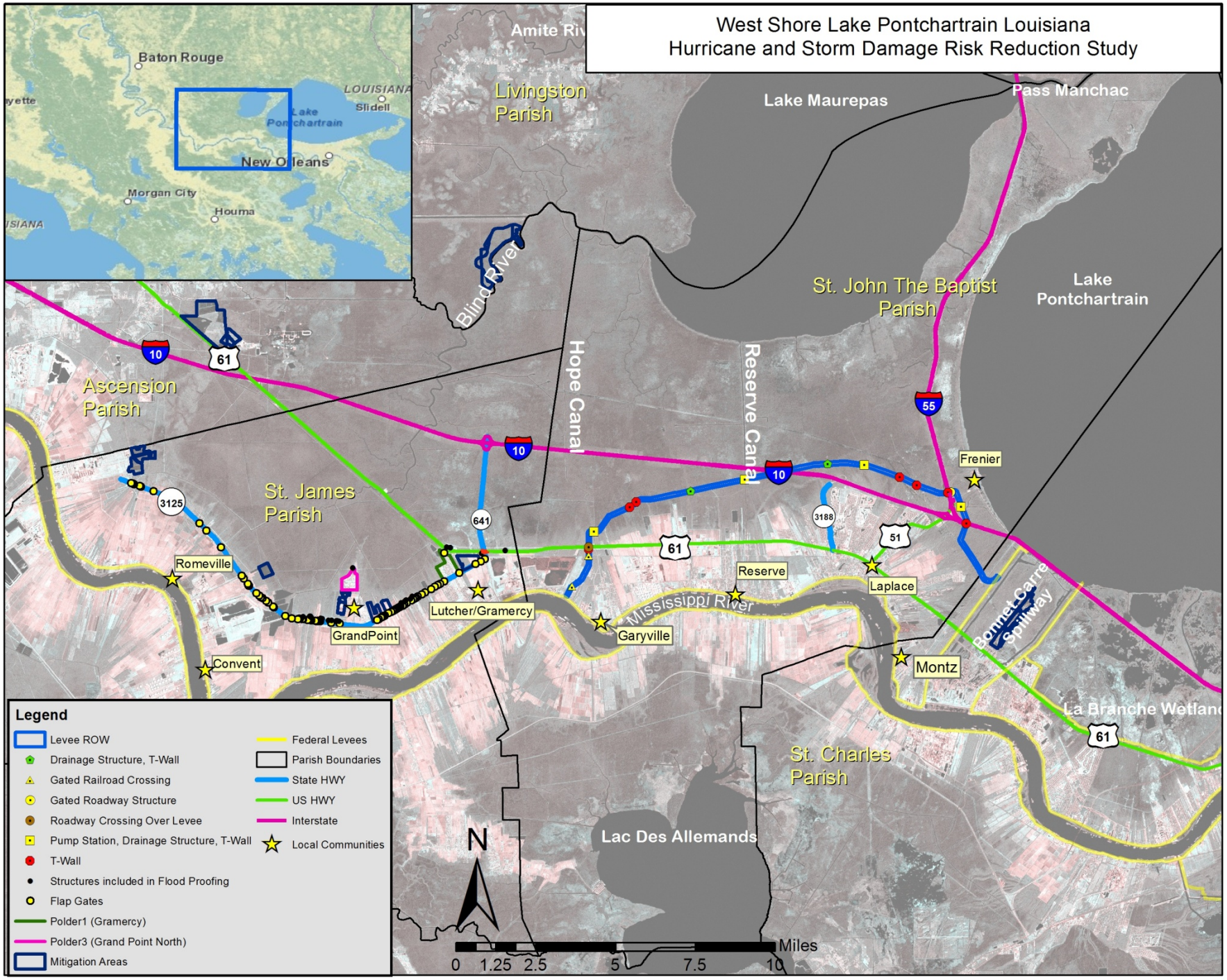
Judith Y. Gutierrez
Chief, Appraisal & Planning Branch
Real Estate Region South Division
November 19, 2014

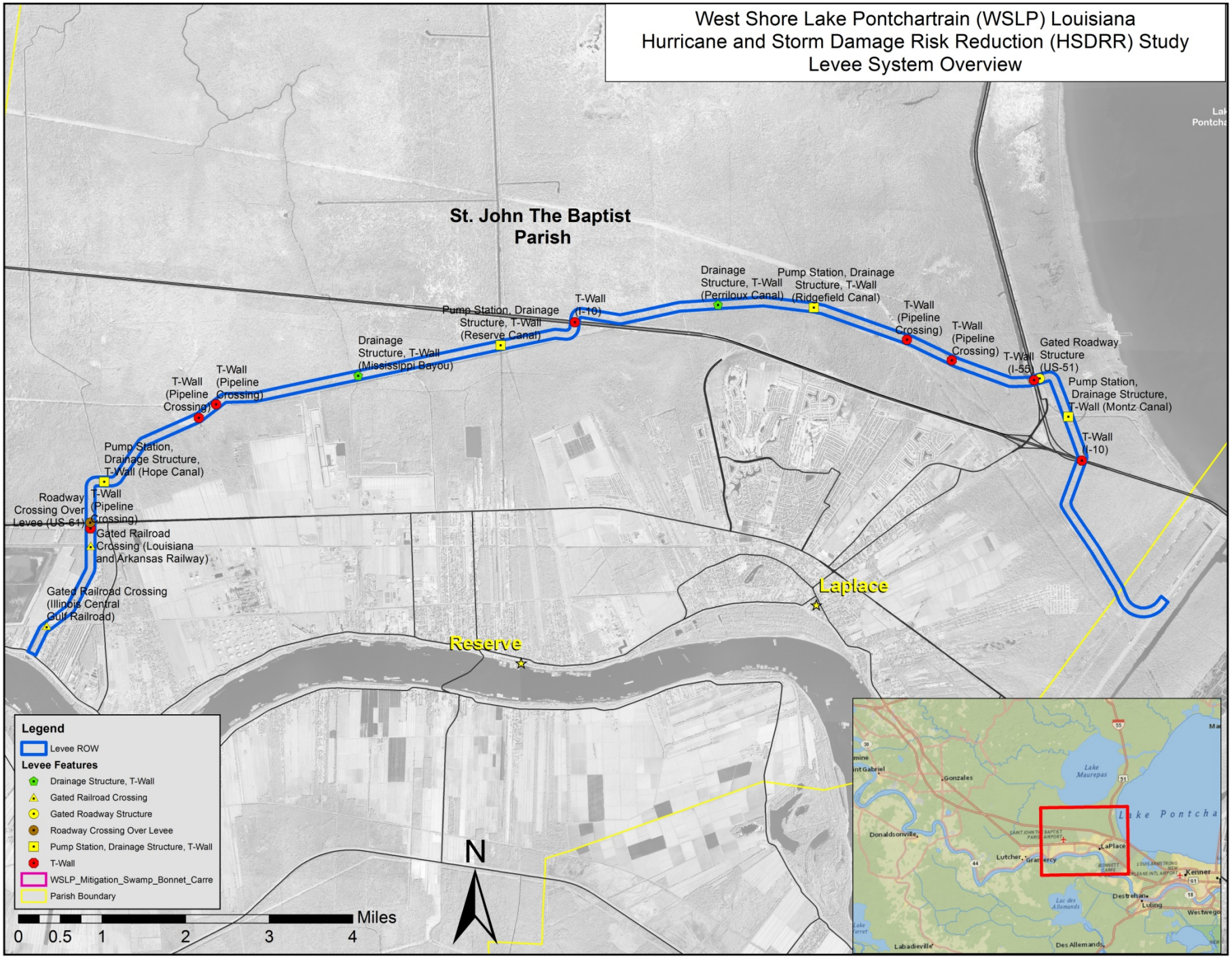
WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

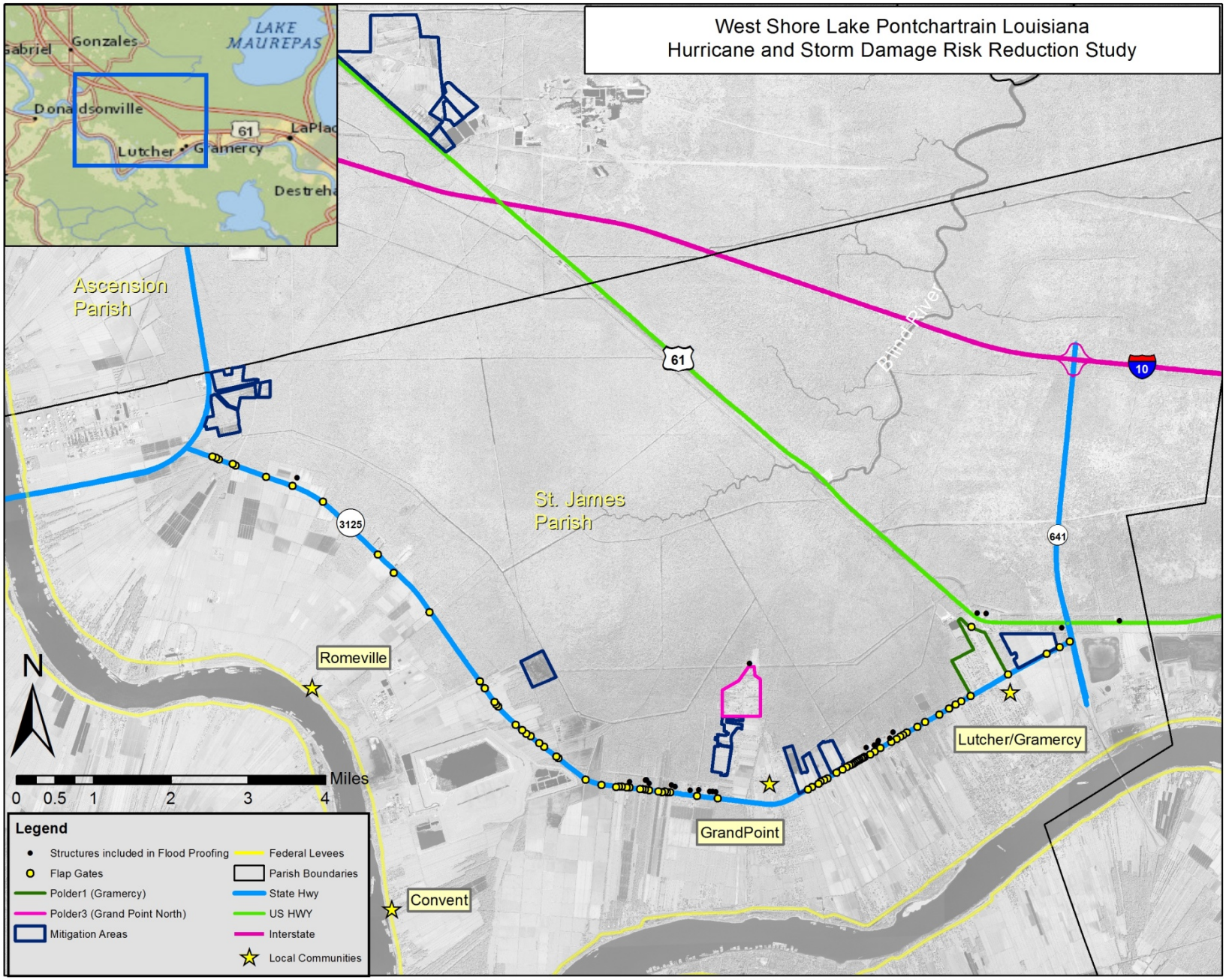
APPENDIX C

ANNEX A

PROJECT MAPS


West Shore Lake Pontchartrain Louisiana
Hurricane and Storm Damage Risk Reduction Study
Baton Rouge
LOUISIANA
Slidell
Lake Pontchartrain
New Orleans
Morgan City
Houma
Amite Riv
Livingston Parish
Lake Maurepas
Pass Manchac
Blind River
St. John The Baptist Parish
Lake Pontchartrain
Ascension Parish
Hope Canal
Reserve Canal
St. James Parish
Frenier
Romeville
Lutcher/Gramercy
GrandPoint
Reserve
Laplace
Mississippi River
Garyville
Convent
Montz
Bonnet Carre Spillway
La Branche Wetland
St. Charles Parish
Lac Des Allemands
N
Miles
0 1.25 2.5 5 7.5 10
Legend
Levee ROW
Drainage Structure, T-Wall
Gated Railroad Crossing
Gated Roadway Structure
Roadway Crossing Over Levee
Pump Station, Drainage Structure, T-Wall
T-Wall
Structures included in Flood Proofing
Flap Gates
Polder1 (Gramercy)
Polder3 (Grand Point North)
Mitigation Areas
Federal Levees
Parish Boundaries
State HWY
US HWY
Interstate
Local Communities


West Shore Lake Pontchartrain (WSLP) Louisiana
Hurricane and Storm Damage Risk Reduction (HSDRR) Study
Levee System Overview
St. John The Baptist Parish
Drainage Structure, T-Wall (Perrilloux Canal)
Pump Station, Drainage Structure, T-Wall (Ridgefield Canal)
T-Wall (I-10)
Pump Station, Drainage Structure, T-Wall (Reserve Canal)
Drainage Structure, T-Wall (Mississippi Bayou)
T-Wall (Pipeline Crossing)
T-Wall (Pipeline Crossing)
T-Wall (Pipeline Crossing)
T-Wall (Pipeline Crossing)
T-Wall (I-55)
Gated Roadway Structure (US-51)
Pump Station, Drainage Structure, T-Wall (Montz Canal)
T-Wall (I-10)
Pump Station, Drainage Structure, T-Wall (Hope Canal)
Roadway Crossing Over Levee (US-61)
T-Wall (Pipeline Crossing)
Gated Railroad Crossing (Louisiana and Arkansas Railway)
Gated Railroad Crossing (Illinois Central Gulf Railroad)
Laplace
Reserve
Legend
Levee ROW
Levee Features
Drainage Structure, T-Wall
Gated Railroad Crossing
Gated Roadway Structure
Roadway Crossing Over Levee
Pump Station, Drainage Structure, T-Wall
T-Wall
WSLP_Mitigation_Swamp_Bonnet_Carre
Parish Boundary
N
Miles
0 0.5 1 2 3 4
Lake Maurepas
Lake Pontcha
Gonzales
Donaldsonville
Lutcher
Gramercy
LaPlace
Kenner
Destrehan
Luling
Westwego
Lac des Allemands
Labadieville
Des Allemands


West Shore Lake Pontchartrain Louisiana
Hurricane and Storm Damage Risk Reduction Study
LAKE MAUREPAS
Gonzales
Donaldsonville
Lutcher
Gramercy
LaPlace
Destrehan
61
Ascension Parish
St. James Parish
Blind River
10
3125
641
Romeville
Convent
GrandPoint
Lutcher/Gramercy
N
Miles
0 0.5 1 2 3 4
Legend
Structures included in Flood Proofing
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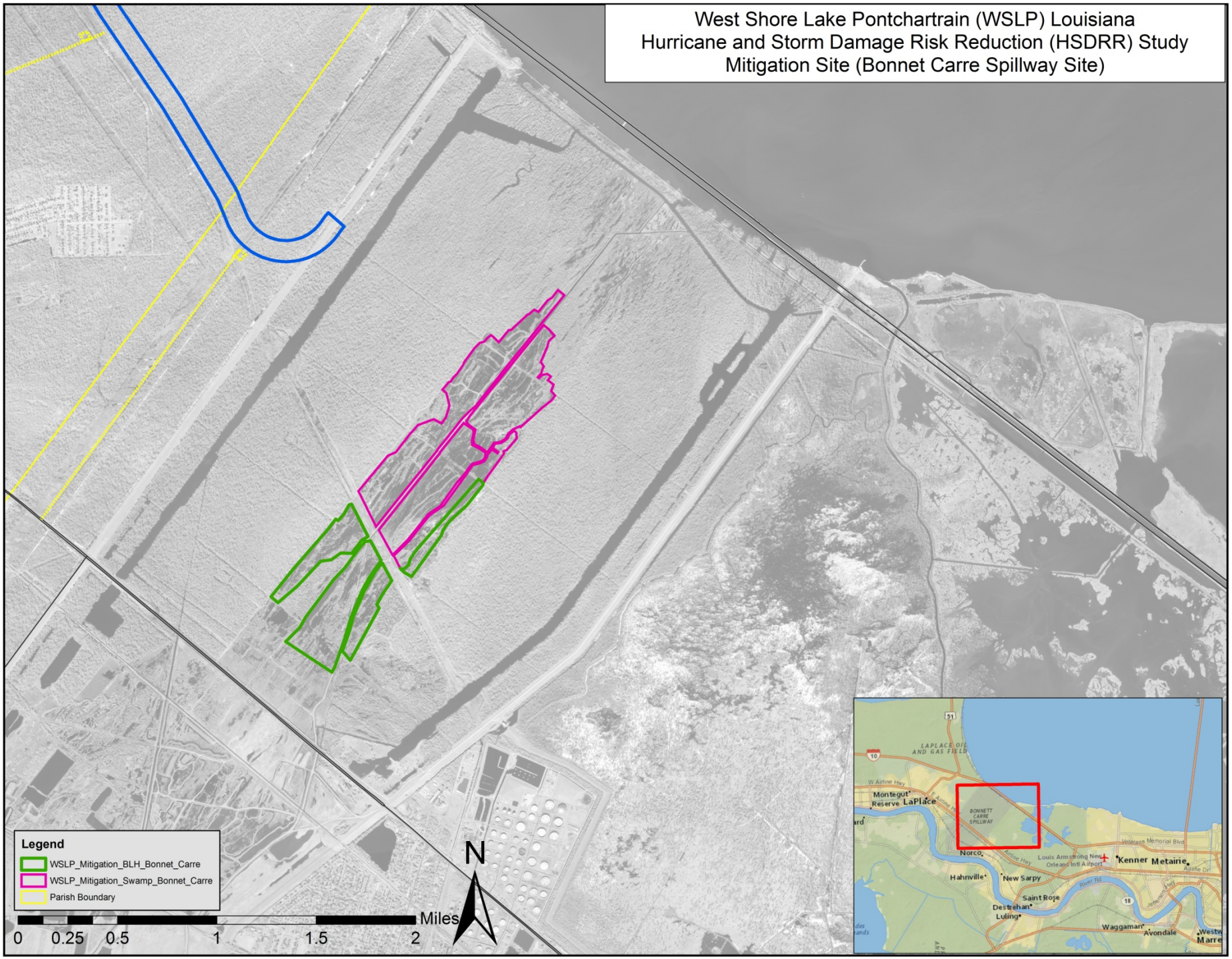
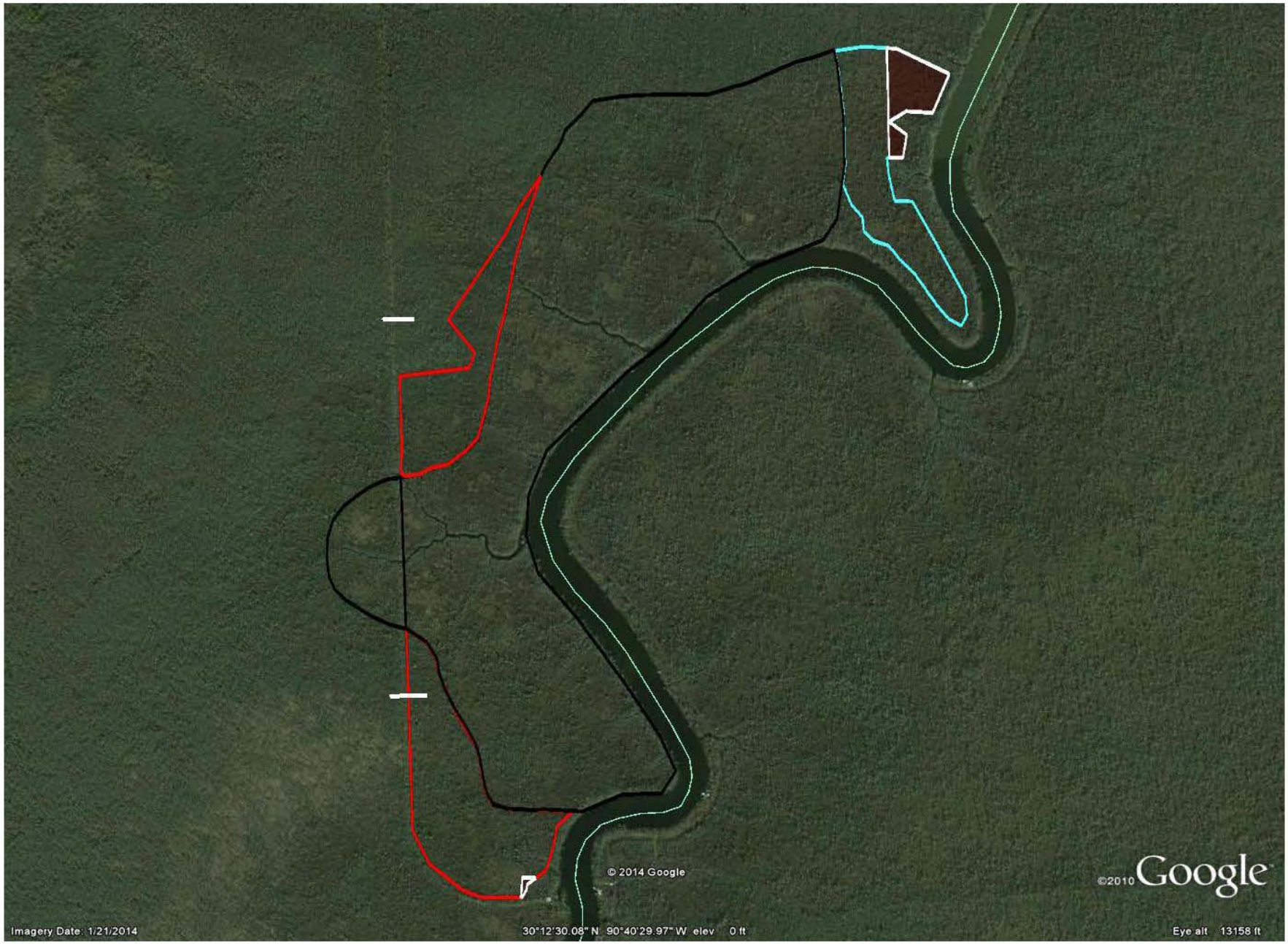
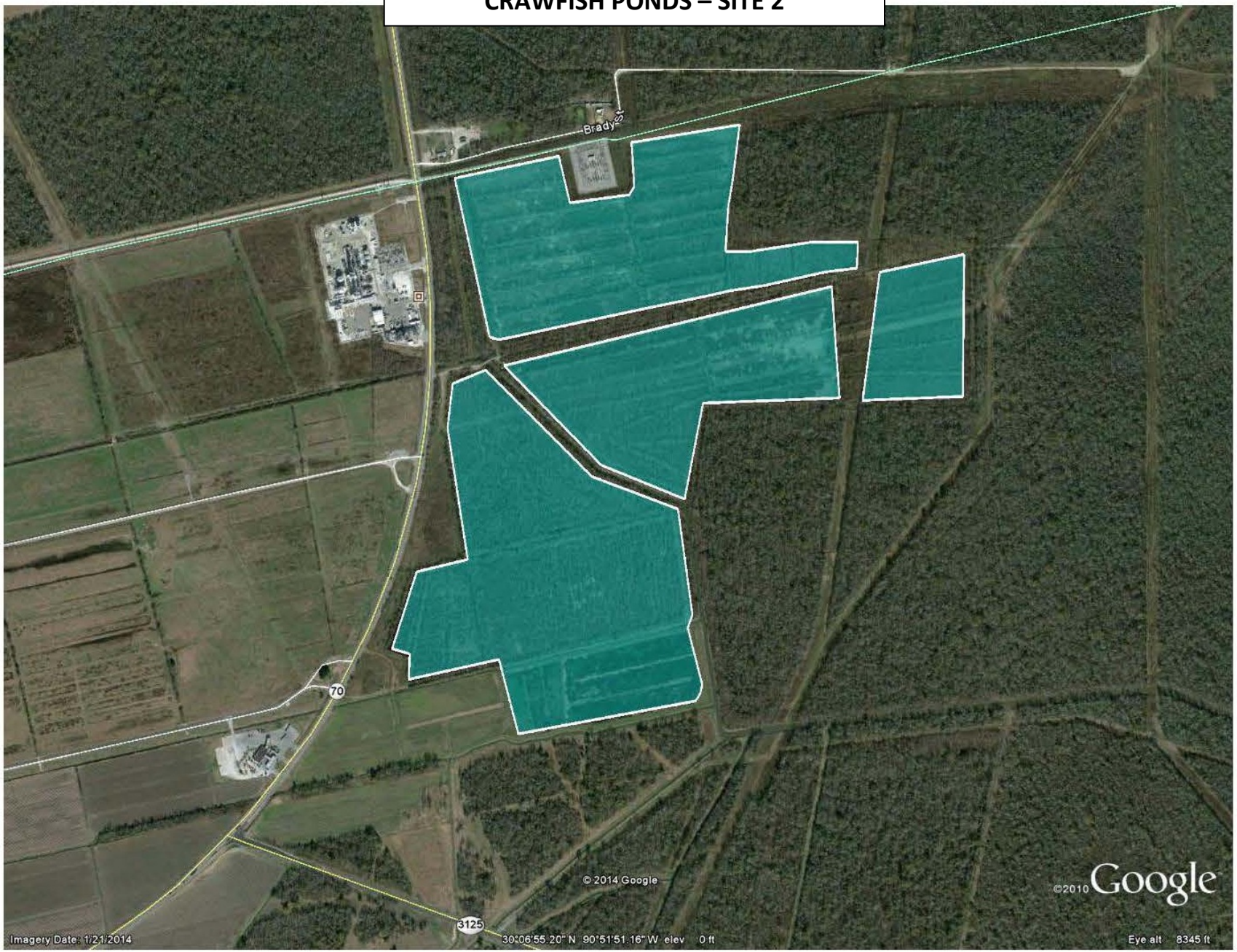

West Shore Lake Pontchartrain (WSLP) Louisiana
Hurricane and Storm Damage Risk Reduction (HSDRR) Study
Mitigation Site (Bonnet Carre Spillway Site)
Legend
WSLP_Mitigation_BLH_Bonnet_Carre
WSLP_Mitigation_Swamp_Bonnet_Carre
Parish Boundary
0 0.25 0.5 1 1.5 2
Miles
N
Montegut
Reserve
LaPlace
Norco
Hahnville
New Sarpy
Saint Rose
Destrehan
Luling
Kenner
Metairie
Waggaman
Avondale

BLIND RIVER MITIGATION



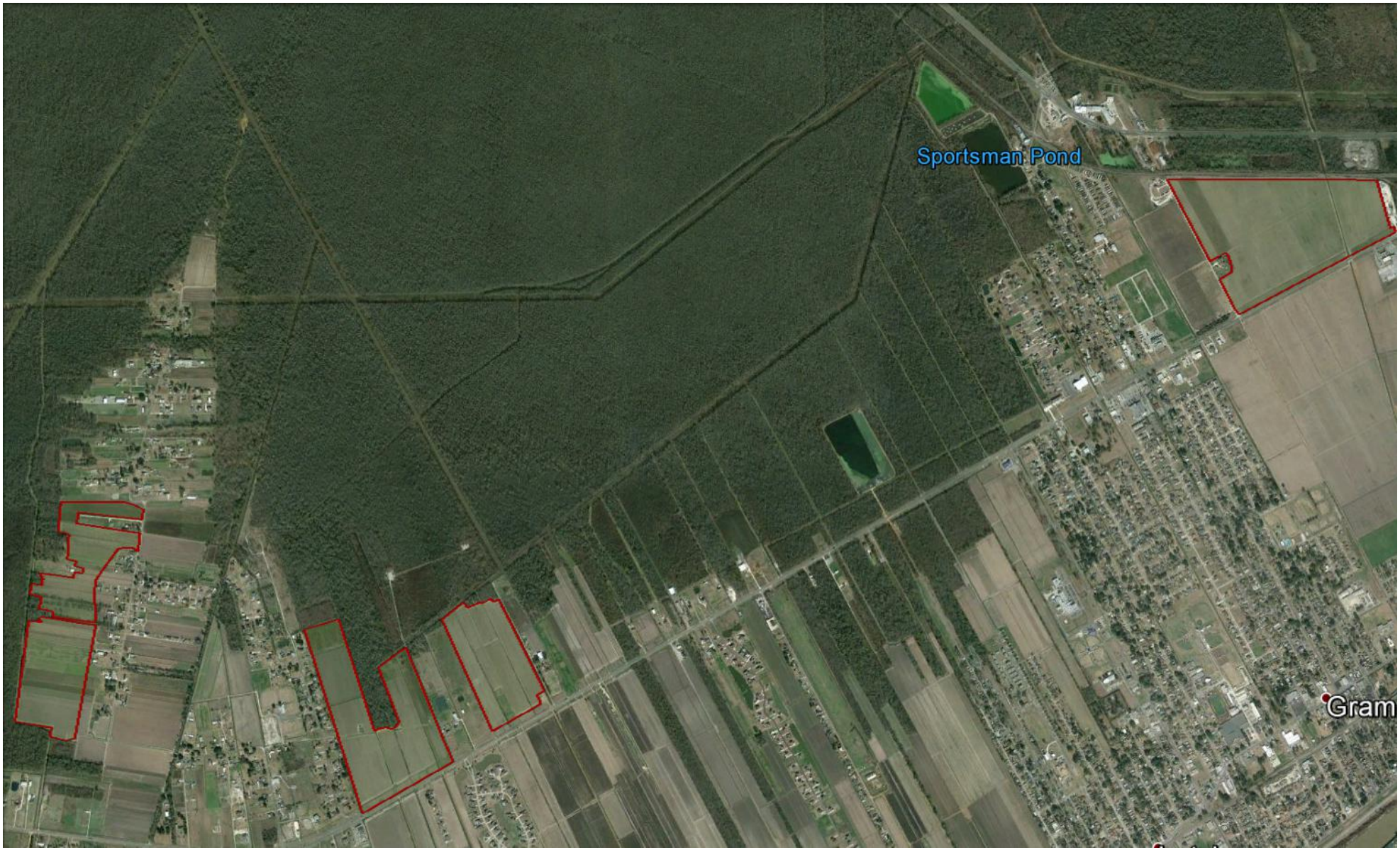
MAUREPAS SWAMP MITIGATION FROM CRAWFISH PONDS – SITE 1

MAUREPAS SWAMP MITIGATION FROM CRAWFISH PONDS – SITE 2



MAUREPAS SWAMP MITIGATION FROM CRAWFISH PONDS – SITE 3

LUTCHER POLDER FARMLAND



WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
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APPENDIX C

ANNEX B

ASSESSMENT OF NON-FEDERAL SPONSOR'S

ACQUISITION CAPABILITY

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

COASTAL PROTECTION AND RESTORATION AUTHORITY ("CPRA"), IMPLEMENTATION ARM OF THE COASTAL PROTECTION AND RESTROATION AUTHORITY BOARD ("BOARD")

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **NO, however, CPRA, the implementation and enforcement arm of the Board, has the ability to acquire, own, administer, alienate, and otherwise dispose of all kinds of property, movable and immovable, corporeal and incorporeal for projects authorized by the CPRA Board. (RS 49:214.6.2)**

b. Does the sponsor have the power of eminent domain for this project?
YES. Through CPRA, the implementation arm of the Board, the Sponsor does have conventional eminent domain authority under RS 49:214.6.2(D)(2) and RS 19:2.

c. Does the sponsor have "quick-take" authority for this project?
NO. CPRA, the implementation and enforcement arm of the Board, does not have quick take authority however, should this be needed for the project, CPRA or the CPRA Board may partner with a Levee District or Parish Government which has that authority pursuant to La. R.S. 38:301.1, La. R.S. 49:214.5.2(7) and (11) , and 49:214.6.2(D)(1) and (2), pursuant to an intergovernmental agreement.

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? **NO**

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **Unknown at this time however, there are rail roads located in the vicinity of the project.**

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? **NO**

b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? **N/A**

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **YES**

d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule? **Not at this time. However, CPRA has numerous contracts in place**

e. Can the sponsor obtain contractor support, if required in a timely fashion? **YES, contracts are in place now.**

f. Will the sponsor likely request USACE assistance in acquiring real estate? **It is not likely that the Sponsor will request assistance.**

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site? **YES**

b. Has the sponsor approved the project/real estate schedule/milestones? **At the feasibility level, there are too many unknowns to develop a definite project schedule. Once project designs are finalized, the CPRA will be requested to provide an acquisition schedule.**

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? **YES**

b. With regard to this project, the sponsor is anticipated to be: highly capable/fully capable/moderately capable/marginally capable/insufficiently capable. **Highly capable.**

V. Coordination:

a. Has this assessment been coordinated with the sponsor? **YES**

b. Does the sponsor concur with this assessment? **YES**

Prepared by:	Approved by:	Approved by:
Karen Vance	James L. Altman	Jerome Zeringue
Karen E. Vance Realty Specialist Appraisal & Planning Branch Real Estate Region South Division USACE	James L. Altman Land Manager Legal/Real Estate Division Coastal Protection & Restoration Authority	Jerome Zeringue Chairman Coastal Protection & Restoration Authority Board
6/16/14	6-17-14	6-19-2014
Date	Date	Date

WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

APPENDIX C

ANNEX C

NON-MATERIAL DEVIATION FROM

STANDARD ESTATE

TEMPORARY ACCESS EASEMENT

&

PERPETUAL ACCESS EASEMENT

TEMPORARY ACCESS EASEMENT

A non-exclusive and assignable temporary easement for a period not to exceed _____years beginning with date possession of the land is granted to the Coastal Protection and Restoration Authority Board (CPRAB), for use by the CPRAB, its representatives, agents, and contractors as an access route and/or right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____); together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way, reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired, including the right to cross over the right-of-way as access to their adjoining land; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

In accordance with paragraph 12-9 c. of ER 405-1-12, the District Chief of Real Estate may approve a non-standard estate if it serves the intended project purpose, substantially conforms with and does not materially deviate from a corresponding standard estate, and does not increase the costs or potential liability of the Government. The foregoing estate complies with those requirements as it achieves the project purpose in as narrow a manner as practical, and is a minor modification of the standard Road Easement, adding language for a temporary term and replacing the word "road" with the words "access route" and/or "right of way".

Reviewed by:

Marco Rosamano

Marco Rosamano
Assistant District Counsel
New Orleans District

Approved by:

Linda Labure
Chief, Real Estate Division
New Orleans District

PERPETUAL ACCESS EASEMENT

A perpetual non-exclusive and assignable easement for use by the Coastal Protection and Restoration Authority Board (CPRAB), for use by the CPRAB, its representatives, agents, and contractors as an access route and/or right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____); together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way, reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired, including the right to cross over the right-of-way as access to their adjoining land; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

In accordance with paragraph 12-9 c. of ER 405-1-12, the District Chief of Real Estate may approve a non-standard estate if it serves the intended project purpose, substantially conforms with and does not materially deviate from a corresponding standard estate, and does not increase the costs or potential liability of the Government. The foregoing estate complies with those requirements as it achieves the project purpose in as narrow a manner as practical, and is a minor modification of the standard Road Easement, adding language for a perpetual term and replacing the word "road" with the words "access route" and/or "right of way".

Reviewed by:

Marco Rosamano
Assistant District Counsel
New Orleans District

Approved by:

Linda Labure
Chief, Real Estate Division
New Orleans District

WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
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ANNEX D

NON-MATERIAL DEVIATION FROM

STANDARD ESTATE

FLOOD PROTECTION BERM EASEMENT

FLOOD PROTECTION BERM EASEMENT

A perpetual and assignable right and easement in (the land described in Schedule A) (Tracts Nos, ____, ____ and ____) to construct, maintain, repair, operate, patrol and replace a flood protection berm, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

In accordance with paragraph 12-9 c. of ER 405-1-12, the District Chief of Real Estate may approve a non-standard estate if it serves the intended project purpose, substantially conforms with and does not materially deviate from a corresponding standard estate, and does not increase the costs or potential liability of the Government. The foregoing estate complies with those requirements as it achieves the project purpose in as narrow a manner as practical, and is a minor modification of the standard Flood Protection Levee Easement, replacing the words "levee, floodwall, gate closure, sandbag closure" with the word "berm".

Approved by:

Linda C. Labure
New Orleans District, Chief
Real Estate Region South Division

WEST SHORE LAKE PONTCHARTRAIN
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ANNEX E

FACILITY/UTILITY RELOCATIONS

UG
UG
SORRENTO PIPELINE COMPANY
ST CHARLES PARISH COUNCIL
EQUILON PIPELINE COMPANY LLC
ST. JOHN THE BAPTIST PARISH
TEXACO PIPELINES LLC
CHARLES DEPT OF N
SHELL PIPELINE COMPANY LP
SOUTHERN STATES PIPELINE CORP
CONCHA CHEMICAL PIPELINE COMPANY
SORRENTO PIPELINE COMPANY LLC
WILLBROS PIPELINE CO
I.P. PETROLEUM CO
UNITEDGAS
CONOCO
SHELL PIPELINE COMPANY LP
SHELL OIL COMPANY
SHELL PIPELINE CO
SHELL PIPELINE COMPANY LP
MIDPRISE PIPELINE CO
BRIDGELINE GAS DISTR
AIR PRODUCTS
MARATHON
ST JOHN PARISH
ST JOHN PARISH
SHELL PIPELINE COMPANY LLC
MIDPRISE PIPELINE COMPANY LLC

West Shore Lake Pontchartrain, LA Hurricane Protection Project

Alignment C (Pipeline Avoidance) Pipeline Crossings
30% Contingency

COMPANY	PRODUCT	SIZE	MII COSTS
MARATHON ASHLAND PIPELINE LLC	CRUDE OIL	30"	$727,289
SHELL PIPELINE COMPANY	REFINED PRODUCTS LINE	24"	$696,083
	GAS	24"	$696,223
ST. JOHN THE BAPTIST PARISH POTABLE WATER	TRANSMISSION LINE	24"	$696,083
SHELL PIPELINE COMPANY LP	AREA WIDE MAINTENANCE	24"	$696,223
MARATHON ASHLAND PIPELINE LLC	PETROLEUM PRODUCT	20"	$636,218
WILPRISE PIPELINE COMPANY	PIPELINE	12.75"	$463,882
SOUTHERN STATES PIPELINE COMPANY	GAS	12.75"	$463,882
WILPRISE PIPELINE COMPANY	NATURAL GAS LIQUID	12"	$463,882
SHELL PIPELINE COMPANY LP	PIPELINE AREA WIDE MAINTENANCE	12"	$463,882
WILPRISE PIPELINE COMPANY	NATURAL GAS LIQUID	12"	$672,761
WILPRISE PIPELINE COMPANY	PIPELINE	12"	$672,761
AIR PRODUCTS	HYDROGEN DUPONT MAINLINE	12"	$672,761
GULF LIQUIDS NEW RIVER	PIPELINE	12"	$672,761
GULF INTERSTATE / BIG THREE INDUSTRIES	NITROGEN	12"	$672,761
GULF INTERSTATE / BIG THREE INDUSTRIES	OXYGEN	12"	$672,761
WILPRISE PIPELINE COMPANY	PIPELINE	12"	$672,761
GULF LIQUIDS NEW RIVER	PIPELINE	12"	$672,761
TEXACO PIPELINE LLC.	EXISTING PIPELINE MAINTENANCE	8"	$448,377
BRIDGELINE GAS DISTRIBUTION LLC	SURVEY LINE	8"	$448,377
ENTERPRISE PIPELINE COMPANY	PROPANE	8"	$448,377
SORRENTO PIPELINE COMPANY	PIPELINE	8"	$448,377
ENTERPRISE - WILPRISE	NGL PROPANE	6.629"	$433,219
BRIDGELINE GAS DISTRIBUTION LLC	BUTANE	6"	$433,219
WILPRISE PIPELINE COMPANY	PIPELINE MAINTENANCE - CLEAR ROW	6"	$433,219
WILPRISE PIPELINE COMPANY	PIPELINE MAINTENANCE - CLEAR ROW	6"	$433,219
BRIDGELINE GAS DISTRIBUTION LLC	BUTANE	6"	$433,219
NICOR EXPLORATION GAS	GAS	6"	$433,219
CHEVRON TEXACO	AREA WIDE FLOWLINE MAINTENANCE & REPAIR (SS01)	6"	$433,219
BRIDGELINE GAS DISTRIBUTION LLC	PROPANE	6"	$433,219
SHELL PIPELINE COMPANY LP	FLOWLINE INSPECT / REPAIR	6"	$433,219
ENTERPRISE PIPELINE COMPANY	LIQUIFIED PETROLEUM GASES (PROPANE)	6"	$433,219
LIG	GAS	4"	$421,624
SHELL OIL COMPANY	EPSILON ETHYLENE CONNECTION	4"	$421,624
SHELL PIPELINE COMPANY LP	EXISTING PIPELINE MAINTENANCE	4"	$421,624
I.P. PETROLEUM COMPANY	PIPELINE	4"	$421,624
		TOTAL	$19,197,927

WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
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ANNEX F

RISK LETTER

DEPARTMENT OF THE ARMY
REAL ESTATE REGION SOUTH DIVISION, CORPS OF ENGINEERS
NEW ORLEANS DISTRICT REAL ESTATE OFFICE
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

REPLY TO
ATTENTION OF

Real Estate Division
Appraisal & Planning Branch

Mr. Jerome Zeringue, Chairman
Coastal Protection and Restoration
Authority Board
P. O. Box 44027
Baton Rouge, LA 70804-4027

Dear Mr. Zeringue:

As you are aware, the West Shore Lake Pontchartrain Hurricane Storm Damage Risk Reduction Study is near complete. The Final Integrated Feasibility Report is scheduled to be complete in December 2014. The report contains preliminary right-of-way maps, which may change once the detail design of the project is completed. For this reason, in accordance with Corps of Engineers Regulation 405-1-12, Chapter 12, dated May 1, 1998, we are hereby formally advising you of the risks associated with acquisition of real estate rights prior to signing of the Project Partnership Agreement (PPA) and receiving a request from our agency for right of entry for construction.

Should you decide to proceed with acquisition of realty interests needed for construction of the subject project prior to our request for such efforts, you will assume full and sole responsibility for any and all costs, responsibility, or liability arising out of such efforts. Generally, these risks include, but may not be limited to the following:

a. The CPRAB may acquire interests or estates that are later determined by the Government to be inappropriate for the project, thus incurring costs, which may not be creditable under the provisions of Public Law 99-662.

b. The CPRAB may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations, including liability arising out of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended.

c. The CPRAB may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under Public Law 91-646, as amended, as well as the payment of additional fair market value to affected landowners which could have been avoided by delaying acquisition until after the report

is approved for any land, easements, and rights-of-way, and the performance of relocations and disposals (LERRD).

d. The CPRAB may incur costs or expenses in connection with its decision to acquire LERRD in advance of the executed PPA and the Government's Notice to Proceed, which may not be creditable under the provisions of Public Law 99-662, or the PPA.

However, should you decide to proceed with acquisition of real estate interests, you are hereby notified that acquisition activities must conform to Public Law 91-646, The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. The Uniform Act describes the rights of landowners impacted by a federally funded project and the responsibilities of government agencies performing acquisition of real estate interests for such projects. Furthermore, in order to ensure that you receive the maximum possible credit once the project alignment is finalized, we suggest that you send for our review the résumé and proposed fees of your intended contractors as well as the following real estate products once completed: ownership plat and legal descriptions, appraisal reports, title reports, proposed negotiated settlements, and relocations assistance payments, if applicable.

If you have questions regarding the acquisition and crediting process, please call Judith Gutierrez, Chief Appraiser at (504) 862-2575 or Todd Klock, Chief, Local Sponsor Acquisition Branch at (504) 862-1920.

Sincerely,

for Judith Gutierrez

Linda C. LaBure
District Chief of Real Estate, New Orleans
Real Estate Region South Division
Real Estate Contracting Officer

WEST SHORE LAKE PONTCHARTRAIN
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West Shore Lake Pontchartrain LA Hurricane and Storm Surge Risk Reduction Feasibility Study
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PART 1: BACKGROUND INFORMATION

INTRODUCTION

General. This appendix presents an economic evaluation of the Recommended Plan for the West Shore Lake Pontchartrain LA Hurricane and Surge Risk Reduction Feasibility Study. The evaluation area includes portions of three parishes in Southeast Louisiana. It 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 Users 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 under existing and future conditions and projects costs. The damages and costs were first calculated using October 2012 price levels but were later updated to October 2014 price levels using the Civil Works Construction Costs Index System (CWCCIS). Damages were converted to equivalent annual values using the FY 2014 Federal discount rate of 3.5 percent and a period of analysis of 50 years. The year 2020 was identified as the base year for each of the alternatives as the basis for plan comparison. Once the Recommended Plan was determined, the equivalent annual damage and benefit estimates, in addition to average annual construction and OMRR&R costs, were recalculated using the current FY 2015 Federal discount rate of 3.375 percent.

NED Benefit Categories Considered. The NED procedure manuals for coastal 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 alternative generally result from the reduction of actual or potential damages caused by inundation. Inundation reduction, which is the only category of NED benefits addressed in this evaluation, includes the reduction of physical damages to structures, contents, and vehicles.

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. Damages included in the appendix considered both existing and future conditions. Projections of the future development expected to be in place in the study area during the period of analysis were included as part of the future condition analysis.

Office of Management and Budget survey forms were used to collect information on the value and placement of contents in the industrial facilities located in the study area. The information from these surveys was used to develop the physical flood damage and benefits for these industrial properties. This is applicable to the Zapps Potato Chip facility.

Emergency Cost Reduction Benefits. Emergency costs are those costs incurred by the community during and immediately following a major storm. They include the costs of emergency measures, such as evacuation and reoccupation activities conducted by local governments and homeowners, repair of streets, highways, and railroad tracks, and the subsequent cleanup and restoration of private, commercial, and public properties. Due to time and budget constraints, emergency costs were not quantified in this evaluation.

Regional Economic Development. When the economic activity lost in the 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 was used to address the impacts of the construction spending only associated with the Recommended Plan, since only this alternative provides detailed cost information necessary to prepare a complete and accurate analysis. The RED account is addressed at the conclusion of this appendix.

DESCRIPTION OF THE STUDY AREA

Geographic Location. The study area includes the portions of St. James and St. John the Baptist Parishes located on the east bank of the Mississippi River and the portion of St. Charles Parish on the east bank of the Mississippi River west of the Bonnet Carre' Spillway. The West Shore Lake Pontchartrain evaluation area was divided into 81 unique hydrologic reaches to enable an economic analysis of the project alternatives through the use of the HEC-FDA certified model.

Land Use. The total number of acres of developed, agricultural, and undeveloped land in the study area is shown in Table 1. As shown in the table, approximately 5 percent of the total acres in the study area are currently developed. Since there are approximately 24,000 acres of agricultural land and 124,000 acres of undeveloped land there is sufficient land available to accommodate the projected residential and non-residential development through the year 2080 without impacting the wetlands in the area. This projected future development is expected to be located on parcels that tend to be relatively higher ground and are the least exposed to flood risk.

SOCIOECONOMIC SETTING

Population and Number of Households. Table 2 displays the population in each of the parishes for the years 1980, 1990, 2000, and 2010 as well as projections for the year 2020 and the year 2080, the two years that engineering inputs were modeled and used to calculate damages. Population projections are based on the Moody's County Forecast Database, which has population projections to the year 2038. Moody's projections were extended by New Orleans District from the year 2030 to the year 2080 based on the growth rate forecasted by Moody's for the years 2018 through 2038. As shown in Table 2, St. Charles, St. James and St. John Parishes experienced a steady increase in population between 1980 and 2010.

Table 3 displays the estimated population of the three parishes located within the inventoried portion of the study area for the year 2012 and the projected population for the years 2020 and 2070. The 2012 estimates are based on an inventory of residential and non-residential properties assembled in 2012 by field survey teams. The number of inventoried residential structures was then multiplied by 2.9, the average number of persons per household in the study area in 2012. The annual compounded growth rate in population between 2012 and 2020 is expected to be 0.32 percent and 0.77 percent between 2020 and 2070.

Table 4 shows the total number of households in each parish for the years 1980, 1990, 2000, and 2010 and projections for the years 2020 and 2080. The projected number of households was based on the Moody's County Forecast Database and extended from the year 2038 to the year 2080 based on the growth rate forecasted by Moody's for the years 2018 through 2038.

The three parishes experienced a steady increase in the total number of households between 1980 and 2010, which paralleled the growth in population. This increase is commensurate with the population growth experienced by the entire Gulf Coast region during the same period. Similar to the projected population growth in the three-parish area, the number of households is expected to continue increasing through the year 2080.

Income. Table 5 shows the per capita personal income levels for each parish for the years 1990, 2000, 2005, 2010 and 2012, the year with the latest available data. As shown in the table, both parishes experienced a steady increase in per capita income between 1990 and 2012.

Employment. Table 6 shows the total nonfarm employment by parish for the years 1970, 1980, 1990, 2000, 2010, and projections for the years 2020 and 2080. The employment projections were based on the Moody's County Forecast Database and extended from the year 2038 to the year 2080 based on the growth rate forecasted by Moody's for the years 2018 through 2038.

In all portions of the study area, growth is highly dependent upon the major employment sectors. The increase in employment in the three parishes is likely the result of the influx of population and businesses that occurred to the area after Hurricane Katrina after 2005. The leading employment sectors include educational services, health care and social assistance, manufacturing, and retail trade. Approximately 1,900 non-residential structures are located in the study area including petroleum service companies, river services companies, Zapp's Potato Chips Factory in Gramercy, and the Marathon refinery in Garyville. Slightly over 10 percent of the total acres in the study area, or 23,800 acres, is devoted to agriculture, and about half of these acres is used for growing sugar cane.

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

RECENT FLOOD HISTORY

Tropical Flood Events. While the three parishes have periodically experienced localized flooding from excessive rainfall events, the primary cause of the flood events that have taken place in the three-parish study area has been the tidal surges from hurricanes and tropical storms. During the past 25 years, coastal Louisiana was impacted by eight major tropical events: Hurricane Juan (1985), Hurricane Andrew (1992), Tropical Storm Isidore and Hurricane Lili (2002), Hurricanes Katrina and Rita (2005), and Hurricanes Gustav and Ike (2008). While none of these storms tracked directly through the study area, the tidal surges associated with these storm events inundated structures and resulted in billions of dollars in damages throughout coastal Louisiana.

Table 7 provides a summary of the total Federal Emergency Management Agency (FEMA) flood claims paid to all Louisiana policyholders as a result of these tropical events. The table includes the number of paid losses, the total amount paid, and the

average amount paid on each loss. The total and average paid losses have been converted to reflect 2011 price levels. The table excludes losses that were not covered by flood insurance.

The following is a summary of each of the eight major tropical events and their effects on the two-parish area and coastal Louisiana.

Hurricane Juan. Hurricane Juan caused extensive flooding throughout southern Louisiana due to its prolonged 5-day movement back and forth along the Louisiana coast. Rainfall totals in the area ranged from 5 inches to almost 17 inches. The storm was responsible for storm surges of 5 to 8 feet and tides of 3 to 6 feet above normal. According to FEMA officials, the estimated value of the residential and commercial damage and public assistance throughout coastal Louisiana totaled $112.5 million.

Hurricane Andrew. On August 26, 1992, Hurricane Andrew made landfall in St. Mary Parish, 80 miles west of Morgan City. FEMA reported that over 2,000 flood claims were filed as a result of the storm in Louisiana. These claims had a total value of over $25 million.

Tropical Storm Isidore and Hurricane Lili. On October 3, 2002, one week after Tropical Storm Isidore affected the southeastern and south central coastal areas of Louisiana, Hurricane Lili made landfall on the western edge of Vermilion Bay south of the cities of Abbeville and New Iberia as a weak Category 2 hurricane. The high winds caused tidal flooding in the communities east of the eye of the storm.

Insured flood losses from Tropical Storm Isidore and Hurricane Lili totaled nearly $600 million. Approximately $105 million of insured losses were related to Tropical Storm Isidore, while Hurricane Lili caused $471 million of insured losses. According to windshield surveys conducted by the American Red Cross, approximately 10,000 residential structures were damaged by winds and storm surges of the two storms. These surveys included both insured and uninsured structures. Tropical Storm Isidore caused damage to 2,905 structures, while Hurricane Lili caused damage to 7,356 structures.

In a revised report released in mid-November by the Louisiana State University Agricultural Center (LSU AgCenter), the estimated agricultural damages caused by Tropical Storm Isidore and Hurricane Lili totaled $454.3 million. This estimate also includes the agricultural damages caused by the continuation of rain during the month of October, which delayed the harvesting of crops. The excessive rains and storm surge flooded the agricultural fields and increased the harvest costs.

Hurricane Katrina. On August 29, 2005, Hurricane Katrina made landfall near the town of Buras in Plaquemines Parish about 50 miles east of coastal Lafourche and Terrebonne parishes. While the storm entered as a category 3 storm with winds in excess of 120 mile per hour, its storm surge of approximately 30 feet was more characteristic of a Category 5

hurricane. The majority of the damages from Hurricane Katrina occurred outside of the West Shore Lake Pontchartrain study area. However, if the hurricane had taken a more westerly track, the study area could have experienced the same magnitude of flooding as the city of New Orleans.

According to the Department of Health and Hospitals, approximately 1,400 deaths were reported following Hurricane Katrina. Approximately 1.3 million residents were displaced immediately following the storm, and 900,000 residents remained displaced as of October 5, 2005.

The storm caused more than $40.6 billion of insured losses to the homes, businesses, and vehicles in six states. Approximately two thirds of these losses, or $25.3 billion, occurred in Louisiana based on data obtained from the Insurance Information Institute. According to the Louisiana Recovery Authority, approximately 150,000 housing units were damaged, and according to the Department of Environmental Quality, 350,000 vehicles, and 60,000 fishing and recreational vessels were damaged.

According to the LSU AgCenter, agricultural losses totaled approximately $825 million. The agricultural resources impacted by the storm include sugarcane, cotton, rice, soybeans, timber, pecans, citrus, and livestock. The losses to aquaculture (crawfish, alligators, and turtles), fisheries (shrimp, oysters, and menhaden), and wildlife and recreational resources totaled approximately $175 million.

Hurricane Rita. The hurricane made landfall along the Texas-Louisiana border on September 24, 2005, as a Category 3 storm with winds in excess of 120 miles per hour. A storm surge of approximately 15 - 20 feet affected Coastal Louisiana from Terrebonne Parish to the Texas border. With estimated insured losses of approximately $3 billion, Hurricane Rita became one of the most costly natural disasters in U.S. history.

Approximately 2,000 square miles of farmland and marshes throughout the coastal area were inundated. According to the LSU AgCenter, agricultural losses totaled approximately $490 million. The agricultural resources impacted by the storm include sugarcane, cotton, rice, soybeans, timber, pecans, citrus, and livestock. The losses to aquaculture (crawfish, alligators, and turtles), fisheries (shrimp, oysters, and menhaden), and wildlife and recreational resources totaled approximately $100 million.

Hurricanes Gustav and Ike. On September 1, 2008, almost exactly three years after Hurricane Katrina, Hurricane Gustav made landfall near Cocodrie in Terrebonne Parish as a strong Category 2 hurricane. It followed a northwest path into central Louisiana, and most of the damages caused by the storm resulted from its high winds and heavy rain. Coastal flooding occurred in the low lying areas of Jefferson and Lafourche Parishes and the coastal areas of Terrebonne Parish south of the City of Houma.

Nearly 2 million residents of South Louisiana evacuated in the days before Gustav made landfall. Louisiana officials reported that emergency spending totaled approximately $500 million, which included $210 million for state agencies, $48 million for deploying the National Guard, $13.5 million for general evacuation shelters, $3 million for special-needs medical shelters, $6.1 million for transporting the medical needy, $21 million for costs of contraflow and evacuation from coastal communities and other areas, $20 million in special generators to open ice plants, pharmacies and service stations throughout the impacted areas, $5 million for state-purchased fuel, $19.7 million for ready-to-eat meals, $5.3 million for ice, and $2.5 million for water supplies. The State Department of Transportation estimated that it cost approximately $50 million to remove 1.5 million cubic yards of debris, and approximately $20 million to repair draw bridges.

Almost two weeks later, on September 12 and 13, the Louisiana coastal region incurred additional flood damages as Hurricane Ike moved along the Louisiana coast. According to estimates from the state officials, approximately 12,000 homes and businesses were flooded by the two storms. Approximately 2,500 buildings in Terrebonne Parish south of the City of Houma incurred flood damages from Hurricane Ike.

The LSU AgCenter estimated that potential lost revenues and damages to the infrastructure of the agriculture, forestry, and fisheries industries in Louisiana resulting from the two hurricanes totaled approximately $959 million. The storm surge primarily affected the cattle, rice, soybeans, and sugarcane.

Hurricane Isaac. On 29 August 2012, exactly seven years to the day after Hurricane Katrina, Southeast Louisiana was impacted by Hurricane Isaac. The storm made landfall near the mouth of the Mississippi River as a minimal Category 1 hurricane. It then reentered the Gulf of Mexico and made a second landfall near Port Fourchon, Louisiana. Hurricane Isaac produced 45 hours of tropical force winds from the south and southeast as it slowly tracked west of the city of New Orleans. The wind speed and track, combined with slow forward motion, large maximum wind radius, and intense rainfall, produced high storm surges and water elevations throughout coastal Louisiana. Substantial flooding occurred in areas outside federal levee systems, including, but not limited to Slidell, Mandeville, Madisonville, LaPlace, Braithwaite, and Lafitte. In the study area, the hurricane flooded approximately 7,000 structures in the area of LaPlace. The flood claims attributed to Hurricane Isaac in St. John Parish were approximately $226,810,360. This figure is based on 3,332 flood claims reported by FEMA which does not include households without flood insurance policies.

FEMA Flood Claims. The study area has been impacted by numerous tropical events during the past several decades. According to FEMA data, flood claims for the three parishes in the West Shore-Lake Pontchartrain evaluation area that were paid between 1978 and December 2012 totaled $338 million: $100 million in St. Charles Parish, $236 million in St. John the Baptist Parish, and $1.74 million in St. James Parish. Table 8 shows the insurance payments between 1978 and December 2012 for each of the parishes in the study area.

SCOPE OF THE STUDY

Problem Description. The exposure of the study area to coastal storm surge was made apparent by Hurricane Isaac (August 2012). Approximately 7,000 structures in the study area were damaged and the I-10 and I-55 transportation routes were impassable for 6 days after the storm had passed, necessitating the use of alternative transportation routes. The damages and response times during Hurricane Isaac were exacerbated due to standing water for days after the event.

Project Alternatives. Four alternatives were considered as part of the evaluation. Alternative A consists of 20.41 miles of earthen levee, which begins at the West Guide levee of the Bonne Carre' Spillway. It extends west around the interstate interchange and along the wet/dry interface. The Recommended Plan follows the same alignment as Alternative A between the West Guide levee of the Bonnet Carre' Spillway to the US-51 Interchange where it tracks north across US-51. It consists of 18.27 miles of earthen levees and a T-wall. Both Alternatives A and C will implement voluntary localized storm surge risk reduction measures which include elevation of structures and acquisition by government in the western portion of the study area. Alternative D is a westward continuation of The Recommended Plan along the I-10 corridor into Ascension Parish. At the St. James Parish line, Alternative D continues west just slightly north of I-10 until it reaches Old New River where it will proceed north to a non-federal levee in Ascension Parish (Laurel Ridge Levee). There are no localized storm surge risk reduction measures involved in this alternative.

Alternative C was determined to be the Recommended Plan for the 0.01 annual exceedance probability (AEP) level of risk reduction. The alternative includes the construction of levee alignment C in St. John the Baptist and St. Charles parishes, along with localized storm surge risk reduction measures in St. James Parish. These measures in St. James Parish include the construction of three berms built to the elevation 6.5 feet NGVD and the installation of flap gates for the culverts along Highway 3125. For areas located outside of the influence of berms and flap gates that contain structures with first floor elevations below the stages associated with the 2020 1% (100-year) ACE event, 14 residential structures will be raised to the stage associated with the 2070 1% (100-year) ACE event; 4 non-residential structures will be flood proofed to 3 feet above the ground elevation; and smaller berms will be constructed for 5 light industrial/warehouse facilities.

PART 2: ECONOMIC AND ENGINEERING INPUTS TO THE HEC-FDA MODEL

HEC-FDA MODEL

Model Overview. The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.2.5a Corps-certified model was used to calculate the damages and benefits for the West Shore Lake Pontchartrain evaluation. The economic and engineering inputs necessary for the model to calculate damages for existing conditions (2012), the project base year (2020), and the final year in the period of analysis (2070) include structure inventory, future development, contents-to-structure value ratios, vehicles, first floor elevations, and depth-damage relationships, ground elevations, and without-project stage probability relationships.

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

ECONOMIC INPUTS TO THE HEC-FDA MODEL

Structure Inventory. Field surveys were completed in 2012 (prior to Hurricane Isaac) to develop a residential and non-residential structure inventory for the economic analysis. Based on the structural information collected during the field surveys, the Marshall and Swift Valuation Service was used to calculate a depreciated replacement cost for all residential and non-residential structures in the study area reaches. The inventoried structures were classified as one of 14 structure types: residential one-story with slab or pier foundation, residential two-story with slab or pier foundation, mobile home, eating and recreation, grocery and gas station, multi-family residence, professional building, public and semi-public building, repairs and home use establishment, retail and personal services building, and warehouse, and contractor services building. Table 9 shows the number of structures by structure category and the total number of vehicles associated with the residential structures for existing conditions (2012) for each study area reach or HEC-FDA model station number. The value of the land was not included in the analysis.

Future Development Inventory. Projections were made of the future residential and non-residential development to take place in the West Shore Lake Pontchartrain study area under without-project conditions. Based on a pattern of historical development, a total of 565 residential and 149 non-residential structures were placed on the undeveloped land within the study area reaches as part of the structure inventory for the year 2020. An additional 10,428 residential and 679 non-residential structures were added to the inventory for the year 2020 to obtain the structure inventory for the year 2070.

The development projected to occur in each study area reach between the year 2012 and the year 2020 was placed at an elevation equal to the stage associated with the 2020 without-project one percent annual chance exceedance (1% ACE) 100-year event, unless the ground elevation was higher. The projected development occurring after the year 2020 was placed at an elevation equal to the stage associated with the without-project 1% ACE (100-year) event for the year 2070, unless the ground elevation was higher. The values for the projected residential and non-residential structures were assigned using the average value calculated for each structure category based on the 2012 existing development.

Table 10 shows the number of structures in each structure category and the average depreciated replacement values for (2012 price level) existing conditions. Table 11 shows the projected number of structures in each structure category for the future years 2020 and 2070, respectively. The value of the land was not included in the analysis.

Residential and Non-Residential Content-to-Structure Value Ratios. Content-to-structure value ratios (CSVRs) were developed based on the on-site interviews conducted as part of the Jefferson-Orleans, Donaldsonville to the Gulf, and Morganza to the Gulf evaluations. These interviews were conducted with the owners of a sample of structures from each of the three residential content categories and each of the eight non-residential content categories from each of the three evaluation areas. Thus, a total of 96 residential structures and 210 non-residential structures were used to determine the CSVRs for each of the residential and non-residential categories.

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 is a method that 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. Thus, bootstrapping provides a way to account for the distortions caused by the specific sample that may not be fully representative of the population.

As shown in Table 12, a CSVR was computed for each residential and non-residential structure in the sample based on the total depreciated content value developed from the surveys. An average CSVR and standard deviation for each of the five residential structure categories and nine commercial structure classifications was calculated as the average of the individual structure CSVRs.

Vehicle Inventory. Based on 2000 Census block group data for the evaluation area, it was determined that there are an average of 1.74 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. Using the Manheim Used Vehicle Value Index, which is based on over 4 million annual automobile transactions adjusted to reflect retail replacement value, each vehicle was assigned an average value of $12,879 at the 2012 price level. Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $6,723 ($12,879 x 1.74 x 0.30) was assigned to each individual residential structure record in the HEC-FDA model. This figure was rounded to $7,000 per vehicle for the calculation of damages. If an individual structure had more than one housing unit, then the adjusted vehicle value was assigned to each housing unit in a residential or multi-family structure category.

First Floor Elevations and Elevation of Vehicles. Topographical data obtained from the Light Detection and Ranging (LIDAR) digital elevation model (DEM) using the NAVD88 (2004.65 epoch) were used to determine ground elevations. Field survey teams estimated the height of each residential and non-residential structure above the ground using hand levels. The ground elevation was added to the height of the foundation of the structure above the ground in order to determine the first floor elevation of the structure. Vehicles were assigned to the ground elevation of the adjacent residential structures.

Depth-Damage Relationships. Site-specific saltwater, long duration (approximately one week) depth-damage relationships, developed by a panel of building and construction experts for a separate study in Jefferson and Orleans Parishes, were used in the economic analysis. The Jefferson Orleans study area is adjacent to West Shore Lake Pontchartrain study area, approximately 25 miles to the east. These curves indicate the percentage of the total structure value that would be damaged at various depths of flooding. Damage percentages were determined for each one-half foot increment from one-half foot below first floor elevation to two feet above first floor, and for each one-foot increment from 2 feet to 15 feet above first floor elevation. The panel of experts developed depth-damage relationships for five residential structure categories and for three commercial structure categories. Depth-damage relationships were also developed for three residential content categories and eight commercial content categories.

Based on observations after Hurricane Katrina, mold and mildew only affects the contents located on the second floor of residential structures if the depth of flooding reaches the second floor. Thus, an adjustment was made to only include damages to second floor contents in cases where the depth of flooding extended above the first floor. This more adequately represents damages to the contents of two story residential structures.

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

Table 13 shows the residential and non-residential depth-damage relationships developed for structures, contents, and vehicles. More specific data regarding the depth-damage relationships can be found in the final report in support of Jefferson and Orleans Flood Control Feasibility Study (June 1996).

A post-flood survey was conducted to obtain damage information from residents in the study area whose properties had incurred flood damage from Hurricane Isaac. The owners of five one-story residential structures participated in the survey. The residents were asked to provide structural information that could be used to determine the depreciated replacement cost of their homes and the depth of flooding above first floor elevation, the dollar value of the damage to their structure, and the percentage of the contents damaged as a result of Hurricane Isaac. The residents were also asked to provide the dollar value of the damage to their vehicles. The information obtained from the surveys was then compared to the depth-damage relationships used in the evaluation. An evaluation of these data showed that residential one story structures receiving an average of 1.4 feet of flooding had an average of 61 percent of the structure damaged and 80 percent of the contents damaged. In addition, the vehicles were shown to be 100 percent damaged at an average of 1.4 feet of flooding. This empirical evidence closely correlates with the information received from the expert elicitation used in the salt-water, long-duration depth damage functions.

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

Structure and Vehicle Values. In order to quantify the uncertainty surrounding the values calculated for the residential and non-residential structure inventory, several survey teams valued an identical set of structures from various evaluation areas in the Gulf Coast region. The structure values calculated by each of the teams during windshield surveys were used to

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

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

Content-to-Structure Value Ratios. A CSVR was computed for each residential and non-residential structure in the sample based on the total depreciated content value developed from these interviews. The mean and standard deviation values for each residential and non-residential category were entered into the HEC-FDA model after applying statistical bootstrapping. The model used a normal probability density function to describe the uncertainty surrounding the CSVR for each content category. The expected values and standard deviations are shown for each of the three residential categories and the eight non-residential categories are shown in Table 12.

First Floor Elevations. The topographical data used to estimate the first floor elevations assigned to the structure inventory contain two sources of uncertainty. The first source of uncertainty arises from the use of the 2009 LIDAR data, and the second source of uncertainty arises from the use of hand levels to determine the structure foundation heights above ground elevation. The error implicit in using LIDAR data to estimate the ground elevation of each of the inventoried structures is normally distributed with a mean of zero and a standard deviation of 0.6 feet. According to the Hydrologic Engineering Center training manual, and the uncertainty implicit in estimating foundation heights using hand levels from within 50 feet of the structure is normally distributed with a mean of zero and a standard deviation of 0.3 feet at the 95 percent level of confidence.

Depth-Damage Relationships. A triangular probability density function was used to determine the uncertainty surrounding the damage percentage associated with each depth of flooding. A minimum, maximum and most likely damage estimate was provided by a panel of experts for each depth of flooding. The specific range of values regarding probability distributions for the depth-damage curves can be found in the final report dated June 1996 entitled *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs)in Support of the Jefferson and Orleans Flood Control Feasibility Studies*.

ENGINEERING INPUTS TO THE HEC-FDA MODEL

Ground Elevations. Geospatial Engineering acquired elevation data for the West Shore Lake Pontchartrain study area. The LIDAR data were processed and used to create a digital elevation model (DEM) with a five-foot by five-foot horizontal grid resolution. The DEM used NAVD88 2004.65 vertical datum to determine the ground elevations for each of the residential and non-residential structures in the evaluation area.

Stage-Probability Relationships. Stage-probability relationships were provided for the existing (2012) without-project condition, future without-project conditions (2020 and 2070) and for future with-project conditions 0.01 AEP level of risk reduction (2020 and 2070). Water surface profiles were provided for eight annual chance exceedance (ACE) events: 99% (1-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year), 0.5% (200-year), and 0.2% (500-year). The without-project water surface profiles were based on storm surge and incorporated heavy rainfall events. The with-project water surface profiles were based only on rainfall.

The 99% ACE (1-year) event, 20% ACE (5-year) event, and 10% ACE (10-year) event water surface profiles for the year 2012 were based on gage data for the without-project condition. For each of these ACE events, the water surface profiles for the years 2020 and 2070 were determined by adding relative sea level rise to the gage data. The water surface profiles for the 2% ACE (50-year) event through the 0.2% ACE (500-year) event were based on results from the ADCIRC model. The 4% ACE (25-year) event stages were determined by interpolation between the 10% ACE (10-year) event stages and the 2% ACE (50-year) event stages.

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

Ground Elevations. An engineering survey was conducted to estimate the uncertainty surrounding the use of the 2009 LIDAR data to estimate ground elevations in urbanized areas. A combination of the uncertainty surrounding the ground elevations and the foundation height (0.6 feet) of a residential and non-residential structure was discussed in the first floor elevation uncertainty section of this report.

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

PART 3: NATIONAL ECONOMIC DEVELOPMENT (NED) FLOOD DAMAGE AND BENEFIT CALCULATIONS

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 83 study area reaches for which a structure inventory had been conducted. A range of possible values, with a maximum and a minimum value for each economic variable (first floor elevation, structure and content values, and depth-damage relationships), was entered into the HEC-FDA model to calculate the uncertainty or error surrounding the elevation-damage, or stage-damage, relationships. The model also used the number of years that stages were recorded at a given gage to determine the hydrologic uncertainty surrounding the stage-probability relationships.

The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. For each variable, a sampling technique was used to select from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes.

Stage-Damage Relationships with Uncertainty. The HEC-FDA model used the economic and engineering inputs to generate a stage-damage relationship for each structure category in each study area reach under existing (2012) and future (2020 and 2070) conditions. The possible occurrences of each economic variable were derived through the use of Monte Carlo simulation. A total of 1,000 iterations were executed by the model for the West Shore Lake Pontchartrain evaluation. The sum of all sampled values was divided by the number of samples to yield the expected value for a specific simulation. A mean and standard deviation was automatically calculated for the damages at each stage.

Stage-Probability Relationships with Uncertainty. The HEC-FDA model used an equivalent record length (50 years) for each study area reach to generate a stage-probability relationship with uncertainty for the without-project condition under existing (2012) and future (2020 and 2070) conditions through the use of graphical analysis. The model used the eight stage-probability events together with the equivalent record length to define the full range of the stage-probability or stage-probability functions by interpolating between the data points. Confidence bands surrounding the stages for each of the probability events were also provided.

Without-Project Expected Annual Damages. The model used Monte Carlo simulation to sample from the stage-probability curve with uncertainty. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). For the without-project alternative, the expected annual damages (EAD) were totaled for each study area reach to obtain the total without-project EAD under existing (2012) and future (2020 and 2070) conditions. Table 14 shows the number and type of structures that are damaged by each of annual chance exceedance events for the years 2020 and 2070 under without-project conditions using the intermediate sea level rise scenario. Table 15 shows the without-project damages by probability event for the years 2020 and 2070 using the intermediate sea level rise scenario.

Structure Inventory Adjustments for Repetitive Flooding. Adjustments were made to the structure inventory before executing the HEC-FDA model to more accurately reflect the most likely future without-project and with-project conditions. Under without-project and with-project conditions, owners of those structures that were identified as repetitively flooded structures are expected to take remedial measures to reduce flood risk rather than incur repair costs a highly frequent basis. To account for this effect, for the 2020 residential and non-residential structure inventory, all structures with a first floor elevation less than or equal to the 2012 10% ACE (10-year) water surface elevation within each study area reach were elevated to the stage associated with the 2070 1% ACE (100-year) event using the historic rate of sea-level rise scenario projected to occur during the period of analysis. This would also ensure that the structures would not be located within the 100-year floodplain during the period of analysis. The first floor elevations of 241 residential and 81 non-residential structures were adjusted for repetitive flooding. All but 10 structures would be behind the levee system. The remaining 10 structures are south of hwy 3125 and only decreases the available benefits associated with the flap gates.

Equivalent Annual Damages. Damages for each of the years during the period of analysis were computed by linear interpolation between 2020 and 2070. The FY 2014 Federal discount rate of 3.5 percent was used to compound the stream of expected annual damages and benefits before the project base year and to discount the stream of expected annual damages and benefits occurring after the base year to calculate the total present value of the damages over the period of analysis. The present value of the expected annual damages was then amortized over the period of analysis using the Federal discount rate to calculate the equivalent annual damages. Table 16 shows the equivalent annual without-project damages, with-project damages, equivalent annual benefits in both 2012 and inflated 2014 prices for each flood risk management component using projected intermediate sea level rise. It should be noted that future development was not included in the damage and benefit estimates for the proposed localized storm surge risk

reduction measures in St. James Parish. Since future development was not included in the damage and benefit calculations for the localized flood risk reduction components in St. James Parish, then the future development in St. James Parish was also excluded in the damage and benefit calculations for the Recommended Plan. This was done in order to have consistent damage results for all the individual components totaled and the results for the components combined into one model. Table 17 shows the equivalent annual without-project damages, with-project damages, equivalent annual benefits in both 2012 and inflated 2014 prices for the Recommended Plan by study area reaches using projected intermediate sea level rise.

PART 4: PROJECT COSTS OF THE RECOMMENDED PLAN

Construction Schedule. Construction of the Recommended Plan is expected to begin in the year 2015 and will continue through the year 2020, which is established as the base year for analysis. For the 0.01 ACE level of risk reduction structural system component of this plan, four levee lifts are scheduled after the year 2020 to maintain the design elevation. The first levee lift will be overbuilt and allowed to settle for several years before the later levee lifts are added. The later lifts will account for the relative sea-level rise and subsidence that is projected to occur throughout the period of analysis. Construction of the berms and the installation of the flap gates on culverts are expected to begin in the year 2018 and be completed in the year 2019. Other localized storm surge risk reduction measures are implemented in the year 2019.

Average Annual Costs. Life cycle cost estimates were provided for the Alternative C levee alignment system in October 2014 price levels. The localized flood risk reduction components for the Recommend Plan, which included the costs associated with structure elevation, flood proofing and smaller berms for selected light industry/warehouse facilities, were initially estimated at 2012 price levels and inflated to 2014 price levels using the CWCCIS. The initial construction cost (first costs), along with the schedule of expenditures, were used to determine the interest during construction and gross investment cost at the end of the installation period (2020). The FY 2014 Federal discount rate of 3.5 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis. The costs for the recommend plan are also shown using the current FY 2015 Federal discount rate of 3.375 percent.

The operations, maintenance, relocations, rehabilitation, and repair (OMRR&R) costs for each component of the Recommended Plan during the period of analysis was discounted to present value and annualized using the Federal discount rate of 3.5 percent for 50 years. The OMRR&R costs for the recommend plan were also annualized using the current FY 2015 discount rate of 3.375 percent.

Tables 18 through 24 C provide the life cycle costs for each of the project components, the average annual construction costs, the annual operation and maintenance costs, and the total average annual costs. The interest during construction costs is also included in the calculation of total average annual costs. Tables 25 through 31 C displays the annualization of OMRR&R costs over the period of analysis.

PART 5: RESULTS OF THE ECONOMIC ANALYSIS

NET BENEFIT ANALYSIS

Calculation of Net Benefits. The expected annual benefits attributable to the project alternative were converted to an equivalent time frame by using the FY14 Federal discount rate of 3.5 percent, and also at the current FY 2015 Federal discount rate of 3.375 percent for the Recommended Plan. The base year for this conversion is the year 2020 for the Recommended Plan. The equivalent annual benefits were then compared to the average annual costs to develop a benefit-to-cost ratio for the alternative. The net benefits for the alternative were calculated by subtracting the average annual costs from the equivalent annual benefits. The net benefits were used to determine the economic justification of the project alternative.

Net Benefits for the Flood Risk Management Project Components including Levee Alignment Alternative C and all Localized Storm Surge Risk Reduction Measures. Tables 32 through 37 summarize the equivalent annual damages and benefits, total annual costs, benefit-to-cost ratio, and equivalent annual net benefits for each component of the system analyzed. The benefits and costs are displayed in both 2012 and 2014 price levels. The benefits were originally calculated in 2012 price levels and the costs were calculated in 2014 price levels. The Civil Works Construction Cost Index System (CWCCIS) was used to price level the benefits and costs. Table 38 A contains the information mentioned above for the localized storm surge risk reduction measures outside of the structural levee system and Table 38 B shows the same results excluding Berm 2, given that this increment was not economically justified. Table 39 A summarizes the equivalent annual damages and benefits, total annual costs, benefit-to-cost ratio, and equivalent annual net benefits for the all components analyzed in the West Shore Lake Pontchartrain study area. This includes both the structural levee alignment and all localized storm surge risk reduction measures.

Net Benefits for the Recommended Plan. The equivalent annual damages and benefits, total annual costs, benefit-to-cost ratio, and equivalent annual net benefits for the Recommended Plan are displayed in Table 39 B. This includes Alternative C levee alignment and all of the localized storm surge risk reduction measures excluding Berm 2. The Recommended Plan has higher equivalent annual net benefits than the plan including Berm 2, and thus constitutes the National Economic Development (NED) Plan. Table 39 C shows the results from a single execution of the HEC-FDA model combining all flood

risk management components as a system (structural and localized storm surge risk reduction measures excluding Berm 2). Table 39 D shows the net benefits for the recommend plan using the current FY 2015 Federal discount rate of 3.375 percent. Estimates of EAD and benefits displayed as the summation of model executions for each individual FRM component varies from the estimates displayed for a model execution combining all flood risk management components is attributable to the manner in which the aforementioned Monte Carlo simulations are performed when system components are permitted to interact with each other.

Results at the OMB 7% Discount Rate. Project costs, OMRR&R, equivalent annual project damages, benefits, and net benefits are similarly displayed in Tables 40 through 61 C using the Office of Management and Budget (OMB) discount rate of 7 percent.

REGIONAL ECONOMIC DEVELOPMENT IMPACTS OF RECOMMENDED PLAN

Background. The Westshore Lake Pontchartrain hurricane risk reduction system consists of a levee alignment in St. Charles and St. John the Baptist Parishes and a series of localized storm surge risk reduction measures including the construction of berms, the installation of flap gates, the raising residential structures, and the floodproofing nonresidential structures in St. James Parish. This system is being implemented in response to reoccurring hurricane storm damage and is designed to prevent loss of life and to reduce flood damages. For this analysis, the regional economic development (RED) effects of implementing the components of the Westshore Lake Pontchartrain hurricane risk reduction system will be estimated. The RECONS impact area the Gulf of Louisiana consisting of the New Orleans and Baton Rouge Metropolitan Statistical Areas was selected based on the labor market, commuter-shed, and population centers serving the project area. According to RECONS' 2009 data, the population of the study area is 2,199,734. The number of households is 816,005. Total personal income is $90,517 million (Table 62).

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

The specific input-output model used in this analysis is RECONS (Regional Economic System). This model was developed by the Institute for Water Resources (IWR), Michigan State University, and the Louis Berger Group. RECONS uses industry multipliers derived from the commercial input-output model IMPLAN to estimate the effects that spending on USACE projects has on a regional economy. The model is linear and static, showing relationships and impacts at a certain fixed point in time. Spending impacts are composed of three different effects: direct, indirect, and induced.

Direct effects represent the impacts the new federal expenditures have on industries which directly support the new project. Labor and construction materials can be considered direct components to the project. Indirect effects represent changes to secondary industries that support the direct industries. Induced effects are changes in consumer spending patterns caused by the change in employment and income within the industries affected by the direct and induced effects. The additional income workers receive via a project may be spent on clothing, groceries, dining out, and other items in the regional area.

The inputs for the RECONS model are expenditures that are entered by work activity or industry sector, each with its own unique production function. The production function "FRM Construction" was selected to gauge the impacts of the construction of the levee, the berms, the installation of the flap gates, the structure raising, and the floodproofing of structures. The production function "FRM Operations and Maintenance" was selected to gauge the impacts of the operations and maintenance costs associated with the features of the system. The baseline data used by RECONS to represent the regional economy of Louisiana are annual averages from the Bureau of the Census, the Bureau of Labor Statistics, and the Bureau of Economic Analysis for the year 2009. The model results are expressed in 2014 dollars.

Assumptions. Input-output analysis rests on the following assumptions. The production functions of industries have constant returns to scale, so if output is to increase, inputs will increase in the same proportion. Industries face no supply constraints; they have access to all the materials they can use. Industries have a fixed commodity input structure; they will not substitute any commodities or services used in the production of output in response to price changes. Industries produce their commodities in fixed proportions, so an industry will not increase production of a commodity without increasing production in every other commodity it produces. Furthermore, it is assumed that industries use the same technology to produce all of its commodities. Finally, since the model is static, it is assumed that the economic conditions of 2009, the year of the socio-economic data in the RECONS model database, will prevail during the years of the construction process.

Description of Metrics. "Output" is the sum total of transactions that take place as a result of the construction project, including both value added and intermediate goods purchased in the economy. "Labor Income" includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. "Gross Regional Product (GRP)" is the value-added output of the study regions. This metric

captures all final goods and services produced in the study areas because of the project's existence. It is different from output in the sense that one dollar of a final good or service may have multiple transactions associated with it. "Jobs" is the estimated worker-years of labor required to build the project.

Results. For the region including the study area, the construction stimulus of $1.066 billion would generate 15,773 worker-years of labor, $853,482,895 in labor income, $1,743,979,232 in output, and $1,130,044,210 in Gross Regional Product (see Table 62). For the state of Louisiana as a whole, the construction stimulus would generate 16,623 worker-years of labor, $907,236,790 in labor income, $1,837,864,861 in output, and $1,198,467,210 in Gross Regional Product (see Table 62).

The impact area captures about 90% of the direct spending on the project. About 4% of the spending leaks out into other parts of the state of Louisiana. The rest of the nation captures about 6%. The secondary impacts, the combined indirect and induced multiplier effects, account for nearly 44% of the total output, about 38% of employment, 33% of labor income, and almost 42% of gross regional product in the impact area.

OPTIMIZATION OF LEVEL OF RISK REDUCTION

Optimization of Alternative C Levee Alignment System. The 0.02 (50-year) AEP, 0.01 (100-year) AEP, and 0.005 (200-year) AEP levels of risk reduction (LORR) were estimated using the stage-probability relationships for the without-project conditions. A top of levee elevation was also entered into the HEC-FDA model for each of the three LORRs equal to the 0.02 (50-year) ACE stage, the 0.01 (100-year) ACE stage, and the 0.005 (200-year) ACE stage, respectively. While detailed engineering inputs were available for the 0.01 (100-year) AEP, only the without-project stage-probability relationships with a top of levee elevation was used to analyze the 0.01 (100-year) AEP in order to maintain consistency in results for optimization purposes. It should be noted that the results for the 0.01 (100-year) AEP using only the without-project conditions with a top of levee elevation will not be equivalent to the results based on the detailed engineering inputs. However, this approach can be used to show the level of risk reduction that generates the highest level of net benefits.

The HEC-FDA model was used to calculate the expected annual without and with-project damages for each of the three levels of risk reduction for 2020 and 2070. The expected annual damage values were then converted to equivalent annual damages using the FY 2014 Federal discount rate and a 50-year period of analysis. The equivalent annual without project damages minus the equivalent annual damages for each of the three LORRs were used to calculate the equivalent annual benefits.

Preliminary project costs which were later revised for final draft report were only available for the 0.01 (100-year) AEP level of risk reduction for the Alternative C

alignment levee system. The costs for the 0.01 (100-year) AEP level of risk reduction were adjusted to reflect costs for the 0.02 (50-year) AEP and the 0.005 (200-year) AEP levels of risk reduction based on adjustments to reflect additional levee height, quantity of fill, relocations, railroad gates, mitigations and administrative costs. The costs were annualized using the FY 2014 Federal discount rate, a 50-year period of analysis, and 2014 price levels. The level of risk reduction with the highest net benefits was determined to be the 100-year level of risk reduction for Alternative C levee alignment system in St. Charles and St. John parishes. The results of the optimization for the 0.02 (50-year) AEP, 0.01 (100-year) AEP and the 0.005 (200-year) AEP are shown in Tables 63, 64, and 65.

SENSITIVITY ANALYSIS

Alternative C Levee Alignment – Without Future Development. The projected development was removed from the structure inventory for the study area reaches receiving risk reduction from the Alternative C Levee Alignment System. Table 66 shows the benefits, benefit-to-cost ratio and net benefits for the levee alignment without future development.

Alternative C Levee Alignment Without and With Localized Storm Surge Risk Reduction Measures - Without Future Development. Table 67 shows the benefits, benefit-to-cost ratio and net benefits for Levee alignment C including all of the localized storm surge risk reduction measures when removing the future development from the structure inventory. Tables 68 and 69 show the net benefits for the Alternative C Levee Alignment and Alternative C Levee alignment including the localized storm surge risk reduction measures at the 7 percent OMB interest rate.

Recommended Plan - Without Future Development. Tables 69 B and 69 C displays the benefits, benefit-to-cost ratio and net benefits for the Recommended Plan which includes the Alternative C Levee Alignment and localized storm surge risk reduction measures excluding Berm 2 with future development removed from the structure inventory. Table 69 D and E show the results from a single execution of the HEC-FDA model at both the 3.5 percent and 7 percent discount rates combining all flood risk management components as a system (structural and localized storm surge risk reduction measures excluding Berm 2). Estimates of EAD and benefits displayed as the summation of model executions for each individual FRM component varies from the estimates displayed for a model execution combining all flood risk management components is attributable to the manner in which the aforementioned Monte Carlo simulations are performed when system components are permitted to interact with each other.

Sea Level Rise Scenarios. The without-project conditions for Alternative C Levee Alignment for the three sea level rise scenarios, low/ historic, intermediate, and high were estimated using the HEC-FDA model results from the draft report and the intermediate sea level rise model results from the current analysis. The difference in without-project damages between the intermediate and low sea level rise and the difference in damages between the intermediate and high sea level rise was applied to the intermediate without-project damages using updated engineering inputs. The percent reduction in the without-project damages for the intermediate sea-level rise in the current phase of the analysis was applied to the without-project damages for the two other sea level rise scenarios previously calculated. The benefits were then calculated for low and high sea level rise applying the percent reduction in damages that was calculated with the Alternative C levee alignment in place. The benefits were then compared to the project costs for the three sea level rise scenarios. Estimates of without-project damages were revised based in the current phase due to refinement of engineering inputs. The results of the sea level rise scenarios are shown in Table 70. The sea-level rise scenarios without future development are shown in Table 71. The analysis shows that the Recommended Plan is economically justified for all sea level rise scenarios with or without future development.

RISK ANALYSIS

Benefit Exceedance Probability Relationship. The HEC-FDA model used the uncertainty surrounding the economic and engineering inputs to generate results that can be used to assess the performance of the Recommended Plan. A spreadsheet was developed using the expected annual damage and benefit results from the HEC-FDA model to calculate the equivalent annual without-project and with-project damages and the damages reduced for each of the project alternatives. Table 72 shows the equivalent annual benefits at the 75, 50, and 25 percentiles. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values. The benefit exceedance probability relationship for each of the project alternatives can be compared to the point estimate of the average annual costs for each of the project alternatives. The table indicates the percent chance that the equivalent annual benefits will exceed the equivalent annual costs therefore the benefit cost ratio is greater than one and the net benefits are positive.

Project Performance by Reach for the Years of Analysis. The results from the HEC-FDA model were also used to calculate the long-term annual exceedance probability (AEP) and the conditional non-exceedance probability, or assurance, for various probability storm events. The model provided a target stage to assess project performance for each study area reach for the base year, 2020, and the last year in the 50-year period of analysis under both without-project and with-project conditions. For study area reaches without proposed levees or berms, the target stage was set by default at the elevation where the model calculated five percent residual damages for the 1% ACE (100-year) event.

The HEC-FDA model calculated a target stage AEP with a median and expected value that reflected the likelihood that the target stages will be exceeded in a given year. The median value was calculated using point estimates, while the expected value was calculated using Monte Carlo simulation. The results also show the long-term risk or the probability of a target stage being exceeded over 10-year, 30-year, and 50-year periods. Finally, the model results show the conditional non-exceedance probability or the likelihood that a target stage will not be exceeded by the 10% ACE (10 year), the 4% ACE (25-year), the 2% ACE (50-year), the 1% ACE (100-year), the 0.4% ACE (250-year), and the 0.2% ACE (500-year). Tables 73 and 74 display the project performance results for each study area reach for the base year, 2020, and the last year in the 50-year period of analysis, 2070, under without-project and with-project conditions.

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Table 1
West Shore Lake Pontchartrain, LA Feasibility Study
Land Use in the Study Area
(2009)

Land Class Name	Acres	Percentage of Total
Developed land	10,947	4.7
Agricultural Land	23,779	10.3
Undeveloped Land	124,181	53.9
Open Water	71,576	31.1
Total	230,483	100.0

Source: National Agricultural Statistical Service

Note: Sugarcane accounts for approximately half of the agricultural land and pasture/hay the remainder.

Table 2
Historical and Projected Parish Population
West Shore Lake Pontchartrain, LA Feasibility Study
(1,000s)

Parish	1980	1990	2000	2010	2020	2080
St. Charles	37.5	42.5	48.2	52.8	56.2	65.5
St. James	21.6	20.8	21.4	22.1	22.3	26.5
St. John the Baptist	32.3	40.1	43.1	45.9	51.7	60.2
Total	91.4	103.4	112.7	120.8	130.2	152.1

Source: U.S. Census data, and Moody's County Forecast Database

Table 3

Existing Condition and Projected Population within
Inventoried Study Area

West Shore Lake Pontchartrain, LA Feasibility Study
(1,000s)

Parish	2012	2020	2070
Total in Study Area	62.90	64.7	95.9

Source: U.S. Census data, and Moody's County Forecast Database

Note: Population estimates in 2012 assumes 2.9 residents per housing unit and 20 housing units within a multi family structure.

Table 4
Number of Households by Parish
West Shore Lake Pontchartrain, LA Feasibility Study
(1,000s)

Parish	1980	1990	2000	2010	2020	2080
St. Charles	11.6	14.4	16.5	17.2	18.3	22.0
St. James	6.1	6.4	7.0	6.9	7.2	8.7
St. John the Baptist	9.4	12.7	14.3	15.1	16.3	19.6
Total	27.1	33.5	37.8	39.2	41.8	50.2

Source: U.S. Census data, and Moody's County Forecast Database

Table 5
Per Capita Income ($s)
West Shore Lake Pontchartrain, LA Feasibility Study

Parish	1990	2000	2005	2010	2012
St. Charles	17,297	24,228	26,826	32,599	34,992
St. John the Baptist	14,231	18,327	22,951	29,663	31,492
St. James	14,440	19,720	24,715	29,351	31,349

Source: U.S. Census data, and Moody's County Forecast Database

Table 6
Total Non-Farm Employment
West Shore Lake Pontchartrain, LA Feasibility Study
(1,000s)

Parish	1970	1980	1990	2000	2010	2020	2080
St. Charles	9.0	18.1	18.5	20.1	24.3	26.3	36.2
St. John the Baptist	5.4	9.8	9.4	7.6	8.1	8.9	11.5
St. James	4.2	9.4	11.0	13.4	15.0	16.3	22.4
Total	18.5	37.2	39.0	41.1	47.4	51.5	70.1

Source: U.S. Census data, and Moody's County Forecast Database

Table 7
FEMA Flood Claims in Louisiana
West Shore Lake Pontchartrain, LA Feasibility Study

Event	Year	Number of Paid Claims	Total Amount Paid (1,000s)	Average Amount Paid (1,000s)
Tropical Storm Juan	Oct-85	6,187	$ 189,842	$ 30.7
Hurricane Andrew	Aug-92	5,589	$ 270,791	$ 48.5
Tropical Storm Isadore	Sep-02	8,441	$ 141,869	$ 16.8
Hurricane Lili	Oct-02	2,563	$ 46,049	$ 18.0
Hurricane Katrina	Aug-05	167,099	$ 18,556,254	$ 111.0
Hurricane Rita	Sep-05	9,507	$ 539,086	$ 56.7
Hurricane Gustav	Sep-08	4,524	$ 115,250	$ 25.5
Hurricane Ike	Sep-08	46,137	$ 2,712,969	$ 58.8

Source: Federal Emergency Management Agency (FEMA)
Note: Total amount paid and average amount paid have been updated to the Oct 2011 price level using the CPI for all urban consumers.

Table 8
FEMA Flood Claims by Parish
1978-2011
West Shore Lake Pontchartrain, LA Feasibility Study

Parish	Number of Claims December 2012	Total Nominal Dollar Amount (in millions)	Average Dollar Amount per Claim (in thousands)
St. Charles	5907	$ 100.13	$ 16.95
St. James	135	$ 1.74	$ 12.87
St. John the Baptist	3840	$ 236.18	$ 61.51
Total	9882	$ 338.05	$ 34.21

Source: FEMA
Note: Average dollar amount for total claims due to Hurricane Isaac is approximately $125,000.

Table 9
Number of Structures in the Existing Condition
(2012)
West Shore Lake Pontchartrain, LA Feasibility Study

Reach Name	Residential	Mobile Home	Non-Residential	Vehicle	Total
Total	18,470	1,488	1,882	33,564	55,404

Table 10
Residential and Non-Residential Structure Inventory
Existing Conditions (2012)
West Shore Lake Pontchartrain, LA Feasibility Study
(2012 price levels in $1,000s)

Structure Category	Number	Average Depreciated Replacement Value
Residential		
One-Story Slab	11,532	$ 156
One-Story Pier	4,551	$ 88
Two-Story Slab	2,236	$ 186
Two-Story Pier	151	$ 171
Mobile Home	1,488	$ 14
Total Residential	**19,958**	
Eating and Recreation	128	$ 223
Professional	310	$ 646
Public and Semi-Public	402	$ 967
Repair and Home Use	74	$ 158
Retail and Personal Services	258	$ 368
Warehouse	543	$ 249
Grocery and Gas Station	78	$ 286
Multi-Family Occupancy	86	$ 307
Industrial	3	$ 2,568
Total Non-Residential	**1,882**	

Table 11
Number of Projected Residential and Non-Residential Structures
West Shore Lake Pontchartrain, LA Feasibility Study

Future Conditions (2020)	
Structure Category	Number
Residential	
One-Story Slab	312
One-Story Pier	63
Two-Story Slab	23
Two-Story Pier	5
Mobile Home	162
Total Residential	**565**
Non-Residential	
Eating and Recreation	11
Professional	27
Public and Semi-Public	32
Repair and Home Use	5
Retail and Personal Services	18
Warehouse	48
Grocery and Gas Station	5
Multi-Family Occupancy	3
Industrial	0
Total Non-Residential	**149**
Future Conditions (2070)	
Structure Category	Number
Residential	
One-Story Slab	5,745
One-Story Pier	1,206
Two-Story Slab	394
Two-Story Pier	91
Mobile Home	2,992
Total Residential	**10,428**
Non-Residential	
Eating and Recreation	54
Professional	120
Public and Semi-Public	133
Repair and Home Use	30
Retail and Personal Services	85
Warehouse	217
Grocery and Gas Station	23
Multi-Family Occupancy	17
Industrial	0
Total Non-Residential	**679**

Table 12

Content-to-Structure Value Ratios (CSVRs) and Standard Deviations (SDs)
by Structure Category
West Shore Lake Pontchartrain, LA Feasibility Study

Structure Category		(CSVR, SD)	Bootstrapped (CSVR,SD)
Residential	One-story	(0.69, 0.37)	(0.69, 0.37)
	Two-story	(0.67, 0.35)	(0.67, 0.35)
	Mobile home	(01.14, 0.79)	(1.14, 0.79)
Non-Residential	Eating and Recreation	(1.70, 3.27)	(1.70, 2.93)
	Groceries and Gas Stations	(1.34, 0.80)	(1.34, 0.78)
	Professional Buildings	(0.54, 0.59)	(0.54, 0.54)
	Public and Semi-Public Buildings	(0.55, 0.90)	(0.55, 0.80)
	Multi-Family Buildings	(0.28, 0.17)	(0.28, 0.17)
	Repair and Home Use	(2.36, 3.20)	(2.36, 2.95)
	Retail and Personal Services	(1.19, 1.11)	(1.19, 1.05)
	Warehouses and Contractor Services	(2.07, 3.66)	(2.07. 3.25)

Table 13

Depth-Damage Relationships for Structures, Contents, and Vehicles

West Shore Lake Pontchartrain, LA Feasibility Study

Occupancy Type	Category Name	Damage Type	Parameter																					
1STY-PIER	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	4.0	5.4	20.5	62.4	62.4	64.0	65.6	65.6	68.7	71.9	71.9	71.9	71.9	84.4	84.4	84.4	84.4	84.4	84.4	84.4
			Lower %	0.0	1.5	1.5	7.5	40.5	41.5	41.6	44.7	44.7	44.7	46.3	46.3	46.3	46.3	80.0	80.0	80.0	80.0	80.0	80.0	80.0
			Upper %	0.0	9.5	9.5	33.5	88.0	88.0	88.0	88.0	88.0	88.0	88.0	88.0	88.0	88.0	94.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	0.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
			Lower %	0.0	0.0	0.0	0.0	54.6	60.9	65.6	73.9	75.7	81.8	82.4	84.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0
			Upper %	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1STY-SLAB	Residential		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Structure	Mean %	0.0	0.0	0.0	7.2	56.4	56.4	58.7	58.7	58.7	63.4	66.4	66.4	66.4	66.4	82.1	82.1	82.1	82.1	82.1	82.1	
			Lower %	0.0	0.0	0.0	0.0	36.5	36.5	38.0	38.0	38.0	41.0	61.0	61.0	61.0	61.0	75.4	75.4	75.4	75.4	75.4	75.4	
			Upper %	0.0	0.0	9.5	14.5	63.4	63.4	66.0	66.0	66.0	71.3	72.5	72.5	72.5	72.5	100.0	100.0	100.0	100.0	100.0	100.0	
		Contents	Mean %	0.0	0.0	0.0	0.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	
			Lower %	0.0	0.0	0.0	0.0	54.6	60.9	65.6	73.9	75.7	81.8	82.4	84.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0	
			Upper %	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
2STY-PIER	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	4.0	4.7	17.5	53.6	53.6	54.4	55.2	55.2	56.8	59.9	59.9	59.9	63.1	71.2	72.8	72.8	74.4	74.4	74.4	74.4
			Lower %	0.0	1.1	1.3	6.4	38.7	38.7	39.3	39.8	39.8	41.0	43.3	43.3	43.3	43.3	45.6	51.4	68.5	68.5	70.0	70.0	70.0
			Upper %	0.0	7.9	8.1	28.6	67.0	67.0	68.0	69.0	69.0	70.9	74.9	74.9	74.9	74.9	78.8	89.0	89.0	89.0	89.0	89.0	89.0
		Contents	Mean %	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	95.0	95.0	95.0	95.0	95.0	
			Lower %	0.0	0.0	0.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	90.0	90.0	90.0	90.0	90.0	
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
2STY-SLAB	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	4.0	4.7	17.5	53.6	53.6	54.4	55.2	55.2	56.8	59.9	59.9	59.9	63.1	71.2	72.8	72.8	74.4	74.4	74.4	74.4
			Lower %	0.0	1.1	1.3	6.4	38.7	38.7	39.3	39.8	39.8	41.0	43.3	43.3	43.3	43.3	45.6	51.4	68.5	68.5	70.0	70.0	70.0
			Upper %	0.0	7.9	8.1	28.6	67.0	67.0	68.0	69.0	69.0	70.9	74.9	74.9	74.9	74.9	78.8	89.0	89.0	89.0	89.0	89.0	89.0
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Contents	Mean %	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	95.0	95.0	95.0	95.0	95.0	
			Lower %	0.0	0.0	0.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	90.0	90.0	90.0	90.0	90.0	
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
AUTO	AUTO		Stage	0.0	0.5	1.0	1.5	2.0	3.0															
		Structure	Mean %	0.0	2.3	22.8	54.2	95.8	100.0															
			Lower %	0.0	0.0	2.0	50.0	75.0	100.0															
			Upper %	0.0	5.0	50.0	75.0	100.0	100.0															

Table 13 (Cont)

Depth-Damage Relationships for Structures, Contents and Vehicles

Occupancy T	Category Nar	Damage Typ	Parameter																					
EAT	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8	
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7	
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8	
		Contents	Mean %	0.0	0.0	0.0	61.6	82.6	87.3	88.4	93.3	93.5	93.5	93.5	93.5	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	
			Lower %	0.0	0.0	0.0	41.6	62.6	67.3	68.4	73.3	73.5	73.5	73.5	73.5	79.3	79.3	79.3	79.3	79.3	79.3	79.3	79.3	
			Upper %	0.0	0.0	0.0	81.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
GROC	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8	
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7	
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8	
		Contents	Mean %	0.0	0.0	0.0	82.5	97.5	97.8	99.1	99.4	99.7	99.7	99.7	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
			Lower %	0.0	0.0	0.0	77.5	92.5	9.3	94.1	94.4	94.7	94.7	94.7	94.7	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	
			Upper %	0.0	0.0	0.0	87.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
MOBHOM	MOBHOME		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Structure	Mean %	0.0	12.1	12.1	32.1	62.1	63.8	64.2	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	66.3	
			Lower %	0.0	10.1	10.9	29.6	57.4	59.3	59.7	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	
			Upper %	0.0	13.4	15.1	34.6	66.8	68.3	68.7	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	
		Contents	Mean %	0.0	0.0	0.0	0.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	
			Lower %	0.0	0.0	0.0	0.0	47.5	52.0	59.6	73.7	77.6	88.8	89.1	89.4	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	
			Upper %	0.0	0.0	0.0	0.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
MULT	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8	
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7	
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8	
		Contents	Mean %	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	100.0	100.0	100.0	100.0	100.0	
			Lower %	0.0	0.0	0.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	80.0	80.0	80.0	80.0	80.0	
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
PROF	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8	
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7	
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8	
		Contents	Mean %	0.0	0.0	0.0	98.5	98.5	98.5	98.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
			Lower %	0.0	0.0	0.0	78.5	78.5	78.5	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

Table 13 (Cont)
Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

PUBL	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8
		Contents	Mean %	0.0	0.0	0.0	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	45.2	85.0	85.0	85.0	85.0	85.0	85.0
			Upper %	0.0	0.0	0.0	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	100.0	100.0	100.0	100.0	100.0	100.0
REPA	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8
		Contents	Mean %	0.0	0.0	0.0	87.5	87.5	87.5	87.5	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	67.5	67.5	67.5	67.5	78.9	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
RETA	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	99.4	99.5	99.7	99.8	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	79.4	79.5	79.7	79.8	79.9	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
WARE	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	3.5	36.5	36.8	36.8	41.1	41.1	48.5	48.5	48.5	49.5	49.5	65.0	65.0	72.5	75.0	77.8	77.8	77.8
			Lower %	0.0	0.0	0.0	24.3	28.6	29.4	32.0	33.6	41.5	42.0	42.0	42.9	44.3	59.3	59.7	66.5	68.8	74.7	75.7	75.7
			Upper %	0.0	0.0	7.0	41.0	41.3	41.3	46.1	46.1	54.5	58.2	58.2	58.2	58.2	79.2	79.2	88.3	91.4	94.8	94.8	94.8
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	36.1	53.0	61.5	69.9	79.5	96.3	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
			Lower %	0.0	0.0	0.0	1.1	18.0	26.5	34.9	44.5	61.3	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0
			Upper %	0.0	0.0	0.0	71.1	88.0	96.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Based on*Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Lower Atchafalaya and Morganza to the Gulf, Louisiana, Feasibility Study Final Report* dated May 1997

Table 14

Structures Damaged by Probability Event in 2020 and 2070 Intermediate Sea Level Rise
Residential, Non-Residential, Mobile Homes and Industrial
Existing and Future Without-Project Conditions
West Shore Lake Pontchartrain, LA Feasibility Study

Annual Chance Exceedance Event (ACE)	Residential	Non-Residential	Mobile Home	IND	Total
Base year 2020					
0.99 (1 yr)	-	-	-	-	-
0.20 (5 yr)	-	-	-	-	-
0.10 (10 yr)	89	30	26	-	145
0.04 (25 yr)	558	117	98	-	773
0.02 (50 yr)	4,313	323	271	1	4,908
0.01 (100 yr)	6,942	647	523	2	8,114
0.005 (200 yr)	8,440	822	595	2	9,859
0.002 (500 yr)	9,170	1,014	672	2	10,858
Future year 2070 Intermediate Sea Level Rise					
0.99 (1 yr)	19	21	-	-	40
0.20 (5 yr)	258	48	56	-	362
0.10 (10 yr)	1,705	234	231	2	2,172
0.04 (25 yr)	4,486	400	420	2	5,308
0.02 (50 yr)	12,316	1,128	826	2	14,272
0.01 (100 yr)	19,381	2,032	1,037	2	22,452
0.005 (200 yr)	21,273	2,212	1,173	2	24,660
0.002 (500 yr)	23,037	2,446	1,241	2	26,726

Table 15

Damages By Probability Event in 2020 and 2070 Intermediate Sea Level Rise
Residential, Non-Residential, Mobile Homes and Industrial
Existing and Future Without-Project Conditions
West Shore Lake Pontchartrain, LA Feasibility Study
(Damages in $1,000s using 2012 Price Levels)

Annual Chance Exceedance Event (ACE)	Residential	Non-Residential	Mobile Home	IND	Total
Base year 2020					
0.99 (1 yr)	$ -	$ -	$ -	$ -	$ -
0.20 (5 yr)	-	-	-	-	-
0.10 (10 yr)	805	1,315	47	-	2,168
0.04 (25 yr)	45,685	17,621	452	-	63,758
0.02 (50 yr)	492,044	112,847	3,744	10	608,645
0.01 (100 yr)	1,060,300	177,277	6,767	344	1,244,688
0.005 (200 yr)	1,428,436	402,940	11,242	685	1,843,303
0.002 (500 yr)	1,634,417	526,761	13,299	885	2,175,362
Future year 2070 Intermediate Sea Level Rise					
0.99 (1 yr)	93	37	-	-	130
0.20 (5 yr)	9,025	1,030	149	-	10,204
0.10 (10 yr)	154,128	59,334	1,502	130	215,094
0.04 (25 yr)	472,488	117,001	3,748	587	593,825
0.02 (50 yr)	1,741,939	642,685	15,150	1,732	2,401,506
0.01 (100 yr)	2,966,925	1,492,510	21,187	1,829	4,482,451
0.005 (200 yr)	3,687,303	1,766,872	24,871	1,829	5,480,875
0.002 (500 yr)	4,059,892	2,067,546	28,044	1,829	6,157,311

Note: 2012 price levels were used for the damages.

Table 16
West Shore Lake Pontchartrain, LA Feasibility Study
Flood Risk Management (FRM) System by Component
(Damages in $1,000s in 2012 and 2014 Price Levels)

FRM Component	Equiv Annual Without Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
0.01 AEP (100-year) Level of Risk Reduction Structural System	$ 177,193	$ 91,832	$ 85,146	$ 87,700
Berm 1	$ 2,110	$ 1,069	$ 1,042	$ 1,073
Berm 2	$ 905	$ 683	$ 222	$ 229
Berm 3	$ 1,419	$ 491	$ 928	$ 956
Installation of Flap Gates on Culverts	$ 3,677	$ 2,590	$ 1,087	$ 1,119
Structure Raising outside of Levee Alignment and Berms	$ 2,411	$ 187	$ 2,223	$ 2,290

Note: Separate HEC-FDA model runs are made for each Flood Risk Management component.
Inducements of $215,110 attributed to the 0.01 AEP Level of Risk Reduction Structural System are included in the analysis.

Table 17
West Shore Lake Pontchartrain, LA Feasibility Study
Recommended Plan
(Damages in $1,000s)

Reach	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
1	$ 1,300.8	$ 368.3	$ 932.5	$ 960.5
10	$ 33.1	$ 35.6	$ (2.5)	$ (2.5)
11	$ 2,858.3	$ 424.9	$ 2,433.3	$ 2,506.3
12	$ 15.0	$ 16.5	$ (1.5)	$ (1.6)
13	$ -	$ -	$ -	$ -
14	$ -	$ -	$ -	$ -
15	$ 1.2	$ 1.3	$ (0.1)	$ (0.1)
16	$ 2.9	$ 2.8	$ 0.1	$ 0.1
17	$ -	$ -	$ -	$ -
18	$ -	$ -	$ -	$ -
19	$ -	$ -	$ -	$ -
2	$ 72.6	$ 8.3	$ 64.3	$ 66.2
20	$ -	$ -	$ -	$ -
21	$ 801.5	$ 111.5	$ 690.0	$ 710.7
22	$ -	$ -	$ -	$ -
23	$ -	$ -	$ -	$ -
24	$ 231.4	$ 4.3	$ 227.1	$ 233.9
25	$ 1.2	$ 1.3	$ (0.1)	$ (0.1)
26	$ 0.1	$ 0.1	$ -	$ -
27	$ -	$ -	$ -	$ -
28	$ -	$ -	$ -	$ -
29	$ -	$ -	$ -	$ -
3	$ 33.5	$ 36.2	$ (2.7)	$ (2.8)
30	$ 11.1	$ 12.1	$ (1.0)	$ (1.1)
31	$ -	$ -	$ -	$ -
32	$ -	$ -	$ -	$ -
33	$ 50.0	$ 3.8	$ 46.2	$ 47.6
34	$ -	$ -	$ -	$ -
35	$ -	$ -	$ -	$ -
36	$ 4.2	$ 3.1	$ 1.1	$ 1.1
37	$ 1.5	$ 1.6	$ (0.1)	$ (0.1)
38	$ -	$ -	$ -	$ -
39	$ 3.6	$ 3.8	$ (0.2)	$ (0.2)
4	$ -	$ -	$ -	$ -
40	$ 0.2	$ 0.2	$ (0.0)	$ (0.0)
41	$ -	$ -	$ -	$ -
42	$ 4.6	$ 5.0	$ (0.4)	$ (0.4)
43	$ 7.6	$ 8.0	$ (0.4)	$ (0.4)
44	$ 0.3	$ 0.3	$ (0.0)	$ (0.0)
45	$ -	$ -	$ -	$ -
46	$ 1,824.4	$ 898.3	$ 926.1	$ 953.9

Table 17 cont.
West Shore Lake Pontchartrain, LA Feasibility Study
Recommended Plan
(Damages in $1,000s)

Reach	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
47	$ -	$ -	$ -	$ -
48	$ -	$ -	$ -	$ -
49	$ -	$ -	$ -	$ -
5	$ 0.1	$ 0.1	$ -	$ -
50	$ -	$ -	$ -	$ -
51	$ -	$ -	$ -	$ -
52	$ 8.4	$ 8.9	$ (0.6)	$ (0.6)
53	$ 430.9	$ 452.2	$ (21.2)	$ (21.9)
54	$ 765.9	$ 67.3	$ 698.6	$ 719.5
55	$ 1,109.3	$ 204.6	$ 904.7	$ 931.8
56	$ 641.7	$ 252.2	$ 389.5	$ 401.2
57	$ 28.9	$ 6.9	$ 21.9	$ 22.6
58	$ 216.1	$ 8.4	$ 207.7	$ 213.9
59	$ 50.3	$ 51.9	$ (1.6)	$ (1.6)
6	$ 83.1	$ 83.2	$ (0.2)	$ (0.2)
60	$ 854.4	$ 860.1	$ (5.6)	$ (5.8)
7	$ 4,537.5	$ 409.4	$ 4,128.1	$ 4,251.9
8	$ 1,909.3	$ 1,158.1	$ 751.2	$ 773.8
9	$ 49.7	$ 53.7	$ (4.0)	$ (4.1)
SA 1	$ 2,954.4	$ 2,151.4	$ 803.0	$ 827.1
SA 10	$ 3,551.6	$ 217.3	$ 3,334.3	$ 3,434.3
SA 11	$ 11.9	$ 0.2	$ 11.8	$ 12.1
SA 12	$ 1,303.1	$ 644.0	$ 659.1	$ 678.9
SA 13	$ 1,229.4	$ 156.6	$ 1,072.8	$ 1,105.0
SA 14	$ 53,512.0	$ 52,327.8	$ 1,184.1	$ 1,219.7
SA 15	$ 522.0	$ 279.5	$ 242.5	$ 249.8
SA 16	$ 2,223.8	$ 1,258.1	$ 965.6	$ 994.6
SA 17	$ -	$ -	$ -	$ -
SA 18	$ 84.2	$ 2.4	$ 81.8	$ 84.2
SA 19	$ 1.7	$ -	$ 1.7	$ 1.7
SA 2	$ 2,694.9	$ 2,154.8	$ 540.1	$ 556.3
SA 20	$ -	$ -	$ -	$ -
SA 21	$ 11,183.1	$ 4,279.4	$ 6,903.7	$ 7,110.8
SA 22	$ 1,176.0	$ 847.4	$ 328.6	$ 338.5
SA 23	$ 560.2	$ 118.4	$ 441.8	$ 455.1
SA 24	$ 1,107.4	$ 348.5	$ 759.0	$ 781.7
SA 25	$ 258.9	$ 139.4	$ 119.6	$ 123.1
SA 26	$ 13.7	$ 0.1	$ 13.6	$ 14.0
SA 27	$ 2,093.1	$ 61.4	$ 2,031.6	$ 2,092.6
SA 28X	$ 1,154.5	$ 6.4	$ 1,148.1	$ 1,182.5
SA 28Y	$ 609.2	$ 6.9	$ 602.3	$ 620.4
SA 29	$ 4,646.7	$ 14.9	$ 4,631.8	$ 4,770.7
SA 29C	$ 632.6	$ 434.0	$ 198.6	$ 204.5
SA 3	$ 2,834.5	$ 2,814.9	$ 19.6	$ 20.2
SA 30	$ 6,269.7	$ 190.5	$ 6,079.2	$ 6,261.6
SA 30C	$ 971.5	$ 3.0	$ 968.5	$ 997.5
SA 31	$ 7,408.5	$ 17.7	$ 7,390.8	$ 7,612.5
SA 31C	$ -	$ -	$ -	$ -
SA 32	$ 10,827.0	$ 119.8	$ 10,707.3	$ 11,028.5

Table 17 cont.
West Shore Lake Pontchartrain, LA Feasibility Study
Recommended Plan
(Damages in $1,000s)

Reach	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
SA 33	$ 8,869.9	$ 312.6	$ 8,557.3	$ 8,814.0
SA 34	$ 9,979.4	$ 819.2	$ 9,160.2	$ 9,435.0
SA 35	$ 2,673.2	$ 40.6	$ 2,632.5	$ 2,711.5
SA 36	$ 1,448.9	$ 0.6	$ 1,448.4	$ 1,491.8
SA 37	$ 0.7	$ -	$ 0.7	$ 0.7
SA 38	$ 4,194.3	$ 26.9	$ 4,167.4	$ 4,292.4
SA 39	$ 136.8	$ 0.1	$ 136.7	$ 140.8
SA 39C	$ 146.4	$ -	$ 146.4	$ 150.8
SA 4	$ 15,585.9	$ 15,142.9	$ 443.0	$ 456.3
SA 40P	$ 46.7	$ 0.7	$ 46.0	$ 47.4
SA 41	$ 890.5	$ 2.2	$ 888.3	$ 915.0
SA 41P	$ 6.6	$ 0.0	$ 6.6	$ 6.8
SA 42P	$ 3.7	$ -	$ 3.7	$ 3.8
SA 43P	$ -	$ -	$ -	$ -
SA 44C	$ -	$ -	$ -	$ -
SA 5	$ 345.0	$ 260.3	$ 84.6	$ 87.2
SA 6	$ 2,915.6	$ 2,863.8	$ 51.8	$ 53.4
SA 7	$ 807.7	$ 393.2	$ 414.6	$ 427.0
SA 8	$ 792.2	$ 66.2	$ 726.0	$ 747.8
SA 9	$ 2,489.0	$ 650.4	$ 1,838.7	$ 1,893.9
Total	$ 189,112.1	$ 94,738.1	$ 94,373.9	$ 97,205.2

Note: Future development is included in St. John Parish but not in St. James Parish.
Recommended Plan excludes Berm 2.

Table 18
Average Annual Costs

Hurricane Protection Levee
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.1475	67,324
2016	-3	124,713	1.1087	138,271
2017	-2	124,713	1.0712	133,595
2018	-1	124,713	1.0350	129,078
2019	0	124,713	1.0000	124,713
2020	1	-	0.9662	-
2021	2	-	0.9335	-
2022	3	-	0.9019	-
2023	4	-	0.8714	-
2024	5	-	0.8420	-
2025	6	-	0.8135	-
2026	7	7,441	0.7860	5,849
2027	8	7,441	0.7594	5,651
2028	9	-	0.7337	-
2029	10	17,008	0.7089	12,057
2030	11	8,504	0.6849	5,825
2031	12	8,504	0.6618	5,628
2032	13	-	0.6394	-
2033	14	-	0.6178	-
2034	15	-	0.5969	-
2035	16	-	0.5767	-
2036	17	-	0.5572	-
2037	18	-	0.5384	-
2038	19	-	0.5202	-
2039	20	-	0.5026	-
2040	21	-	0.4856	-
2041	22	-	0.4692	-
2042	23	-	0.4533	-
2043	24	-	0.4380	-
2044	25	-	0.4231	-
2045	26	19,284	0.4088	7,884
2046	27	9,642	0.3950	3,809
2047	28	9,642	0.3817	3,680
2048	29	-	0.3687	-
2049	30	-	0.3563	-
2050	31	-	0.3442	-
2051	32	-	0.3326	-
2052	33	-	0.3213	-
2053	34	-	0.3105	-
2054	35	-	0.3000	-
2055	36	-	0.2898	-
2056	37	-	0.2800	-
2057	38	-	0.2706	-
2058	39	-	0.2614	-
2059	40	-	0.2526	-
2060	41	15,807	0.2440	3,857
2061	42	7,904	0.2358	1,863
2062	43	7,904	0.2278	1,800
2063	44	-	0.2201	-
2064	45	-	0.2127	-
2065	46	-	0.2055	-
2066	47	-	0.1985	-
2067	48	-	0.1918	-
2068	49	-	0.1853	-
2069	50	-	0.1791	-
Total:		676,598		650,883

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 27,750
Annual OMRR&R Costs:		4,374
Total Average Annual Costs:		$ 32,124

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 19
Average Annual Costs

Berm 1
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1	7140	1.0350	7,390
2019	0	7140	1.0000	7,140
2020	1		0.9662	-
2021	2		0.9335	-
2022	3		0.9019	-
2023	4		0.8714	-
2024	5		0.8420	-
2025	6		0.8135	-
2026	7		0.7860	-
2027	8		0.7594	-
2028	9		0.7337	-
2029	10		0.7089	-
2030	11		0.6849	-
2031	12		0.6618	-
2032	13		0.6394	-
2033	14		0.6178	-
2034	15		0.5969	-
2035	16		0.5767	-
2036	17		0.5572	-
2037	18		0.5384	-
2038	19		0.5202	-
2039	20		0.5026	-
2040	21		0.4856	-
2041	22		0.4692	-
2042	23		0.4533	-
2043	24		0.4380	-
2044	25		0.4231	-
2045	26		0.4088	-
2046	27		0.3950	-
2047	28		0.3817	-
2048	29		0.3687	-
2049	30		0.3563	-
2050	31		0.3442	-
2051	32		0.3326	-
2052	33		0.3213	-
2053	34		0.3105	-
2054	35		0.3000	-
2055	36		0.2898	-
2056	37		0.2800	-
2057	38		0.2706	-
2058	39		0.2614	-
2059	40		0.2526	-
2060	41		0.2440	-
2061	42		0.2358	-
2062	43		0.2278	-
2063	44		0.2201	-
2064	45		0.2127	-
2065	46		0.2055	-
2066	47		0.1985	-
2067	48		0.1918	-
2068	49		0.1853	-
2069	50		0.1791	-
Total:		14,280		14,530

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 619
Annual OMRR&R Costs:		223
Total Average Annual Costs:		$ 842

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 20
Average Annual Costs

Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1	8972	1.0350	9,286
2019	0	8972	1.0000	8,972
2020	1		0.9662	-
2021	2		0.9335	-
2022	3		0.9019	-
2023	4		0.8714	-
2024	5		0.8420	-
2025	6		0.8135	-
2026	7		0.7860	-
2027	8		0.7594	-
2028	9		0.7337	-
2029	10		0.7089	-
2030	11		0.6849	-
2031	12		0.6618	-
2032	13		0.6394	-
2033	14		0.6178	-
2034	15		0.5969	-
2035	16		0.5767	-
2036	17		0.5572	-
2037	18		0.5384	-
2038	19		0.5202	-
2039	20		0.5026	-
2040	21		0.4856	-
2041	22		0.4692	-
2042	23		0.4533	-
2043	24		0.4380	-
2044	25		0.4231	-
2045	26		0.4088	-
2046	27		0.3950	-
2047	28		0.3817	-
2048	29		0.3687	-
2049	30		0.3563	-
2050	31		0.3442	-
2051	32		0.3326	-
2052	33		0.3213	-
2053	34		0.3105	-
2054	35		0.3000	-
2055	36		0.2898	-
2056	37		0.2800	-
2057	38		0.2706	-
2058	39		0.2614	-
2059	40		0.2526	-
2060	41		0.2440	-
2061	42		0.2358	-
2062	43		0.2278	-
2063	44		0.2201	-
2064	45		0.2127	-
2065	46		0.2055	-
2066	47		0.1985	-
2067	48		0.1918	-
2068	49		0.1853	-
2069	50		0.1791	-
Total:		17,943		18,257

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 778
Annual OMRR&R Costs:		278
Total Average Annual Costs:		$ 1,057

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 21
Average Annual Costs

Berm 3
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1	7109	1.0350	7,358
2019	0	7109	1.0000	7,109
2020	1		0.9662	-
2021	2		0.9335	-
2022	3		0.9019	-
2023	4		0.8714	-
2024	5		0.8420	-
2025	6		0.8135	-
2026	7		0.7860	-
2027	8		0.7594	-
2028	9		0.7337	-
2029	10		0.7089	-
2030	11		0.6849	-
2031	12		0.6618	-
2032	13		0.6394	-
2033	14		0.6178	-
2034	15		0.5969	-
2035	16		0.5767	-
2036	17		0.5572	-
2037	18		0.5384	-
2038	19		0.5202	-
2039	20		0.5026	-
2040	21		0.4856	-
2041	22		0.4692	-
2042	23		0.4533	-
2043	24		0.4380	-
2044	25		0.4231	-
2045	26		0.4088	-
2046	27		0.3950	-
2047	28		0.3817	-
2048	29		0.3687	-
2049	30		0.3563	-
2050	31		0.3442	-
2051	32		0.3326	-
2052	33		0.3213	-
2053	34		0.3105	-
2054	35		0.3000	-
2055	36		0.2898	-
2056	37		0.2800	-
2057	38		0.2706	-
2058	39		0.2614	-
2059	40		0.2526	-
2060	41		0.2440	-
2061	42		0.2358	-
2062	43		0.2278	-
2063	44		0.2201	-
2064	45		0.2127	-
2065	46		0.2055	-
2066	47		0.1985	-
2067	48		0.1918	-
2068	49		0.1853	-
2069	50		0.1791	-
Total:		14,218		14,467

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 617
Annual OMRR&R Costs:		223
Total Average Annual Costs:		$ 839

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 22
Average Annual Costs

Installation of Flap Gates on Culverts
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1	2995	1.0350	3,100
2019	0	2995	1.0000	2,995
2020	1		0.9662	-
2021	2		0.9335	-
2022	3		0.9019	-
2023	4		0.8714	-
2024	5		0.8420	-
2025	6		0.8135	-
2026	7		0.7860	-
2027	8		0.7594	-
2028	9		0.7337	-
2029	10		0.7089	-
2030	11		0.6849	-
2031	12		0.6618	-
2032	13		0.6394	-
2033	14		0.6178	-
2034	15		0.5969	-
2035	16		0.5767	-
2036	17		0.5572	-
2037	18		0.5384	-
2038	19		0.5202	-
2039	20		0.5026	-
2040	21		0.4856	-
2041	22		0.4692	-
2042	23		0.4533	-
2043	24		0.4380	-
2044	25		0.4231	-
2045	26		0.4088	-
2046	27		0.3950	-
2047	28		0.3817	-
2048	29		0.3687	-
2049	30		0.3563	-
2050	31		0.3442	-
2051	32		0.3326	-
2052	33		0.3213	-
2053	34		0.3105	-
2054	35		0.3000	-
2055	36		0.2898	-
2056	37		0.2800	-
2057	38		0.2706	-
2058	39		0.2614	-
2059	40		0.2526	-
2060	41		0.2440	-
2061	42		0.2358	-
2062	43		0.2278	-
2063	44		0.2201	-
2064	45		0.2127	-
2065	46		0.2055	-
2066	47		0.1985	-
2067	48		0.1918	-
2068	49		0.1853	-
2069	50		0.1791	-
Total:		5,990		6,094

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 260
Annual OMRR&R Costs:		204
Total Average Annual Costs:		$ 464

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 23
Average Annual Costs

Other Localized Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1		1.0350	-
2019	0	7005	1.0000	7,005
2020	1		0.9662	-
2021	2		0.9335	-
2022	3		0.9019	-
2023	4		0.8714	-
2024	5		0.8420	-
2025	6		0.8135	-
2026	7		0.7860	-
2027	8		0.7594	-
2028	9		0.7337	-
2029	10		0.7089	-
2030	11		0.6849	-
2031	12		0.6618	-
2032	13		0.6394	-
2033	14		0.6178	-
2034	15		0.5969	-
2035	16		0.5767	-
2036	17		0.5572	-
2037	18		0.5384	-
2038	19		0.5202	-
2039	20		0.5026	-
2040	21		0.4856	-
2041	22		0.4692	-
2042	23		0.4533	-
2043	24		0.4380	-
2044	25		0.4231	-
2045	26		0.4088	-
2046	27		0.3950	-
2047	28		0.3817	-
2048	29		0.3687	-
2049	30		0.3563	-
2050	31		0.3442	-
2051	32		0.3326	-
2052	33		0.3213	-
2053	34		0.3105	-
2054	35		0.3000	-
2055	36		0.2898	-
2056	37		0.2800	-
2057	38		0.2706	-
2058	39		0.2614	-
2059	40		0.2526	-
2060	41		0.2440	-
2061	42		0.2358	-
2062	43		0.2278	-
2063	44		0.2201	-
2064	45		0.2127	-
2065	46		0.2055	-
2066	47		0.1985	-
2067	48		0.1918	-
2068	49		0.1853	-
2069	50		0.1791	-
Total:		7,005		7,005

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 299
Annual OMRR&R Costs:		0
Total Average Annual Costs:		$ 299

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 24 A
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all Localized
Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.1475	67,324
2016	-3	124,713	1.1087	138,271
2017	-2	124,713	1.0712	133,595
2018	-1	150,928	1.0350	156,211
2019	0	157,933	1.0000	157,933
2020	1	-	0.9662	-
2021	2	-	0.9335	-
2022	3	-	0.9019	-
2023	4	-	0.8714	-
2024	5	-	0.8420	-
2025	6	-	0.8135	-
2026	7	7,441	0.7860	5,849
2027	8	7,441	0.7594	5,651
2028	9	-	0.7337	-
2029	10	17,008	0.7089	12,057
2030	11	8,504	0.6849	5,825
2031	12	8,504	0.6618	5,628
2032	13	-	0.6394	-
2033	14	-	0.6178	-
2034	15	-	0.5969	-
2035	16	-	0.5767	-
2036	17	-	0.5572	-
2037	18	-	0.5384	-
2038	19	-	0.5202	-
2039	20	-	0.5026	-
2040	21	-	0.4856	-
2041	22	-	0.4692	-
2042	23	-	0.4533	-
2043	24	-	0.4380	-
2044	25	-	0.4231	-
2045	26	19,284	0.4088	7,884
2046	27	9,642	0.3950	3,809
2047	28	9,642	0.3817	3,680
2048	29	-	0.3687	-
2049	30	-	0.3563	-
2050	31	-	0.3442	-
2051	32	-	0.3326	-
2052	33	-	0.3213	-
2053	34	-	0.3105	-
2054	35	-	0.3000	-
2055	36	-	0.2898	-
2056	37	-	0.2800	-
2057	38	-	0.2706	-
2058	39	-	0.2614	-
2059	40	-	0.2526	-
2060	41	15,807	0.2440	3,857
2061	42	7,904	0.2358	1,863
2062	43	7,904	0.2278	1,800
2063	44	-	0.2201	-
2064	45	-	0.2127	-
2065	46	-	0.2055	-
2066	47	-	0.1985	-
2067	48	-	0.1918	-
2068	49	-	0.1853	-
2069	50	-	0.1791	-
Total:		736,034		711,237

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 30,323
Annual OMRR&R Costs:		5,302
Total Average Annual Costs:		$ 35,625

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 24 B
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all Localized
Storm Surge Risk Reduction Measures Except Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.1475	67,324
2016	-3	124,713	1.1087	138,271
2017	-2	124,713	1.0712	133,595
2018	-1	141,957	1.0350	146,925
2019	0	148,962	1.0000	148,962
2020	1	-	0.9662	-
2021	2	-	0.9335	-
2022	3	-	0.9019	-
2023	4	-	0.8714	-
2024	5	-	0.8420	-
2025	6	-	0.8135	-
2026	7	7,441	0.7860	5,849
2027	8	7,441	0.7594	5,651
2028	9	-	0.7337	-
2029	10	17,008	0.7089	12,057
2030	11	8,504	0.6849	5,825
2031	12	8,504	0.6618	5,628
2032	13	-	0.6394	-
2033	14	-	0.6178	-
2034	15	-	0.5969	-
2035	16	-	0.5767	-
2036	17	-	0.5572	-
2037	18	-	0.5384	-
2038	19	-	0.5202	-
2039	20	-	0.5026	-
2040	21	-	0.4856	-
2041	22	-	0.4692	-
2042	23	-	0.4533	-
2043	24	-	0.4380	-
2044	25	-	0.4231	-
2045	26	19,284	0.4088	7,884
2046	27	9,642	0.3950	3,809
2047	28	9,642	0.3817	3,680
2048	29	-	0.3687	-
2049	30	-	0.3563	-
2050	31	-	0.3442	-
2051	32	-	0.3326	-
2052	33	-	0.3213	-
2053	34	-	0.3105	-
2054	35	-	0.3000	-
2055	36	-	0.2898	-
2056	37	-	0.2800	-
2057	38	-	0.2706	-
2058	39	-	0.2614	-
2059	40	-	0.2526	-
2060	41	15,807	0.2440	3,857
2061	42	7,904	0.2358	1,863
2062	43	7,904	0.2278	1,800
2063	44	-	0.2201	-
2064	45	-	0.2127	-
2065	46	-	0.2055	-
2066	47	-	0.1985	-
2067	48	-	0.1918	-
2068	49	-	0.1853	-
2069	50	-	0.1791	-
Total:		718,091		692,980

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual Construction Costs:		$ 29,544
Annual OMRR&R Costs:		5,023
Total Average Annual Costs:		$ 34,568

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 24 C
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all Localized Storm Surge
Risk Reduction Measures Except Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.1420	66,999
2016	-3	124,713	1.1047	137,771
2017	-2	124,713	1.0686	133,273
2018	-1	141,957	1.0338	146,748
2019	0	148,962	1.0000	148,962
2020	1	-	0.9674	-
2021	2	-	0.9358	-
2022	3	-	0.9052	-
2023	4	-	0.8757	-
2024	5	-	0.8471	-
2025	6	-	0.8194	-
2026	7	7,441	0.7927	5,898
2027	8	7,441	0.7668	5,706
2028	9	-	0.7418	-
2029	10	17,008	0.7175	12,204
2030	11	8,504	0.6941	5,903
2031	12	8,504	0.6715	5,710
2032	13	-	0.6495	-
2033	14	-	0.6283	-
2034	15	-	0.6078	-
2035	16	-	0.5880	-
2036	17	-	0.5688	-
2037	18	-	0.5502	-
2038	19	-	0.5322	-
2039	20	-	0.5149	-
2040	21	-	0.4981	-
2041	22	-	0.4818	-
2042	23	-	0.4661	-
2043	24	-	0.4508	-
2044	25	-	0.4361	-
2045	26	19,284	0.4219	8,135
2046	27	9,642	0.4081	3,935
2047	28	9,642	0.3948	3,806
2048	29	-	0.3819	-
2049	30	-	0.3694	-
2050	31	-	0.3574	-
2051	32	-	0.3457	-
2052	33	-	0.3344	-
2053	34	-	0.3235	-
2054	35	-	0.3129	-
2055	36	-	0.3027	-
2056	37	-	0.2928	-
2057	38	-	0.2833	-
2058	39	-	0.2740	-
2059	40	-	0.2651	-
2060	41	15,807	0.2564	4,053
2061	42	7,904	0.2481	1,961
2062	43	7,904	0.2400	1,896
2063	44	-	0.2321	-
2064	45	-	0.2245	-
2065	46	-	0.2172	-
2066	47	-	0.2101	-
2067	48	-	0.2033	-
2068	49	-	0.1966	-
2069	50	-	0.1902	-
Total:		718,091		692,960

FY 2015 Federal Discount Rate:	3.375%		
Amortization Factor:	0.04168		
Average Annual Construction Costs:		$	28,881
Annual OMRR&R Costs:			5,070
Total Average Annual Costs:		$	33,951

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 25
Average Annual Costs

Hurricane Protection Levee
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3	0	1.1087	-
2017	-2	0	1.0712	-
2018	-1	0	1.0350	-
2019	0	0	1.0000	-
2020	1	50	0.9662	48
2021	2	1558	0.9335	1,454
2022	3	1558	0.9019	1,405
2023	4	3377	0.8714	2,943
2024	5	1558	0.8420	1,311
2025	6	2737	0.8135	2,226
2026	7	3567	0.7860	2,803
2027	8	1890	0.7594	1,436
2028	9	1558	0.7337	1,143
2029	10	4377	0.7089	3,103
2030	11	4723	0.6849	3,235
2031	12	1964	0.6618	1,300
2032	13	3409	0.6394	2,180
2033	14	2474	0.6178	1,528
2034	15	1558	0.5969	930
2035	16	4857	0.5767	2,801
2036	17	1737	0.5572	968
2037	18	2474	0.5384	1,332
2038	19	3377	0.5202	1,757
2039	20	2037	0.5026	1,024
2040	21	5146	0.4856	2,499
2041	22	4389	0.4692	2,059
2042	23	1599	0.4533	725
2043	24	1858	0.4380	814
2044	25	3377	0.4231	1,429
2045	26	33213	0.4088	13,579
2046	27	1653	0.3950	653
2047	28	3719	0.3817	1,420
2048	29	1558	0.3687	574
2049	30	2474	0.3563	881
2050	31	36781	0.3442	12,661
2051	32	1954	0.3326	650
2052	33	1599	0.3213	514
2053	34	4293	0.3105	1,333
2054	35	1558	0.3000	467
2055	36	10038	0.2898	2,909
2056	37	12833	0.2800	3,594
2057	38	2389	0.2706	646
2058	39	1685	0.2614	440
2059	40	3843	0.2526	971
2060	41	5146	0.2440	1,256
2061	42	2457	0.2358	579
2062	43	3532	0.2278	805
2063	44	1858	0.2201	409
2064	45	1558	0.2127	331
2065	46	5345	0.2055	1,098
2066	47	1667	0.1985	331
2067	48	2043	0.1918	392
2068	49	3377	0.1853	626
2069	50	72782	0.1791	13,032
Total:		286,561		102,603

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 4,374

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 26
Average Annual Costs

Berm 1
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1		1.0350	-
2019	0		1.0000	-
2020	1	64	0.9662	62
2021	2	64	0.9335	60
2022	3	221	0.9019	199
2023	4	64	0.8714	56
2024	5	147	0.8420	124
2025	6	221	0.8135	180
2026	7	64	0.7860	50
2027	8	64	0.7594	49
2028	9	221	0.7337	162
2029	10	264	0.7089	187
2030	11	64	0.6849	44
2031	12	221	0.6618	146
2032	13	64	0.6394	41
2033	14	64	0.6178	40
2034	15	305	0.5969	182
2035	16	64	0.5767	37
2036	17	64	0.5572	36
2037	18	221	0.5384	119
2038	19	64	0.5202	33
2039	20	288	0.5026	145
2040	21	221	0.4856	107
2041	22	64	0.4692	30
2042	23	64	0.4533	29
2043	24	221	0.4380	97
2044	25	320	0.4231	135
2045	26	64	0.4088	26
2046	27	221	0.3950	87
2047	28	64	0.3817	24
2048	29	64	0.3687	24
2049	30	2579	0.3563	919
2050	31	64	0.3442	22
2051	32	64	0.3326	21
2052	33	221	0.3213	71
2053	34	64	0.3105	20
2054	35	1827	0.3000	548
2055	36	221	0.2898	64
2056	37	64	0.2800	18
2057	38	64	0.2706	17
2058	39	221	0.2614	58
2059	40	288	0.2526	73
2060	41	64	0.2440	16
2061	42	221	0.2358	52
2062	43	64	0.2278	15
2063	44	64	0.2201	14
2064	45	305	0.2127	65
2065	46	64	0.2055	13
2066	47	64	0.1985	13
2067	48	221	0.1918	42
2068	49	64	0.1853	12
2069	50	3567	0.1791	639
Total:		14,491		5,222

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 223

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 27
Average Annual Costs

Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1		1.0350	-
2019	0		1.0000	-
2020	1	80	0.9662	77
2021	2	80	0.9335	75
2022	3	277	0.9019	250
2023	4	80	0.8714	70
2024	5	184	0.8420	155
2025	6	277	0.8135	225
2026	7	80	0.7860	63
2027	8	80	0.7594	61
2028	9	277	0.7337	203
2029	10	330	0.7089	234
2030	11	80	0.6849	55
2031	12	277	0.6618	183
2032	13	80	0.6394	51
2033	14	80	0.6178	49
2034	15	381	0.5969	227
2035	16	80	0.5767	46
2036	17	80	0.5572	45
2037	18	277	0.5384	149
2038	19	80	0.5202	42
2039	20	359	0.5026	180
2040	21	277	0.4856	135
2041	22	80	0.4692	38
2042	23	80	0.4533	36
2043	24	277	0.4380	121
2044	25	400	0.4231	169
2045	26	80	0.4088	33
2046	27	277	0.3950	109
2047	28	80	0.3817	31
2048	29	80	0.3687	29
2049	30	3224	0.3563	1,149
2050	31	80	0.3442	28
2051	32	80	0.3326	27
2052	33	277	0.3213	89
2053	34	80	0.3105	25
2054	35	2284	0.3000	685
2055	36	277	0.2898	80
2056	37	80	0.2800	22
2057	38	80	0.2706	22
2058	39	277	0.2614	72
2059	40	359	0.2526	91
2060	41	80	0.2440	20
2061	42	277	0.2358	65
2062	43	80	0.2278	18
2063	44	80	0.2201	18
2064	45	381	0.2127	81
2065	46	80	0.2055	16
2066	47	80	0.1985	16
2067	48	277	0.1918	53
2068	49	80	0.1853	15
2069	50	4459	0.1791	798
Total:		18,122		6,531

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 278

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Note: Berm 2 is an integral component of the recommended plan but is not a justified increment that comprises the NED Plan. Refer to the NED Plan section of the economic appendix.

Table 28
Average Annual Costs

Berm 3
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1		1.0350	-
2019	0		1.0000	-
2020	1	64	0.9662	62
2021	2	64	0.9335	60
2022	3	221	0.9019	199
2023	4	64	0.8714	56
2024	5	147	0.8420	124
2025	6	221	0.8135	180
2026	7	64	0.7860	50
2027	8	64	0.7594	49
2028	9	221	0.7337	162
2029	10	264	0.7089	187
2030	11	64	0.6849	44
2031	12	221	0.6618	146
2032	13	64	0.6394	41
2033	14	64	0.6178	40
2034	15	305	0.5969	182
2035	16	64	0.5767	37
2036	17	64	0.5572	36
2037	18	221	0.5384	119
2038	19	64	0.5202	33
2039	20	288	0.5026	145
2040	21	221	0.4856	107
2041	22	64	0.4692	30
2042	23	64	0.4533	29
2043	24	221	0.4380	97
2044	25	320	0.4231	135
2045	26	64	0.4088	26
2046	27	221	0.3950	87
2047	28	64	0.3817	24
2048	29	64	0.3687	24
2049	30	2,579	0.3563	919
2050	31	64	0.3442	22
2051	32	64	0.3326	21
2052	33	221	0.3213	71
2053	34	64	0.3105	20
2054	35	1,827	0.3000	548
2055	36	221	0.2898	64
2056	37	64	0.2800	18
2057	38	64	0.2706	17
2058	39	221	0.2614	58
2059	40	288	0.2526	73
2060	41	64	0.2440	16
2061	42	221	0.2358	52
2062	43	64	0.2278	15
2063	44	64	0.2201	14
2064	45	305	0.2127	65
2065	46	64	0.2055	13
2066	47	64	0.1985	13
2067	48	221	0.1918	42
2068	49	64	0.1853	12
2069	50	3,567	0.1791	639
Total:		14,491		5,222

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 223

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 29
Average Annual Costs

Installation of Flap Gates on Culverts
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1		1.0350	-
2019	0		1.0000	-
2020	1	58	0.9662	56
2021	2	58	0.9335	54
2022	3	203	0.9019	183
2023	4	58	0.8714	51
2024	5	135	0.8420	114
2025	6	203	0.8135	165
2026	7	58	0.7860	46
2027	8	58	0.7594	44
2028	9	203	0.7337	149
2029	10	242	0.7089	172
2030	11	58	0.6849	40
2031	12	203	0.6618	134
2032	13	58	0.6394	37
2033	14	58	0.6178	36
2034	15	280	0.5969	167
2035	16	58	0.5767	33
2036	17	58	0.5572	32
2037	18	203	0.5384	109
2038	19	58	0.5202	30
2039	20	264	0.5026	133
2040	21	203	0.4856	99
2041	22	58	0.4692	27
2042	23	58	0.4533	26
2043	24	203	0.4380	89
2044	25	293	0.4231	124
2045	26	58	0.4088	24
2046	27	203	0.3950	80
2047	28	58	0.3817	22
2048	29	58	0.3687	21
2049	30	2,364	0.3563	842
2050	31	58	0.3442	20
2051	32	58	0.3326	19
2052	33	203	0.3213	65
2053	34	58	0.3105	18
2054	35	1,675	0.3000	502
2055	36	203	0.2898	59
2056	37	58	0.2800	16
2057	38	58	0.2706	16
2058	39	203	0.2614	53
2059	40	264	0.2526	67
2060	41	58	0.2440	14
2061	42	203	0.2358	48
2062	43	58	0.2278	13
2063	44	58	0.2201	13
2064	45	280	0.2127	60
2065	46	58	0.2055	12
2066	47	58	0.1985	12
2067	48	203	0.1918	39
2068	49	58	0.1853	11
2069	50	3,270	0.1791	586
Total:		13,272		4,781

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 204

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 30
Average Annual Costs

Other Localized Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.1475	-
2016	-3		1.1087	-
2017	-2		1.0712	-
2018	-1		1.0350	-
2019	0		1.0000	-
2020	1	-	0.9662	-
2021	2	-	0.9335	-
2022	3	-	0.9019	-
2023	4	-	0.8714	-
2024	5	-	0.8420	-
2025	6	-	0.8135	-
2026	7	-	0.7860	-
2027	8	-	0.7594	-
2028	9	-	0.7337	-
2029	10	-	0.7089	-
2030	11	-	0.6849	-
2031	12	-	0.6618	-
2032	13	-	0.6394	-
2033	14	-	0.6178	-
2034	15	-	0.5969	-
2035	16	-	0.5767	-
2036	17	-	0.5572	-
2037	18	-	0.5384	-
2038	19	-	0.5202	-
2039	20	-	0.5026	-
2040	21	-	0.4856	-
2041	22	-	0.4692	-
2042	23	-	0.4533	-
2043	24	-	0.4380	-
2044	25	-	0.4231	-
2045	26	-	0.4088	-
2046	27	-	0.3950	-
2047	28	-	0.3817	-
2048	29	-	0.3687	-
2049	30	-	0.3563	-
2050	31	-	0.3442	-
2051	32	-	0.3326	-
2052	33	-	0.3213	-
2053	34	-	0.3105	-
2054	35	-	0.3000	-
2055	36	-	0.2898	-
2056	37	-	0.2800	-
2057	38	-	0.2706	-
2058	39	-	0.2614	-
2059	40	-	0.2526	-
2060	41	-	0.2440	-
2061	42	-	0.2358	-
2062	43	-	0.2278	-
2063	44	-	0.2201	-
2064	45	-	0.2127	-
2065	46	-	0.2055	-
2066	47	-	0.1985	-
2067	48	-	0.1918	-
2068	49	-	0.1853	-
2069	50	-	0.1791	-
Total:		-		-

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ -

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 31 A
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all
Localized Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	-	1.1475	-
2016	-3	-	1.1087	-
2017	-2	-	1.0712	-
2018	-1	-	1.0350	-
2019	0	-	1.0000	-
2020	1	316	0.9662	305
2021	2	1,824	0.9335	1,702
2022	3	2,480	0.9019	2,236
2023	4	3,643	0.8714	3,175
2024	5	2,171	0.8420	1,828
2025	6	3,659	0.8135	2,976
2026	7	3,833	0.7860	3,012
2027	8	2,156	0.7594	1,638
2028	9	2,480	0.7337	1,819
2029	10	5,477	0.7089	3,883
2030	11	4,989	0.6849	3,417
2031	12	2,886	0.6618	1,910
2032	13	3,675	0.6394	2,350
2033	14	2,740	0.6178	1,693
2034	15	2,829	0.5969	1,688
2035	16	5,123	0.5767	2,954
2036	17	2,003	0.5572	1,116
2037	18	3,396	0.5384	1,828
2038	19	3,643	0.5202	1,895
2039	20	3,236	0.5026	1,626
2040	21	6,068	0.4856	2,947
2041	22	4,655	0.4692	2,184
2042	23	1,865	0.4533	845
2043	24	2,780	0.4380	1,218
2044	25	4,710	0.4231	1,993
2045	26	33,479	0.4088	13,687
2046	27	2,575	0.3950	1,017
2047	28	3,985	0.3817	1,521
2048	29	1,824	0.3687	672
2049	30	13,220	0.3563	4,710
2050	31	37,047	0.3442	12,753
2051	32	2,220	0.3326	738
2052	33	2,521	0.3213	810
2053	34	4,559	0.3105	1,416
2054	35	9,171	0.3000	2,751
2055	36	10,960	0.2898	3,176
2056	37	13,099	0.2800	3,668
2057	38	2,655	0.2706	718
2058	39	2,607	0.2614	681
2059	40	5,042	0.2526	1,273
2060	41	5,412	0.2440	1,321
2061	42	3,379	0.2358	797
2062	43	3,798	0.2278	865
2063	44	2,124	0.2201	468
2064	45	2,829	0.2127	602
2065	46	5,611	0.2055	1,153
2066	47	1,933	0.1985	384
2067	48	2,965	0.1918	569
2068	49	3,643	0.1853	675
2069	50	87,645	0.1791	15,693
Total:		346,937		124,358

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 5,302

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 31 B
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all
Localized Storm Surge Risk Reduction Measures Except Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	-	1.1475	-
2016	-3	-	1.1087	-
2017	-2	-	1.0712	-
2018	-1	-	1.0350	-
2019	0	-	1.0000	-
2020	1	236	0.9662	228
2021	2	1,744	0.9335	1,628
2022	3	2,203	0.9019	1,987
2023	4	3,563	0.8714	3,105
2024	5	1,987	0.8420	1,673
2025	6	3,382	0.8135	2,751
2026	7	3,753	0.7860	2,950
2027	8	2,076	0.7594	1,577
2028	9	2,203	0.7337	1,616
2029	10	5,147	0.7089	3,649
2030	11	4,909	0.6849	3,363
2031	12	2,609	0.6618	1,727
2032	13	3,595	0.6394	2,299
2033	14	2,660	0.6178	1,643
2034	15	2,448	0.5969	1,461
2035	16	5,043	0.5767	2,908
2036	17	1,923	0.5572	1,072
2037	18	3,119	0.5384	1,679
2038	19	3,563	0.5202	1,853
2039	20	2,877	0.5026	1,446
2040	21	5,791	0.4856	2,812
2041	22	4,575	0.4692	2,146
2042	23	1,785	0.4533	809
2043	24	2,503	0.4380	1,096
2044	25	4,310	0.4231	1,824
2045	26	33,399	0.4088	13,655
2046	27	2,298	0.3950	908
2047	28	3,905	0.3817	1,491
2048	29	1,744	0.3687	643
2049	30	9,996	0.3563	3,561
2050	31	36,967	0.3442	12,725
2051	32	2,140	0.3326	712
2052	33	2,244	0.3213	721
2053	34	4,479	0.3105	1,391
2054	35	6,887	0.3000	2,066
2055	36	10,683	0.2898	3,096
2056	37	13,019	0.2800	3,646
2057	38	2,575	0.2706	697
2058	39	2,330	0.2614	609
2059	40	4,683	0.2526	1,183
2060	41	5,332	0.2440	1,301
2061	42	3,102	0.2358	731
2062	43	3,718	0.2278	847
2063	44	2,044	0.2201	450
2064	45	2,448	0.2127	521
2065	46	5,531	0.2055	1,137
2066	47	1,853	0.1985	368
2067	48	2,688	0.1918	516
2068	49	3,563	0.1853	660
2069	50	83,186	0.1791	14,895
Total:		328,815		117,827

FY 2014 Federal Discount Rate:	3.50%	
Amortization Factor:	0.04263	
Average Annual OMRR&R Costs:		$ 5,023

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 31 C
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all Localized
Storm Surge Risk Reduction Measures Except Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	-	1.1420	-
2016	-3	-	1.1047	-
2017	-2	-	1.0686	-
2018	-1	-	1.0338	-
2019	0	-	1.0000	-
2020	1	236	0.9674	228
2021	2	1,744	0.9358	1,632
2022	3	2,203	0.9052	1,994
2023	4	3,563	0.8757	3,120
2024	5	1,987	0.8471	1,683
2025	6	3,382	0.8194	2,771
2026	7	3,753	0.7927	2,975
2027	8	2,076	0.7668	1,592
2028	9	2,203	0.7418	1,634
2029	10	5,147	0.7175	3,693
2030	11	4,909	0.6941	3,408
2031	12	2,609	0.6715	1,752
2032	13	3,595	0.6495	2,335
2033	14	2,660	0.6283	1,671
2034	15	2,448	0.6078	1,488
2035	16	5,043	0.5880	2,965
2036	17	1,923	0.5688	1,094
2037	18	3,119	0.5502	1,716
2038	19	3,563	0.5322	1,896
2039	20	2,877	0.5149	1,481
2040	21	5,791	0.4981	2,884
2041	22	4,575	0.4818	2,204
2042	23	1,785	0.4661	832
2043	24	2,503	0.4508	1,129
2044	25	4,310	0.4361	1,880
2045	26	33,399	0.4219	14,091
2046	27	2,298	0.4081	938
2047	28	3,905	0.3948	1,542
2048	29	1,744	0.3819	666
2049	30	9,996	0.3694	3,693
2050	31	36,967	0.3574	13,211
2051	32	2,140	0.3457	740
2052	33	2,244	0.3344	751
2053	34	4,479	0.3235	1,449
2054	35	6,887	0.3129	2,155
2055	36	10,683	0.3027	3,234
2056	37	13,019	0.2928	3,812
2057	38	2,575	0.2833	729
2058	39	2,330	0.2740	638
2059	40	4,683	0.2651	1,241
2060	41	5,332	0.2564	1,367
2061	42	3,102	0.2481	769
2062	43	3,718	0.2400	892
2063	44	2,044	0.2321	475
2064	45	2,448	0.2245	550
2065	46	5,531	0.2172	1,201
2066	47	1,853	0.2101	389
2067	48	2,688	0.2033	546
2068	49	3,563	0.1966	701
2069	50	83,186	0.1902	15,822
Total:		328,815		121,659

FY 2015 Federal Discount Rate:	3.375%	
Amortization Factor:	0.04168	
Average Annual OMRR&R Costs:		$ 5,070

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 32
1% AEP (100-year) Levee Alignment Alternative C
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 177,193	$ 91,832	$ 85,361	$ 87,922
First Costs				$ 676,598
Interest During Construction				$ 35,461
Annual Operation & Maintenance Costs				$ 4,374
Total Annual Costs			$ 31,160	$ 32,124
B/C Ratio			2.74	2.74
Equivalent Annual Net Benefits - 2020 Base Year			$ 54,201	$ 55,798

Table 33
Berm 1
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 2,110	$ 1,069	$ 1,042	$ 1,073
First Costs				$ 14,280
Interest During Construction				$ 250
Annual Operation & Maintenance Costs				$ 223
Total Annual Costs			$ 817	$ 842
B/C Ratio			1.28	1.27
Equivalent Annual Net Benefits - 2020 Base Year			$ 225	$ 231

Table 34
Berm 2
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 905	$ 683	$ 222	$ 229
First Costs				$ 17,943
Interest During Construction				$ 314
Annual Operation & Maintenance Costs				$ 278
Total Annual Costs			$ 1,025	$ 1,057
B/C Ratio			0.22	0.22
Equivalent Annual Net Benefits - 2020 Base Year			$ (803)	$ (828)

Table 35
Berm 3
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 1,419	$ 491	$ 928	$ 956
First Costs				$ 14,218
Interest During Construction				$ 249
Annual Operation & Maintenance Costs				$ 223
Total Annual Costs			$ 814	$ 839
B/C Ratio			1.14	1.14
Equivalent Annual Net Benefits - 2020 Base Year			$ 113	$ 116

Table 36
Installation of Flap Gates on Culverts
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 3,677	$ 2,590	$ 1,087	$ 1,119
First Costs				$ 5,990
Interest During Construction				$ 105
Annual Operation & Maintenance Costs				$ 204
Total Annual Costs			$ 450	$ 464
B/C Ratio			2.42	2.41
Equivalent Annual Net Benefits - 2020 Base Year			$ 637	$ 656

Table 37
Structure Raising outside of Berms and Levee
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 2,411	$ 187	$ 2,223	$ 2,290
First Costs				$ 7,005
Interest During Construction				$ -
Annual Operation & Maintenance Costs				$ -
Total Annual Costs			$ 290	$ 299
B/C Ratio			7.68	7.67
Equivalent Annual Net Benefits - 2020 Base Year			$ 1,934	$ 1,991

Table 38 A
All of the Localized Storm Surge Risk Reduction Measures Outside of Levee Alignment
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 10,521	$ 5,020	$ 5,501	$ 5,666
First Costs				$ 59,436
Interest During Construction				$ 918
Annual Operation & Maintenance Costs				$ 928
Total Annual Costs			$ 3,396	$ 3,501
B/C Ratio			1.62	1.62
Equivalent Annual Net Benefits - 2020 Base Year			$ 2,106	$ 2,166

Note: Localized Storm Surge Risk Reduction measures outside of the levee alignment include the earthen berms, installation of flap gates on culverts and other localized Storm Surge Risk Reduction measures including structure raising and flood proofing.

Table 38 B
All of the Localized Storm Surge Risk Reduction Measures Outside of Levee Alignment Excluding Berm 2
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 9,617	$ 4,337	$ 5,279	$ 5,438
First Costs				$ 41,493
Interest During Construction				$ 604
Annual Operation & Maintenance Costs				$ 649
Total Annual Costs			$ 2,370	$ 2,444
B/C Ratio			2.23	2.23
Equivalent Annual Net Benefits - 2020 Base Year			$ 2,909	$ 2,994

Note: Localized Storm Surge Risk Reduction measures outside of the levee alignment include the earthen berms, installation of flap gates on culverts and other localized Storm Surge Risk Reduction measures including structure raising and flood proofing.

Table 39 A
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures
Summation of Separate HEC-FDA Model Executions
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 187,714	$ 96,852	$ 90,862	$ 93,588
First Costs				$ 736,034
Interest During Construction				$ 36,379
Annual Operation & Maintenance Costs				$ 5,302
Total Annual Costs			$ 34,556	$ 35,625
B/C Ratio			2.63	2.63
Equivalent Annual Net Benefits - 2020 Base Year			$ 56,306	$ 57,963

Note: Future Development is not included in St. James Parish

Table 39 B
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures Excluding Berm 2
Summation of Separate HEC-FDA Model Executions
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 186,809	$ 96,169	$ 90,640	$ 93,359
First Costs				$ 718,091
Interest During Construction				$ 36,065
Annual Operation & Maintenance Costs				$ 5,023
Total Annual Costs			$ 33,531	$ 34,568
B/C Ratio			2.70	2.70
Equivalent Annual Net Benefits - 2020 Base Year			$ 57,109	$ 58,791

Note: Future Development is not included in St. James Parish

Table 39 C
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures Excluding Berm 2
HEC-FDA Model Results for Combined Flood Risk Management System Components
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 189,112	$ 94,738	$ 94,374	$ 97,205
First Costs				$ 718,091
Interest During Construction				$ 36,065
Annual Operation & Maintenance Costs				$ 5,023
Total Annual Costs			$ 33,531	$ 34,568
B/C Ratio			2.81	2.81
Equivalent Annual Net Benefits - 2020 Base Year			$ 60,843	$ 62,637

Note: Future Development is not included in St. James Parish

Table 39 D
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures Excluding Berm 2
HEC-FDA Model Results for Combined Flood Risk Management System Components
(2012 and 2014 Price Levels; 3.375% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 189,785	$ 94,796	$ 94,990	$ 97,840
First Costs				$ 718,091
Interest During Construction				$ 34,740
Annual Operation & Maintenance Costs				$ 5,070
Total Annual Costs			$ 32,933	$ 33,951
B/C Ratio			2.88	2.88
Equivalent Annual Net Benefits - 2020 Base Year			$ 62,057	$ 63,888

Note: Future Development is not included in St. James Parish

Table 40
Average Annual Costs

Hurricane Protection Levee
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.3108	76,903
2016	-3	124,713	1.2250	152,779
2017	-2	124,713	1.1449	142,784
2018	-1	124,713	1.0700	133,443
2019	0	124,713	1.0000	124,713
2020	1	-	0.9346	-
2021	2	-	0.8734	-
2022	3	-	0.8163	-
2023	4	-	0.7629	-
2024	5	-	0.7130	-
2025	6	-	0.6663	-
2026	7	7,441	0.6227	4,634
2027	8	7,441	0.5820	4,331
2028	9	-	0.5439	-
2029	10	17,008	0.5083	8,646
2030	11	8,504	0.4751	4,040
2031	12	8,504	0.4440	3,776
2032	13	-	0.4150	-
2033	14	-	0.3878	-
2034	15	-	0.3624	-
2035	16	-	0.3387	-
2036	17	-	0.3166	-
2037	18	-	0.2959	-
2038	19	-	0.2765	-
2039	20	-	0.2584	-
2040	21	-	0.2415	-
2041	22	-	0.2257	-
2042	23	-	0.2109	-
2043	24	-	0.1971	-
2044	25	-	0.1842	-
2045	26	19,284	0.1722	3,321
2046	27	9,642	0.1609	1,552
2047	28	9,642	0.1504	1,450
2048	29	-	0.1406	-
2049	30	-	0.1314	-
2050	31	-	0.1228	-
2051	32	-	0.1147	-
2052	33	-	0.1072	-
2053	34	-	0.1002	-
2054	35	-	0.0937	-
2055	36	-	0.0875	-
2056	37	-	0.0818	-
2057	38	-	0.0765	-
2058	39	-	0.0715	-
2059	40	-	0.0668	-
2060	41	15,807	0.0624	987
2061	42	7,904	0.0583	461
2062	43	7,904	0.0545	431
2063	44	-	0.0509	-
2064	45	-	0.0476	-
2065	46	-	0.0445	-
2066	47	-	0.0416	-
2067	48	-	0.0389	-
2068	49	-	0.0363	-
2069	50	-	0.0339	-
Total:		676,598		664,248

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:		$ 48,131
Annual OMRR&R Costs:		178
Total Average Annual Costs:		$ 48,310

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 41
Average Annual Costs

Berm 1
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1	7140	1.0700	7,640
2019	0	7140	1.0000	7,140
2020	1		0.9346	-
2021	2		0.8734	-
2022	3		0.8163	-
2023	4		0.7629	-
2024	5		0.7130	-
2025	6		0.6663	-
2026	7		0.6227	-
2027	8		0.5820	-
2028	9		0.5439	-
2029	10		0.5083	-
2030	11		0.4751	-
2031	12		0.4440	-
2032	13		0.4150	-
2033	14		0.3878	-
2034	15		0.3624	-
2035	16		0.3387	-
2036	17		0.3166	-
2037	18		0.2959	-
2038	19		0.2765	-
2039	20		0.2584	-
2040	21		0.2415	-
2041	22		0.2257	-
2042	23		0.2109	-
2043	24		0.1971	-
2044	25		0.1842	-
2045	26		0.1722	-
2046	27		0.1609	-
2047	28		0.1504	-
2048	29		0.1406	-
2049	30		0.1314	-
2050	31		0.1228	-
2051	32		0.1147	-
2052	33		0.1072	-
2053	34		0.1002	-
2054	35		0.0937	-
2055	36		0.0875	-
2056	37		0.0818	-
2057	38		0.0765	-
2058	39		0.0715	-
2059	40		0.0668	-
2060	41		0.0624	-
2061	42		0.0583	-
2062	43		0.0545	-
2063	44		0.0509	-
2064	45		0.0476	-
2065	46		0.0445	-
2066	47		0.0416	-
2067	48		0.0389	-
2068	49		0.0363	-
2069	50		0.0339	-
Total:		14,280		14,780

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:		$ 1,071
Annual OMRR&R Costs:		163
Total Average Annual Costs:		$ 1,234

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 42
Average Annual Costs

Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1	8972	1.0700	9,600
2019	0	8972	1.0000	8,972
2020	1		0.9346	-
2021	2		0.8734	-
2022	3		0.8163	-
2023	4		0.7629	-
2024	5		0.7130	-
2025	6		0.6663	-
2026	7		0.6227	-
2027	8		0.5820	-
2028	9		0.5439	-
2029	10		0.5083	-
2030	11		0.4751	-
2031	12		0.4440	-
2032	13		0.4150	-
2033	14		0.3878	-
2034	15		0.3624	-
2035	16		0.3387	-
2036	17		0.3166	-
2037	18		0.2959	-
2038	19		0.2765	-
2039	20		0.2584	-
2040	21		0.2415	-
2041	22		0.2257	-
2042	23		0.2109	-
2043	24		0.1971	-
2044	25		0.1842	-
2045	26		0.1722	-
2046	27		0.1609	-
2047	28		0.1504	-
2048	29		0.1406	-
2049	30		0.1314	-
2050	31		0.1228	-
2051	32		0.1147	-
2052	33		0.1072	-
2053	34		0.1002	-
2054	35		0.0937	-
2055	36		0.0875	-
2056	37		0.0818	-
2057	38		0.0765	-
2058	39		0.0715	-
2059	40		0.0668	-
2060	41		0.0624	-
2061	42		0.0583	-
2062	43		0.0545	-
2063	44		0.0509	-
2064	45		0.0476	-
2065	46		0.0445	-
2066	47		0.0416	-
2067	48		0.0389	-
2068	49		0.0363	-
2069	50		0.0339	-
Total:		17,943		18,571

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:		$ 1,346
Annual OMRR&R Costs:		223
Total Average Annual Costs:		$ 1,569

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 43
Average Annual Costs

Berm 3
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1	7109	1.0700	7,607
2019	0	7109	1.0000	7,109
2020	1		0.9346	-
2021	2		0.8734	-
2022	3		0.8163	-
2023	4		0.7629	-
2024	5		0.7130	-
2025	6		0.6663	-
2026	7		0.6227	-
2027	8		0.5820	-
2028	9		0.5439	-
2029	10		0.5083	-
2030	11		0.4751	-
2031	12		0.4440	-
2032	13		0.4150	-
2033	14		0.3878	-
2034	15		0.3624	-
2035	16		0.3387	-
2036	17		0.3166	-
2037	18		0.2959	-
2038	19		0.2765	-
2039	20		0.2584	-
2040	21		0.2415	-
2041	22		0.2257	-
2042	23		0.2109	-
2043	24		0.1971	-
2044	25		0.1842	-
2045	26		0.1722	-
2046	27		0.1609	-
2047	28		0.1504	-
2048	29		0.1406	-
2049	30		0.1314	-
2050	31		0.1228	-
2051	32		0.1147	-
2052	33		0.1072	-
2053	34		0.1002	-
2054	35		0.0937	-
2055	36		0.0875	-
2056	37		0.0818	-
2057	38		0.0765	-
2058	39		0.0715	-
2059	40		0.0668	-
2060	41		0.0624	-
2061	42		0.0583	-
2062	43		0.0545	-
2063	44		0.0509	-
2064	45		0.0476	-
2065	46		0.0445	-
2066	47		0.0416	-
2067	48		0.0389	-
2068	49		0.0363	-
2069	50		0.0339	-
Total:		14,218		14,716

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:		$ 1,066
Annual OMRR&R Costs:		178
Total Average Annual Costs:		$ 1,245

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 44
Average Annual Costs

Installation of Flap Gates on Culverts
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1	2995	1.0700	3,204
2019	0	2995	1.0000	2,995
2020	1		0.9346	-
2021	2		0.8734	-
2022	3		0.8163	-
2023	4		0.7629	-
2024	5		0.7130	-
2025	6		0.6663	-
2026	7		0.6227	-
2027	8		0.5820	-
2028	9		0.5439	-
2029	10		0.5083	-
2030	11		0.4751	-
2031	12		0.4440	-
2032	13		0.4150	-
2033	14		0.3878	-
2034	15		0.3624	-
2035	16		0.3387	-
2036	17		0.3166	-
2037	18		0.2959	-
2038	19		0.2765	-
2039	20		0.2584	-
2040	21		0.2415	-
2041	22		0.2257	-
2042	23		0.2109	-
2043	24		0.1971	-
2044	25		0.1842	-
2045	26		0.1722	-
2046	27		0.1609	-
2047	28		0.1504	-
2048	29		0.1406	-
2049	30		0.1314	-
2050	31		0.1228	-
2051	32		0.1147	-
2052	33		0.1072	-
2053	34		0.1002	-
2054	35		0.0937	-
2055	36		0.0875	-
2056	37		0.0818	-
2057	38		0.0765	-
2058	39		0.0715	-
2059	40		0.0668	-
2060	41		0.0624	-
2061	42		0.0583	-
2062	43		0.0545	-
2063	44		0.0509	-
2064	45		0.0476	-
2065	46		0.0445	-
2066	47		0.0416	-
2067	48		0.0389	-
2068	49		0.0363	-
2069	50		0.0339	-
Total:		5,990		6,199

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:	$	449
Annual OMRR&R Costs:		163
Total Average Annual Costs:	$	613

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 45
Average Annual Costs

Other Localized Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1		1.0700	-
2019	0	7005	1.0000	7,005
2020	1		0.9346	-
2021	2		0.8734	-
2022	3		0.8163	-
2023	4		0.7629	-
2024	5		0.7130	-
2025	6		0.6663	-
2026	7		0.6227	-
2027	8		0.5820	-
2028	9		0.5439	-
2029	10		0.5083	-
2030	11		0.4751	-
2031	12		0.4440	-
2032	13		0.4150	-
2033	14		0.3878	-
2034	15		0.3624	-
2035	16		0.3387	-
2036	17		0.3166	-
2037	18		0.2959	-
2038	19		0.2765	-
2039	20		0.2584	-
2040	21		0.2415	-
2041	22		0.2257	-
2042	23		0.2109	-
2043	24		0.1971	-
2044	25		0.1842	-
2045	26		0.1722	-
2046	27		0.1609	-
2047	28		0.1504	-
2048	29		0.1406	-
2049	30		0.1314	-
2050	31		0.1228	-
2051	32		0.1147	-
2052	33		0.1072	-
2053	34		0.1002	-
2054	35		0.0937	-
2055	36		0.0875	-
2056	37		0.0818	-
2057	38		0.0765	-
2058	39		0.0715	-
2059	40		0.0668	-
2060	41		0.0624	-
2061	42		0.0583	-
2062	43		0.0545	-
2063	44		0.0509	-
2064	45		0.0476	-
2065	46		0.0445	-
2066	47		0.0416	-
2067	48		0.0389	-
2068	49		0.0363	-
2069	50		0.0339	-
Total:		7,005		7,005

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:	$	508
Annual OMRR&R Costs:		0
Total Average Annual Costs:	$	508

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 46 A
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all Localized
Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.3108	76,903
2016	-3	124,713	1.2250	152,779
2017	-2	124,713	1.1449	142,784
2018	-1	150,928	1.0700	161,493
2019	0	157,933	1.0000	157,933
2020	1	-	0.9346	-
2021	2	-	0.8734	-
2022	3	-	0.8163	-
2023	4	-	0.7629	-
2024	5	-	0.7130	-
2025	6	-	0.6663	-
2026	7	7,441	0.6227	4,634
2027	8	7,441	0.5820	4,331
2028	9	-	0.5439	-
2029	10	17,008	0.5083	8,646
2030	11	8,504	0.4751	4,040
2031	12	8,504	0.4440	3,776
2032	13	-	0.4150	-
2033	14	-	0.3878	-
2034	15	-	0.3624	-
2035	16	-	0.3387	-
2036	17	-	0.3166	-
2037	18	-	0.2959	-
2038	19	-	0.2765	-
2039	20	-	0.2584	-
2040	21	-	0.2415	-
2041	22	-	0.2257	-
2042	23	-	0.2109	-
2043	24	-	0.1971	-
2044	25	-	0.1842	-
2045	26	19,284	0.1722	3,321
2046	27	9,642	0.1609	1,552
2047	28	9,642	0.1504	1,450
2048	29	-	0.1406	-
2049	30	-	0.1314	-
2050	31	-	0.1228	-
2051	32	-	0.1147	-
2052	33	-	0.1072	-
2053	34	-	0.1002	-
2054	35	-	0.0937	-
2055	36	-	0.0875	-
2056	37	-	0.0818	-
2057	38	-	0.0765	-
2058	39	-	0.0715	-
2059	40	-	0.0668	-
2060	41	15,807	0.0624	987
2061	42	7,904	0.0583	461
2062	43	7,904	0.0545	431
2063	44	-	0.0509	-
2064	45	-	0.0476	-
2065	46	-	0.0445	-
2066	47	-	0.0416	-
2067	48	-	0.0389	-
2068	49	-	0.0363	-
2069	50	-	0.0339	-
Total:		736,034		725,519

OMB Discount Rate:	0.0700	
Amortization Factor:	0.07246	
Average Annual Construction Costs:		52,571
Annual OMRR&R Costs:		4,182
Total Average Annual Costs:		56,753

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 46 B
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all Localized
Storm Surge Risk Reduction Measures Except Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	Construction Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	58,669	1.3108	76,903
2016	-3	124,713	1.2250	152,779
2017	-2	124,713	1.1449	142,784
2018	-1	141,957	1.0700	151,894
2019	0	148,962	1.0000	148,962
2020	1	-	0.9346	-
2021	2	-	0.8734	-
2022	3	-	0.8163	-
2023	4	-	0.7629	-
2024	5	-	0.7130	-
2025	6	-	0.6663	-
2026	7	7,441	0.6227	4,634
2027	8	7,441	0.5820	4,331
2028	9	-	0.5439	-
2029	10	17,008	0.5083	8,646
2030	11	8,504	0.4751	4,040
2031	12	8,504	0.4440	3,776
2032	13	-	0.4150	-
2033	14	-	0.3878	-
2034	15	-	0.3624	-
2035	16	-	0.3387	-
2036	17	-	0.3166	-
2037	18	-	0.2959	-
2038	19	-	0.2765	-
2039	20	-	0.2584	-
2040	21	-	0.2415	-
2041	22	-	0.2257	-
2042	23	-	0.2109	-
2043	24	-	0.1971	-
2044	25	-	0.1842	-
2045	26	19,284	0.1722	3,321
2046	27	9,642	0.1609	1,552
2047	28	9,642	0.1504	1,450
2048	29	-	0.1406	-
2049	30	-	0.1314	-
2050	31	-	0.1228	-
2051	32	-	0.1147	-
2052	33	-	0.1072	-
2053	34	-	0.1002	-
2054	35	-	0.0937	-
2055	36	-	0.0875	-
2056	37	-	0.0818	-
2057	38	-	0.0765	-
2058	39	-	0.0715	-
2059	40	-	0.0668	-
2060	41	15,807	0.0624	987
2061	42	7,904	0.0583	461
2062	43	7,904	0.0545	431
2063	44	-	0.0509	-
2064	45	-	0.0476	-
2065	46	-	0.0445	-
2066	47	-	0.0416	-
2067	48	-	0.0389	-
2068	49	-	0.0363	-
2069	50	-	0.0339	-
Total:		718,091		706,947

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual Construction Costs:		$ 51,225
Annual OMRR&R Costs:		3,959
Total Average Annual Costs:		$ 55,184

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 47
Average Annual Costs

Hurricane Protection Levee
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3	0	1.2250	-
2017	-2	0	1.1449	-
2018	-1	0	1.0700	-
2019	0	0	1.0000	-
2020	1	50	0.9346	47
2021	2	1558	0.8734	1,360
2022	3	1558	0.8163	1,271
2023	4	3377	0.7629	2,576
2024	5	1558	0.7130	1,111
2025	6	2737	0.6663	1,824
2026	7	3567	0.6227	2,221
2027	8	1890	0.5820	1,100
2028	9	1558	0.5439	847
2029	10	4377	0.5083	2,225
2030	11	4723	0.4751	2,244
2031	12	1964	0.4440	872
2032	13	3409	0.4150	1,415
2033	14	2474	0.3878	959
2034	15	1558	0.3624	565
2035	16	4857	0.3387	1,645
2036	17	1737	0.3166	550
2037	18	2474	0.2959	732
2038	19	3377	0.2765	934
2039	20	2037	0.2584	526
2040	21	5146	0.2415	1,243
2041	22	4389	0.2257	991
2042	23	1599	0.2109	337
2043	24	1858	0.1971	366
2044	25	3377	0.1842	622
2045	26	33213	0.1722	5,719
2046	27	1653	0.1609	266
2047	28	3719	0.1504	559
2048	29	1558	0.1406	219
2049	30	2474	0.1314	325
2050	31	36781	0.1228	4,516
2051	32	1954	0.1147	224
2052	33	1599	0.1072	171
2053	34	4293	0.1002	430
2054	35	1558	0.0937	146
2055	36	10038	0.0875	879
2056	37	12833	0.0818	1,050
2057	38	2389	0.0765	183
2058	39	1685	0.0715	120
2059	40	3843	0.0668	257
2060	41	5146	0.0624	321
2061	42	2457	0.0583	143
2062	43	3532	0.0545	193
2063	44	1858	0.0509	95
2064	45	1558	0.0476	74
2065	46	5345	0.0445	238
2066	47	1667	0.0416	69
2067	48	2043	0.0389	79
2068	49	3377	0.0363	123
2069	50	72782	0.0339	2,471
Total:		286,561		47,454

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 3,439

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 48
Average Annual Costs

Berm 1
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1		1.0700	-
2019	0		1.0000	-
2020	1	64	0.9346	60
2021	2	64	0.8734	56
2022	3	221	0.8163	180
2023	4	64	0.7629	49
2024	5	147	0.7130	105
2025	6	221	0.6663	147
2026	7	64	0.6227	40
2027	8	64	0.5820	37
2028	9	221	0.5439	120
2029	10	264	0.5083	134
2030	11	64	0.4751	30
2031	12	221	0.4440	98
2032	13	64	0.4150	27
2033	14	64	0.3878	25
2034	15	305	0.3624	111
2035	16	64	0.3387	22
2036	17	64	0.3166	20
2037	18	221	0.2959	65
2038	19	64	0.2765	18
2039	20	288	0.2584	74
2040	21	221	0.2415	53
2041	22	64	0.2257	14
2042	23	64	0.2109	14
2043	24	221	0.1971	44
2044	25	320	0.1842	59
2045	26	64	0.1722	11
2046	27	221	0.1609	36
2047	28	64	0.1504	10
2048	29	64	0.1406	9
2049	30	2579	0.1314	339
2050	31	64	0.1228	8
2051	32	64	0.1147	7
2052	33	221	0.1072	24
2053	34	64	0.1002	6
2054	35	1827	0.0937	171
2055	36	221	0.0875	19
2056	37	64	0.0818	5
2057	38	64	0.0765	5
2058	39	221	0.0715	16
2059	40	288	0.0668	19
2060	41	64	0.0624	4
2061	42	221	0.0583	13
2062	43	64	0.0545	3
2063	44	64	0.0509	3
2064	45	305	0.0476	15
2065	46	64	0.0445	3
2066	47	64	0.0416	3
2067	48	221	0.0389	9
2068	49	64	0.0363	2
2069	50	3567	0.0339	121
Total:		14,491		2,463

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 178

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 49
Average Annual Costs

Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1		1.0700	-
2019	0		1.0000	-
2020	1	80	0.9346	75
2021	2	80	0.8734	70
2022	3	277	0.8163	226
2023	4	80	0.7629	61
2024	5	184	0.7130	131
2025	6	277	0.6663	185
2026	7	80	0.6227	50
2027	8	80	0.5820	47
2028	9	277	0.5439	151
2029	10	330	0.5083	168
2030	11	80	0.4751	38
2031	12	277	0.4440	123
2032	13	80	0.4150	33
2033	14	80	0.3878	31
2034	15	381	0.3624	138
2035	16	80	0.3387	27
2036	17	80	0.3166	25
2037	18	277	0.2959	82
2038	19	80	0.2765	22
2039	20	359	0.2584	93
2040	21	277	0.2415	67
2041	22	80	0.2257	18
2042	23	80	0.2109	17
2043	24	277	0.1971	55
2044	25	400	0.1842	74
2045	26	80	0.1722	14
2046	27	277	0.1609	45
2047	28	80	0.1504	12
2048	29	80	0.1406	11
2049	30	3224	0.1314	424
2050	31	80	0.1228	10
2051	32	80	0.1147	9
2052	33	277	0.1072	30
2053	34	80	0.1002	8
2054	35	2284	0.0937	214
2055	36	277	0.0875	24
2056	37	80	0.0818	7
2057	38	80	0.0765	6
2058	39	277	0.0715	20
2059	40	359	0.0668	24
2060	41	80	0.0624	5
2061	42	277	0.0583	16
2062	43	80	0.0545	4
2063	44	80	0.0509	4
2064	45	381	0.0476	18
2065	46	80	0.0445	4
2066	47	80	0.0416	3
2067	48	277	0.0389	11
2068	49	80	0.0363	3
2069	50	4459	0.0339	151
Total:		18,122		3,081

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 223

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 50
Average Annual Costs

Berm 3
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1		1.0700	-
2019	0		1.0000	-
2020	1	64	0.9346	60
2021	2	64	0.8734	56
2022	3	221	0.8163	180
2023	4	64	0.7629	49
2024	5	147	0.7130	105
2025	6	221	0.6663	147
2026	7	64	0.6227	40
2027	8	64	0.5820	37
2028	9	221	0.5439	120
2029	10	264	0.5083	134
2030	11	64	0.4751	30
2031	12	221	0.4440	98
2032	13	64	0.4150	27
2033	14	64	0.3878	25
2034	15	305	0.3624	111
2035	16	64	0.3387	22
2036	17	64	0.3166	20
2037	18	221	0.2959	65
2038	19	64	0.2765	18
2039	20	288	0.2584	74
2040	21	221	0.2415	53
2041	22	64	0.2257	14
2042	23	64	0.2109	14
2043	24	221	0.1971	44
2044	25	320	0.1842	59
2045	26	64	0.1722	11
2046	27	221	0.1609	36
2047	28	64	0.1504	10
2048	29	64	0.1406	9
2049	30	2,579	0.1314	339
2050	31	64	0.1228	8
2051	32	64	0.1147	7
2052	33	221	0.1072	24
2053	34	64	0.1002	6
2054	35	1,827	0.0937	171
2055	36	221	0.0875	19
2056	37	64	0.0818	5
2057	38	64	0.0765	5
2058	39	221	0.0715	16
2059	40	288	0.0668	19
2060	41	64	0.0624	4
2061	42	221	0.0583	13
2062	43	64	0.0545	3
2063	44	64	0.0509	3
2064	45	305	0.0476	15
2065	46	64	0.0445	3
2066	47	64	0.0416	3
2067	48	221	0.0389	9
2068	49	64	0.0363	2
2069	50	3,567	0.0339	121
Total:		14,491		2,463

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 178

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 51
Average Annual Costs

Installation of Flap Gates on Culverts
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1		1.0700	-
2019	0		1.0000	-
2020	1	58	0.9346	54
2021	2	58	0.8734	51
2022	3	203	0.8163	166
2023	4	58	0.7629	44
2024	5	135	0.7130	96
2025	6	203	0.6663	135
2026	7	58	0.6227	36
2027	8	58	0.5820	34
2028	9	203	0.5439	110
2029	10	242	0.5083	123
2030	11	58	0.4751	28
2031	12	203	0.4440	90
2032	13	58	0.4150	24
2033	14	58	0.3878	22
2034	15	280	0.3624	101
2035	16	58	0.3387	20
2036	17	58	0.3166	18
2037	18	203	0.2959	60
2038	19	58	0.2765	16
2039	20	264	0.2584	68
2040	21	203	0.2415	49
2041	22	58	0.2257	13
2042	23	58	0.2109	12
2043	24	203	0.1971	40
2044	25	293	0.1842	54
2045	26	58	0.1722	10
2046	27	203	0.1609	33
2047	28	58	0.1504	9
2048	29	58	0.1406	8
2049	30	2,364	0.1314	311
2050	31	58	0.1228	7
2051	32	58	0.1147	7
2052	33	203	0.1072	22
2053	34	58	0.1002	6
2054	35	1,675	0.0937	157
2055	36	203	0.0875	18
2056	37	58	0.0818	5
2057	38	58	0.0765	4
2058	39	203	0.0715	15
2059	40	264	0.0668	18
2060	41	58	0.0624	4
2061	42	203	0.0583	12
2062	43	58	0.0545	3
2063	44	58	0.0509	3
2064	45	280	0.0476	13
2065	46	58	0.0445	3
2066	47	58	0.0416	2
2067	48	203	0.0389	8
2068	49	58	0.0363	2
2069	50	3,270	0.0339	111
Total:		13,272		2,254

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 163

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 52
Average Annual Costs

Other Localized Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4		1.3108	-
2016	-3		1.2250	-
2017	-2		1.1449	-
2018	-1		1.0700	-
2019	0		1.0000	-
2020	1	-	0.9346	-
2021	2	-	0.8734	-
2022	3	-	0.8163	-
2023	4	-	0.7629	-
2024	5	-	0.7130	-
2025	6	-	0.6663	-
2026	7	-	0.6227	-
2027	8	-	0.5820	-
2028	9	-	0.5439	-
2029	10	-	0.5083	-
2030	11	-	0.4751	-
2031	12	-	0.4440	-
2032	13	-	0.4150	-
2033	14	-	0.3878	-
2034	15	-	0.3624	-
2035	16	-	0.3387	-
2036	17	-	0.3166	-
2037	18	-	0.2959	-
2038	19	-	0.2765	-
2039	20	-	0.2584	-
2040	21	-	0.2415	-
2041	22	-	0.2257	-
2042	23	-	0.2109	-
2043	24	-	0.1971	-
2044	25	-	0.1842	-
2045	26	-	0.1722	-
2046	27	-	0.1609	-
2047	28	-	0.1504	-
2048	29	-	0.1406	-
2049	30	-	0.1314	-
2050	31	-	0.1228	-
2051	32	-	0.1147	-
2052	33	-	0.1072	-
2053	34	-	0.1002	-
2054	35	-	0.0937	-
2055	36	-	0.0875	-
2056	37	-	0.0818	-
2057	38	-	0.0765	-
2058	39	-	0.0715	-
2059	40	-	0.0668	-
2060	41	-	0.0624	-
2061	42	-	0.0583	-
2062	43	-	0.0545	-
2063	44	-	0.0509	-
2064	45	-	0.0476	-
2065	46	-	0.0445	-
2066	47	-	0.0416	-
2067	48	-	0.0389	-
2068	49	-	0.0363	-
2069	50	-	0.0339	-
Total:		-		-

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ -

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 53 A
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all
Localized Storm Surge Risk Reduction Measures
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	-	1.3108	-
2016	-3	-	1.2250	-
2017	-2	-	1.1449	-
2018	-1	-	1.0700	-
2019	0	-	1.0000	-
2020	1	316	0.9346	295
2021	2	1,824	0.8734	1,593
2022	3	2,480	0.8163	2,024
2023	4	3,643	0.7629	2,779
2024	5	2,171	0.7130	1,548
2025	6	3,659	0.6663	2,438
2026	7	3,833	0.6227	2,387
2027	8	2,156	0.5820	1,255
2028	9	2,480	0.5439	1,349
2029	10	5,477	0.5083	2,784
2030	11	4,989	0.4751	2,370
2031	12	2,886	0.4440	1,281
2032	13	3,675	0.4150	1,525
2033	14	2,740	0.3878	1,063
2034	15	2,829	0.3624	1,025
2035	16	5,123	0.3387	1,735
2036	17	2,003	0.3166	634
2037	18	3,396	0.2959	1,005
2038	19	3,643	0.2765	1,007
2039	20	3,236	0.2584	836
2040	21	6,068	0.2415	1,466
2041	22	4,655	0.2257	1,051
2042	23	1,865	0.2109	393
2043	24	2,780	0.1971	548
2044	25	4,710	0.1842	868
2045	26	33,479	0.1722	5,765
2046	27	2,575	0.1609	414
2047	28	3,985	0.1504	599
2048	29	1,824	0.1406	256
2049	30	13,220	0.1314	1,737
2050	31	37,047	0.1228	4,548
2051	32	2,220	0.1147	255
2052	33	2,521	0.1072	270
2053	34	4,559	0.1002	457
2054	35	9,171	0.0937	859
2055	36	10,960	0.0875	959
2056	37	13,099	0.0818	1,072
2057	38	2,655	0.0765	203
2058	39	2,607	0.0715	186
2059	40	5,042	0.0668	337
2060	41	5,412	0.0624	338
2061	42	3,379	0.0583	197
2062	43	3,798	0.0545	207
2063	44	2,124	0.0509	108
2064	45	2,829	0.0476	135
2065	46	5,611	0.0445	250
2066	47	1,933	0.0416	80
2067	48	2,965	0.0389	115
2068	49	3,643	0.0363	132
2069	50	87,645	0.0339	2,975
Total:		346,937		57,716

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 4,182

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 53 B
Average Annual Costs
1% AEP (100-year) Levee Alignment Alternative C including all
Localized Storm Surge Risk Reduction Measures Except Berm 2
West Shore Lake Pontchartrain, La. Feasibility Study

Year	Analysis Year	OMRR&R Costs ($1000's)	Present Value Factor	Present Value of Costs ($1000's)
2015	-4	-	1.3108	-
2016	-3	-	1.2250	-
2017	-2	-	1.1449	-
2018	-1	-	1.0700	-
2019	0	-	1.0000	-
2020	1	236	0.9346	221
2021	2	1,744	0.8734	1,523
2022	3	2,203	0.8163	1,798
2023	4	3,563	0.7629	2,718
2024	5	1,987	0.7130	1,416
2025	6	3,382	0.6663	2,253
2026	7	3,753	0.6227	2,337
2027	8	2,076	0.5820	1,208
2028	9	2,203	0.5439	1,198
2029	10	5,147	0.5083	2,617
2030	11	4,909	0.4751	2,332
2031	12	2,609	0.4440	1,158
2032	13	3,595	0.4150	1,492
2033	14	2,660	0.3878	1,032
2034	15	2,448	0.3624	887
2035	16	5,043	0.3387	1,708
2036	17	1,923	0.3166	609
2037	18	3,119	0.2959	923
2038	19	3,563	0.2765	985
2039	20	2,877	0.2584	744
2040	21	5,791	0.2415	1,399
2041	22	4,575	0.2257	1,033
2042	23	1,785	0.2109	377
2043	24	2,503	0.1971	494
2044	25	4,310	0.1842	794
2045	26	33,399	0.1722	5,751
2046	27	2,298	0.1609	370
2047	28	3,905	0.1504	587
2048	29	1,744	0.1406	245
2049	30	9,996	0.1314	1,313
2050	31	36,967	0.1228	4,539
2051	32	2,140	0.1147	246
2052	33	2,244	0.1072	241
2053	34	4,479	0.1002	449
2054	35	6,887	0.0937	645
2055	36	10,683	0.0875	935
2056	37	13,019	0.0818	1,065
2057	38	2,575	0.0765	197
2058	39	2,330	0.0715	166
2059	40	4,683	0.0668	313
2060	41	5,332	0.0624	333
2061	42	3,102	0.0583	181
2062	43	3,718	0.0545	203
2063	44	2,044	0.0509	104
2064	45	2,448	0.0476	117
2065	46	5,531	0.0445	246
2066	47	1,853	0.0416	77
2067	48	2,688	0.0389	104
2068	49	3,563	0.0363	129
2069	50	83,186	0.0339	2,824
Total:		328,815		54,634

OMB Discount Rate:	7.00%	
Amortization Factor:	0.07246	
Average Annual OMRR&R Costs:		$ 3,959

Note: Costs are in October 2014 Price Levels (Fiscal Year 2015)

Table 54
1% AEP (100-year) Levee Alignment Alternative C
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 161,666	$ 91,108	$ 70,558	$ 72,675
First Costs				$ 676,598
Interest During Construction				$ 73,101
Annual Operation & Maintenance Costs				$ 178
Total Annual Costs			$ 46,860	$ 48,310
B/C Ratio			1.51	1.50
Equivalent Annual Net Benefits - 2020 Base Year			$ 23,697	$ 24,365

Table 55
Berm 1
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 1,704	$ 861	$ 843	$ 869
First Costs				$ 14,280
Interest During Construction				$ 500
Annual Operation & Maintenance Costs				$ 178
Total Annual Costs			$ 1,197	$ 1,234
B/C Ratio			0.70	0.70
Equivalent Annual Net Benefits - 2020 Base Year			$ (354)	$ (366)

Table 56
Berm 2
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 725	$ 546	$ 179	$ 184
First Costs				$ 17,943
Interest During Construction				$ 628
Annual Operation & Maintenance Costs				$ 223
Total Annual Costs			$ 1,522	$ 1,569
B/C Ratio			0.12	0.12
Equivalent Annual Net Benefits - 2020 Base Year			$ (1,343)	$ (1,385)

Table 57
Berm 3
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 1,172	$ 400	$ 772	$ 795
First Costs				$ 14,218
Interest During Construction				$ 498
Annual Operation & Maintenance Costs				$ 178
Total Annual Costs			$ 1,207	$ 1,245
B/C Ratio			0.64	0.64
Equivalent Annual Net Benefits - 2020 Base Year			$ (436)	$ (450)

Table 58
Installation of Flap Gates on Culverts
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 2,841	$ 1,952	$ 889	$ 915
First Costs				$ 5,990
Interest During Construction				$ 210
Annual Operation & Maintenance Costs				$ 163
Total Annual Costs			$ 594	$ 613
B/C Ratio			1.50	1.49
Equivalent Annual Net Benefits - 2020 Base Year			$ 295	$ 303

Table 59
Structure Raising Outside of Berms and Levee
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 1,948	$ 145	$ 1,803	$ 1,857
First Costs				$ 7,005
Interest During Construction				$ -
Annual Operation & Maintenance Costs				$ -
Total Annual Costs			$ 492	$ 508
B/C Ratio			3.66	3.66
Equivalent Annual Net Benefits - 2020 Base Year			$ 1,311	$ 1,350

Table 60 A
All of the Localized Flood Risk Reduction Measures Outside of Levee Alignment
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 8,390	$ 3,904	$ 4,486	$ 4,620
First Costs				$ 59,436
Interest During Construction				$ 1,835
Annual Operation & Maintenance Costs				$ 728
Total Annual Costs			$ 5,013	$ 5,168
B/C Ratio			0.89	0.89
Equivalent Annual Net Benefits - 2020 Base Year			$ (527)	$ (548)

Note: Localized Flood Risk Reduction Measures outside of the levee alignment include the earthen berms, installation of flap gates on culverts and other localized flood risk reduction measures including structure raising and flood proofing.

Table 60 B
All of the Localized Flood Risk Reduction Measures Outside of Levee Alignment Excluding Berm 2
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 7,665	$ 3,358	$ 4,307	$ 4,436
First Costs				$ 41,493
Interest During Construction				$ 1,207
Annual Operation & Maintenance Costs				$ 505
Total Annual Costs			$ 3,491	$ 3,599
B/C Ratio			1.23	1.23
Equivalent Annual Net Benefits - 2020 Base Year			$ 816	$ 837

Note: Localized Flood Risk Reduction Measures outside of the levee alignment include the earthen berms, installation of flap gates on culverts and other localized flood risk reduction measures including structure raising and flood proofing.

Table 61 A
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures
Summation of Separate HEC-FDA Model Executions
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 170,056	$ 95,012	$ 75,044	$ 77,295
First Costs				$ 736,034
Interest During Construction				$ 74,936
Annual Operation & Maintenance Costs				$ 4,182
Total Annual Costs			$ 55,050	$ 56,753
B/C Ratio			1.36	1.36
Equivalent Annual Net Benefits - 2020 Base Year			$ 19,993	$ 20,542

Note: Future Development is not included in St. James Parish

Table 61 B
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Flood Risk Reduction Measures Excluding Berm 2
Summation of Separate HEC-FDA Model Executions
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 169,331	$ 94,466	$ 74,865	$ 77,111
First Costs				$ 718,091
Interest During Construction				$ 74,308
Annual Operation & Maintenance Costs				$ 3,959
Total Annual Costs			$ 53,529	$ 55,184
B/C Ratio			1.40	1.40
Equivalent Annual Net Benefits - 2020 Base Year			$ 21,336	$ 21,927

Note: Future Development is not included in St. James Parish

Table 61 C
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Flood Risk Reduction Measures Excluding Berm 2
HEC-FDA Model Results for Combined Flood Risk Management System Components
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 173,332	$ 93,385	$ 79,947	$ 82,346
First Costs				$ 718,091
Interest During Construction				$ 74,308
Annual Operation & Maintenance Costs				$ 3,959
Total Annual Costs			$ 53,529	$ 55,184
B/C Ratio			1.49	1.49
Equivalent Annual Net Benefits - 2020 Base Year			$ 26,419	$ 27,161

Note: Future Development is not included in St. James Parish

Table 62
Westshore Lake Pontchartrain, LA Feasibility Study
Regional Economic Development Analysis (RED)
Impact Region Profile and Summary of Impacts

County	Area (sq. mi)	Population	Households	Total Personal Income (in millions)
Ascension	303	104,702	37,280	$3,916
Assumption	365	23,632	8,552	$799
East Baton Rouge	469	429,211	166,068	$18,149
East Feliciana	456	21,057	6,827	$695
Iberville	653	32,987	10,770	$1,035
Jefferson	496	439,261	169,681	$19,446
Lafourche	1,177	93,768	33,790	$3,954
Livingston	703	122,404	43,929	$3,848
Orleans	349	326,968	124,294	$15,261
Plaquemines	1,041	27,039	9,364	$895
Pointe Coupee	591	23,137	8,750	$784
St Bernard	488	29,365	11,218	$1,224
St Charles	410	53,810	18,475	$1,969
St Helena	410	10,582	4,004	$336
St James	258	22,227	7,460	$689
St John The Baptist	348	48,996	16,546	$1,618
St Tammany	1,110	240,775	87,796	$10,406
Terrebonne	1,480	111,202	38,980	$4,268
West Baton Rouge	205	23,108	8,375	$805
West Feliciana	426	15,503	3,846	$421
Total	**11,737**	**2,199,734**	**816,005**	**$90,517**

Table 62
(Continued)
Westshore Lake Pontchartrain, LA Feasibility Study
Regional Economic Development Analysis (RED)
Impact Region Profile and Summary of Impacts

Impact	Regional	State	National
	Direct Impact		
Output ($000)	962,423	1,004,928	1,063,136
Labor Years (Jobs)	9,741	10,107	10,846
Income ($000)	571,651	610,273	639,606
GRP ($000)	657,907	700,201	732,939
	Secondary Impact		
Output ($000)	781,556	832,937	1,824,677
Labor Years (Jobs)	6,032	6,516	11,434
Income ($000)	281,832	296,964	602,444
GRP ($000)	472,137	498,267	1,039,021
	Total Impact		
Output ($000)	1,743,979	1,837,865	2,887,813
Labor Years (Jobs)	15,773	16,623	22,280
Income ($000)	853,483	907,237	1,242,049
GRP ($000)	1,130,044	1,198,467	1,771,959

Table 63
2% AEP (50-year) Levee Alignment Alternative C
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	190,330.0	122,646.0	67,684.0	$ 69,715
First Costs				$ 542,522
Interest During Construction				$ 28,584
Annual Operation & Maintenance Costs				$ 2,067
Total Annual Costs			$ 21,830	$ 22,505
B/C Ratio			3.10	3.10
Equivalent Annual Net Benefits - 2020 Base Year			$ 45,854	$ 47,210

Note: Calculations based on preliminary cost estimates prepared prior to MII Cost and Risk Analysis.

Table 64
1% AEP (100-year) Levee Alignment Alternative C
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	190,330.0	98,839.0	91,491.0	$ 94,236
First Costs				$ 556,971
Interest During Construction				$ 27,066
Annual Operation & Maintenance Costs				$ 2,067
Total Annual Costs			$ 22,488	$ 23,184
B/C Ratio			4.07	4.06
Equivalent Annual Net Benefits - 2020 Base Year			$ 69,003	$ 71,052

Note: Calculations based on preliminary cost estimates prepared prior to MII Cost and Risk Analysis.

Table 65
0.5% AEP (200-year) Levee Alignment Alternative C
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	190,330.0	82,485.0	107,845.0	$ 111,080
First Costs				$ 1,036,405
Interest During Construction				$ 54,347
Annual Operation & Maintenance Costs				$ 2,067
Total Annual Costs			$ 43,380	$ 44,722
B/C Ratio			2.49	2.48
Equivalent Annual Net Benefits - 2020 Base Year			$ 64,465	$ 66,358

Note: Calculations based on preliminary cost estimates prepared prior to MII Cost and Risk Analysis.

Table 66
1% AEP (100-year) Levee Alignment Alternative C Without Future Development
Sensitivity Analysis
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 94,317	$ 24,805	$ 69,511	$ 72,124
First Costs				$ 676,598
Interest During Construction				$ 35,461
Annual Operation & Maintenance Costs				$ 4,374
Total Annual Costs			$ 31,160	$ 32,124
B/C Ratio			2.23	2.25
Equivalent Annual Net Benefits - 2020 Base Year			$ 38,351	$ 40,000

Note: Inducements of $215,110 attributed to the 0.01 AEP Level of Risk Reduction Structural System are included in the analysis.

Table 67
1% AEP (100-year) Levee Alignment Alternative C including all Localized Storm Surge Risk Reduction Measures without Future Development
Summation of Separate HEC-FDA Model Executions
Sensitivity Analysis
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 104,838	$ 29,825	$ 75,013	$ 77,832
First Costs				$ 736,034
Interest During Construction				$ 36,379
Annual Operation & Maintenance Costs				$ 5,302
Total Annual Costs			$ 34,556	$ 35,625
B/C Ratio			2.17	2.18
Equivalent Annual Net Benefits - 2020 Base Year			$ 40,457	$ 42,207

Table 68
1% AEP (100-year) Levee Alignment Alternative C Without Future Development
Summation of Separate HEC-FDA Model Executions
Sensitivity Analysis
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages 2012 Prices (2020-2070)	Equiv Annual With-Project Damages 2012 Prices (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 83,919	$ 25,202	$ 58,717	$ 60,924
First Costs				$ 676,598
Interest During Construction				$ 73,101
Annual Operation & Maintenance Costs				$ 178
Total Annual Costs			$ 46,860	$ 48,310
B/C Ratio			1.25	1.26
Equivalent Annual Net Benefits - 2020 Base Year			$ 11,857	$ 12,614

Table 69 A
1% AEP (100-year) Levee Alignment Alternative C including all Localized Storm Surge Risk Reduction Measures without Future Development
Summation of Separate HEC-FDA Model Executions
Sensitivity Analysis
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 92,309	$ 29,106	$ 63,203	$ 65,578
First Costs				$ 736,034
Interest During Construction				$ 74,936
Annual Operation & Maintenance Costs				$ 4,182
Total Annual Costs			$ 55,050	$ 56,753
B/C Ratio			1.15	1.16
Equivalent Annual Net Benefits - 2020 Base Year			$ 8,153	$ 8,825

Table 69 B
Recommended Plan Without Future Development
Summation of Separate HEC-FDA Model Executions
Sensitivity Analysis
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study

$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 103,933	$ 29,143	$ 74,790	$ 77,601
First Costs				$ 718,091
Interest During Construction				$ 36,065
Annual Operation & Maintenance Costs				$ 5,023
Total Annual Costs			$ 33,531	$ 34,568
B/C Ratio			2.23	2.24
Equivalent Annual Net Benefits - 2020 Base Year			$ 41,260	$ 43,033

Note: Includes structural alignment and localized Storm Surge Risk Reduction measures excluding Berm 2.

Table 69 C
Recommended Plan Without Future Development
Summation of Separate HEC-FDA Model Executions
Sensitivity Analysis
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study

$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 91,584	$ 28,560	$ 63,024	$ 65,393
First Costs				$ 718,091
Interest During Construction				$ 74,308
Annual Operation & Maintenance Costs				$ 3,959
Total Annual Costs			$ 53,529	$ 55,184
B/C Ratio			1.18	1.18
Equivalent Annual Net Benefits - 2020 Base Year			$ 9,496	$ 10,208

Note: Includes structural alignment and localized Storm Surge Risk Reduction measures excluding Berm 2.

Table 69 D
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures Excluding Berm 2
HEC-FDA Model Results for Combined Flood Risk Management System Components
Sensitivity Analysis
(2012 and 2014 Price Levels; 3.5% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020 2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 112,169	$ 30,584	$ 81,584	$ 84,032
First Costs				$ 718,091
Interest During Construction				$ 36,065
Annual Operation & Maintenance Costs				$ 5,023
Total Annual Costs			$ 33,531	$ 34,568
B/C Ratio			2.43	2.43
Equivalent Annual Net Benefits - 2020 Base Year			$ 48,053	$ 49,464

Table 69 E
Recommended Plan
1% AEP (100-year) Levee Alignment Alternative C Including All Localized Storm Surge Risk Reduction Measures Excluding Berm 2
HEC-FDA Model Results for Combined Flood Risk Management System Components
Sensitivity Analysis
(2012 and 2014 Price Levels; 7% Discount Rate)
Total Equivalent Annual Net Benefits
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

Item	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits and Costs 2012 Prices (2020-2070)	Equiv Annual Benefits and Costs 2014 Prices (2020 2070)
Damage Category				
Residential & Commercial - Structure/Content/Vehicles	$ 99,793	$ 29,517	$ 70,276	$ 72,385
First Costs				$ 718,091
Interest During Construction				$ 74,308
Annual Operation & Maintenance Costs				$ 3,959
Total Annual Costs			$ 53,529	$ 55,184
B/C Ratio			1.31	1.31
Equivalent Annual Net Benefits - 2020 Base Year			$ 16,748	$ 17,201

West Shore Lake Pontchartrain
Sea Level Rise Sensitivity Analysis
Table 70
Alternative C - Levee Alignment

	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)	Annual Costs	B/C Ratio	Net Benefits
Calculations based on with and without intermediate sea level rise including future development as of 2014.	$ 190,330	$ 105,399	$ 84,931	$ 87,479	$ 23,184	3.77	$ 64,295
Estimate of low sea level rise benefits based on percent change from draft report. Preliminary costs are based on providing a 50 year level or risk reduction.	$ 151,057	$ 83,651	$ 67,406	$ 69,428	$ 22,505	3.09	$ 46,923
Estimate of high sea level rise benefits based on percent change from previous analysis . Preliminary costs are based on providing a 200 year level or risk reduction.	$ 348,448	$ 192,961	$ 155,487	$ 160,152	$ 44,722	3.58	$ 115,430

Note: Calculations based on preliminary cost estimates prepared prior to MII Cost and Risk Analysis.

West Shore Lake Pontchartrain
Sea Level Rise Sensitivity Analysis
Table 71
Alternative C - Levee Alignment - Without Future Development

	Equiv Annual W/O Project Damages (2020-2070)	Equiv Annual With-Project Damages (2020-2070)	Equiv Annual Benefits 2012 Prices (2020-2070)	Equiv Annual Benefits 2014 Prices (2020-2070)	Annual Costs	B/C Ratio	Net Benefits
Calculations based with and without intermediate sea level rise without future development as of 2014.	$ 104,663	$ 35,437	$ 69,226	$ 71,303	$ 23,184	3.08	$ 48,119
Estimate of low sea level rise benefits based on percent change from draft report. Preliminary costs are based on providing a 50 year level or risk reduction.	$ 83,067	$ 28,125	$ 54,942	$ 56,590	$ 22,505	2.51	$ 34,085
Estimate of high sea level rise benefits based on percent change from previous analysis . Preliminary costs are based on providing a 200 year level or risk reduction.	$ 191,612	$ 64,877	$ 126,736	$ 130,538	$ 44,722	2.92	$ 85,816

Note: Calculations based on preliminary cost estimates prepared prior to MII Cost and Risk Analysis.

Table 72
Risk Analysis
Probability that Equivalent Annual Benefits Exceed Annual Costs
(2014 Price Level; 3.5% Discount Rate)
West Shore Lake Pontchartrain, LA Feasibility Study
$1000s

		Probabilty Damage Reduced Exceeds Indicated Values (2014 price levels)				
Component	Equivalent Annual Damages Reduced (2014 prices)	0.75	0.50	0.25	Annual Costs (2014 price levels)	Probabilty Benefits Exceed Costs
0.01 AEP (100-year) Level of Risk Reduction						
Structural System	87,922	61,436	84,331	110,252	32,124	Greater than 75 percent
Berm 1	1,073	524	981	1,567	842	Between 50 and 75 percent
Berm 2	229	108	209	348	1,057	Less than a 75 percent
Berm 3	956	267	762	1,477	839	Between 25 and 50 percent
Installation of Flapgates on Culverts	1,119	834	1,107	1,437	464	Greater than 75 percent
Structure Raising outside of Berms and Levee	2,290	1,017	2,028	3,290	299	Greater than 75 percent
Reduction Measures	93,588	69,516	93,923	121,604	35,625	Greater than 75 percent
Recommended Plan which excluding Berm 2	93,359	69,409	93,714	121,257	34,568	Greater than 75 percent

Table 73
Project Performance by Study Area Reach
Levee Alignment C
Without Project
2020
West Shore Lake Pontchartrain

Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10	30	50	0.10	0.04	0.02	0.01	0.004	0.002
SA 1	5.480		0.8361	0.8345	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 10	4.710		0.0265	0.0262	0.2336	0.5498	0.7355	1.0000	0.9998	0.0450	0.0000	0.0000	0.0000
SA 11	7.600		0.0403	0.0416	0.3459	0.7202	0.8803	0.9977	0.4962	0.1892	0.0969	0.0453	0.0277
SA 12	6.510		0.6184	0.6188	0.9999	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 13	5.740		0.0677	0.0693	0.5122	0.8839	0.9724	0.8057	0.2140	0.1222	0.0000	0.0000	0.0000
SA 14	8.100		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 15	9.370		0.8525	0.8505	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 16	5.340		0.9224	0.9159	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 17	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 18	3.550		0.0584	0.0625	0.4758	0.8560	0.9604	0.8687	0.2963	0.0507	0.0136	0.0042	0.0026
SA 19	4.950		0.0219	0.0224	0.2028	0.4933	0.6779	0.9997	0.9455	0.4370	0.1521	0.0505	0.0275
SA 2	5.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 20	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 21	4.010		0.1733	0.1684	0.8418	0.9960	0.9999	0.1037	0.0065	0.0000	0.0000	0.0000	0.0000
SA 22	5.130		0.9822	0.9787	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 23	6.400		0.7995	0.7990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 24	6.510		0.0583	0.0650	0.4892	0.8667	0.9652	0.8467	0.3026	0.0124	0.0000	0.0000	0.0000
SA 25	4.080		0.4754	0.4722	0.9983	1.0000	1.0000	0.0103	0.0014	0.0000	0.0000	0.0000	0.0000
SA 26	4.220		0.0397	0.0518	0.4124	0.7971	0.9299	0.9135	0.5085	0.0372	0.0086	0.0025	0.0015
SA 27	3.060		0.1334	0.1303	0.7524	0.9848	0.9991	0.1973	0.0142	0.0000	0.0000	0.0000	0.0000
SA 28X	4.040		0.0655	0.0719	0.5258	0.8933	0.9760	0.7460	0.2444	0.0192	0.0038	0.0000	0.0000
SA 28Y	3.640		0.0969	0.0948	0.6305	0.9495	0.9931	0.5204	0.0966	0.0085	0.0021	0.0000	0.0000
SA 29	5.170		0.0316	0.0348	0.2983	0.6545	0.8299	0.9889	0.7741	0.1641	0.0388	0.0125	0.0063
SA 29C	3.500		0.8642	0.8616	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 3	13.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 30	4.170		0.0750	0.0799	0.5652	0.9178	0.9845	0.6490	0.1897	0.0100	0.0000	0.0000	0.0000
SA 30C	4.290		0.0686	0.0747	0.5399	0.9026	0.9794	0.7086	0.2222	0.0195	0.0033	0.0000	0.0000
SA 31	5.960		0.0293	0.0293	0.2570	0.5898	0.7736	0.9990	0.9527	0.1364	0.0363	0.0131	0.0067
SA 31C	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 32	4.780		0.0488	0.0574	0.4461	0.8301	0.9479	0.8976	0.3946	0.0313	0.0104	0.0042	0.0027
SA 33	5.460		0.0359	0.0394	0.3308	0.7004	0.8658	0.9986	0.6998	0.0880	0.0343	0.0182	0.0131
SA 34	4.770		0.0566	0.0602	0.4623	0.8445	0.9551	0.9233	0.3166	0.0421	0.0182	0.0105	0.0074
SA 35	4.880		0.0536	0.0582	0.4511	0.8346	0.9502	0.9205	0.3433	0.0494	0.0217	0.0126	0.0093
SA 36	5.510		0.0378	0.0446	0.3664	0.7456	0.8979	0.9718	0.5785	0.0772	0.0237	0.0100	0.0057
SA 37	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 38	5.320		0.0425	0.0507	0.4054	0.7898	0.9257	0.9526	0.4680	0.0605	0.0234	0.0121	0.0084
SA 39	6.560		0.0296	0.0303	0.2647	0.6025	0.7851	0.9993	0.8637	0.1933	0.0711	0.0305	0.0193
SA 39C	8.220		0.0182	0.0175	0.1620	0.4115	0.5868	0.9997	0.9966	0.5514	0.2519	0.1178	0.0747
SA 4	11.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 40P	3.560		0.0935	0.0923	0.6204	0.9453	0.9921	0.5374	0.1095	0.0052	0.0016	0.0000	0.0000
SA 41	4.560		0.0663	0.0709	0.5205	0.8898	0.9747	0.7887	0.2361	0.0216	0.0083	0.0040	0.0029
SA 41P	5.030		0.0335	0.0382	0.3224	0.6888	0.8571	0.9731	0.7353	0.1123	0.0229	0.0056	0.0028
SA 42P	6.140		0.0304	0.0310	0.2702	0.6113	0.7930	0.9970	0.9123	0.1226	0.0323	0.0116	0.0062
SA 43P	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 44C	1.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 5	11.720		0.7618	0.7608	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 6	12.100		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 7	5.920		0.1957	0.2032	0.8968	0.9989	1.0000	0.0723	0.0082	0.0000	0.0000	0.0000	0.0000
SA 8	8.020		0.0265	0.0381	0.3220	0.6884	0.8568	0.9405	0.6974	0.3814	0.0000	0.0000	0.0000
SA 9	4.200		0.2054	0.2132	0.9090	0.9992	1.0000	0.0234	0.0000	0.0000	0.0000	0.0000	0.0000

Table 73 cont.
Levee Alignment C
With Project
2020

Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10	30	50	0.10	0.04	0.02	0.01	0.004	0.002
SA 1	5.480		0.8360	0.8345	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 10	4.710		0.0078	0.0080	0.0767	0.2129	0.3290	0.9996	0.9996	0.9996	0.6860	0.1637	0.0496
SA 11	7.600		0.0403	0.0416	0.3461	0.7204	0.8804	0.9977	0.4958	0.1890	0.0968	0.0452	0.0277
SA 12	6.510		0.6189	0.6192	0.9999	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 13	5.740		0.0678	0.0687	0.5094	0.8819	0.9716	0.7980	0.2121	0.1191	0.0654	0.0109	0.0024
SA 14	8.100		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 15	9.370		0.8521	0.8502	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 16	5.340		0.9221	0.9147	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 17	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 18	3.550		0.0082	0.0080	0.0769	0.2134	0.3297	0.9997	0.9997	0.9997	0.7405	0.0776	0.0153
SA 19	4.950		0.0001	0.0001	0.0010	0.0031	0.0052	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 2	5.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 20	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 21	4.010		0.1733	0.1718	0.8482	0.9965	0.9999	0.0597	0.0041	0.0000	0.0000	0.0000	0.0000
SA 22	5.130		0.9821	0.9771	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 23	6.400		0.7989	0.7982	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 24	6.510		0.0583	0.0606	0.4646	0.8466	0.9560	0.8991	0.2452	0.0992	0.0195	0.0035	0.0000
SA 25	4.080		0.4751	0.4716	0.9983	1.0000	1.0000	0.0059	0.0000	0.0000	0.0000	0.0000	0.0000
SA 26	4.220		0.0004	0.0011	0.0105	0.0312	0.0514	0.9998	0.9998	0.9998	0.9980	0.9466	0.8295
SA 27	3.060		0.0070	0.0107	0.1024	0.2768	0.4173	0.9997	0.9788	0.8094	0.6296	0.3306	0.2015
SA 28X	4.040		0.0007	0.0015	0.0148	0.0438	0.0720	0.9998	0.9998	0.9995	0.9935	0.9017	0.7495
SA 28Y	3.640		0.0018	0.0032	0.0314	0.0912	0.1473	0.9998	0.9998	0.9898	0.9457	0.7227	0.5232
SA 29	5.170		0.0001	0.0005	0.0054	0.0160	0.0266	0.9997	0.9997	0.9997	0.9997	0.9994	0.9921
SA 29C	3.500		0.8639	0.8603	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 3	13.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 30	4.170		0.0005	0.0012	0.0118	0.0351	0.0578	0.9998	0.9998	0.9998	0.9964	0.9345	0.8082
SA 30C	4.290		0.0003	0.0009	0.0093	0.0275	0.0455	0.9998	0.9998	0.9998	0.9988	0.9590	0.8559
SA 31	5.960		0.0001	0.0002	0.0024	0.0073	0.0121	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 31C	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 32	4.780		0.0003	0.0006	0.0064	0.0191	0.0316	0.9996	0.9996	0.9996	0.9996	0.9892	0.9330
SA 33	5.460		0.0001	0.0001	0.0010	0.0030	0.0050	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 34	4.770		0.0010	0.0031	0.0304	0.0885	0.1431	0.9998	0.9954	0.9799	0.9273	0.7760	0.6418
SA 35	4.880		0.0001	0.0004	0.0039	0.0116	0.0192	0.9997	0.9997	0.9997	0.9997	0.9997	0.9987
SA 36	5.510		0.0001	0.0002	0.0017	0.0052	0.0086	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
SA 37	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 38	5.320		0.0003	0.0004	0.0036	0.0109	0.0181	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 39	6.560		0.0001	0.0002	0.0022	0.0066	0.0109	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
SA 39C	8.220		0.0001	0.0002	0.0020	0.0061	0.0102	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
SA 4	11.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 40P	3.560		0.0022	0.0037	0.0364	0.1051	0.1690	0.9997	0.9997	0.9836	0.9256	0.6769	0.4781
SA 41	4.560		0.0001	0.0005	0.0051	0.0152	0.0252	0.9998	0.9998	0.9998	0.9998	0.9965	0.9787
SA 41P	5.030		0.0001	0.0005	0.0050	0.0149	0.0247	0.9998	0.9998	0.9998	0.9998	0.9987	0.9859
SA 42P	6.140		0.0001	0.0004	0.0043	0.0128	0.0213	0.9998	0.9997	0.9997	0.9997	0.9997	0.9997
SA 43P	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 44C	1.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 5	11.720		0.7625	0.7615	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 6	12.100		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 7	5.920		0.1958	0.2049	0.8991	0.9990	1.0000	0.0522	0.0035	0.0000	0.0000	0.0000	0.0000
SA 8	8.020		0.0265	0.0352	0.3014	0.6590	0.8336	0.9458	0.7108	0.3656	0.1323	0.0207	0.0036
SA 9	4.200		0.2056	0.2130	0.9089	0.9992	1.0000	0.0253	0.0000	0.0000	0.0000	0.0000	0.0000

Table 73 cont.
Localized Storm Surge Risk Reduction Measures
Without Project
2020

Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10	30	50	0.10	0.04	0.02	0.01	0.004	0.002
1	2.980		0.1022	0.1007	0.6540	0.9586	0.9950	0.4764	0.0832	0.0093	0.0033	0.0018	0.0000
10	0.000	L	0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	3.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	3.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	3.360		0.0709	0.0728	0.5302	0.8963	0.9771	0.7668	0.2079	0.0617	0.0182	0.0064	0.0039
20	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23	4.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	3.070		0.0938	0.0962	0.6362	0.9519	0.9936	0.5637	0.0836	0.0273	0.0082	0.0028	0.0019
25	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	3.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	3.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	6.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
33	3.710		0.0523	0.0507	0.4054	0.7898	0.9257	0.9968	0.3390	0.1512	0.0422	0.0141	0.0087
34	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
36	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
37	3.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
38	4.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
39	3.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	3.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
41	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
42	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
43	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
44	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
45	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
46	4.120		0.0334	0.0353	0.3022	0.6603	0.8346	0.9998	0.6608	0.2210	0.0753	0.0324	0.0219
47	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
48	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
49	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
51	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
52	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
53	3.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
54	3.520		0.0677	0.0667	0.4987	0.8740	0.9683	0.9012	0.2173	0.0682	0.0241	0.0123	0.0090
55	4.220		0.0278	0.0313	0.2727	0.6153	0.7965	0.9990	0.6985	0.3490	0.1111	0.0301	0.0154
56	4.610		0.0199	0.0233	0.2096	0.5062	0.6915	0.9997	0.8711	0.5021	0.1663	0.0503	0.0252
57	3.630		0.0539	0.0608	0.4658	0.8476	0.9565	0.7603	0.4026	0.2092	0.0967	0.0437	0.0275
58	3.250		0.0787	0.0774	0.5533	0.9109	0.9822	0.6052	0.2769	0.1501	0.0665	0.0293	0.0195
6	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	3.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	4.140		0.9435	0.9375	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	3.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 73 cont.
Localized Storm Surge Risk Reduction Measures
With Project
2020

Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10	30	50	0.10	0.04	0.02	0.01	0.004	0.002
1	2.980		0.1022	0.1008	0.6544	0.9587	0.9951	0.4795	0.0841	0.0078	0.0028	0.0015	0.0000
10	6.500	L	0.0066	0.0075	0.0724	0.2019	0.3133	0.9998	0.9998	0.9856	0.8288	0.1407	0.0105
11	6.500	L	0.0286	0.0310	0.2700	0.6110	0.7927	0.9899	0.9082	0.1500	0.0322	0.0029	0.0002
12	6.500	L	0.0286	0.0332	0.2866	0.6369	0.8152	0.9900	0.9059	0.1456	0.0286	0.0022	0.0003
13	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	6.500	L	0.0034	0.0035	0.0346	0.1004	0.1616	0.9995	0.9995	0.9995	0.9995	0.6633	0.1600
16	6.500	L	0.0200	0.0247	0.2211	0.5275	0.7133	0.9790	0.8683	0.5006	0.2671	0.0918	0.0335
17	3.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	3.360		0.0709	0.0739	0.5359	0.9001	0.9785	0.7666	0.2006	0.0445	0.0112	0.0032	0.0018
20	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	6.500	L	0.0058	0.0066	0.0645	0.1814	0.2837	0.9996	0.9995	0.9856	0.7760	0.3672	0.2144
22	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23	4.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	3.070		0.0938	0.0968	0.6387	0.9529	0.9938	0.5688	0.0916	0.0260	0.0076	0.0023	0.0014
25	6.500	L	0.0200	0.0247	0.2211	0.5275	0.7133	0.9790	0.8683	0.5006	0.2671	0.0918	0.0335
26	6.500	L	0.0200	0.0247	0.2211	0.5275	0.7133	0.9790	0.8683	0.5006	0.2671	0.0918	0.0335
27	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	3.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	6.500	L	0.0071	0.0078	0.0757	0.2103	0.3254	0.9995	0.9995	0.9849	0.8266	0.1050	0.0095
31	6.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
33	3.710		0.0523	0.0519	0.4132	0.7980	0.9304	0.9960	0.3452	0.1357	0.0431	0.0149	0.0098
34	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
36	6.500	L	0.0058	0.0065	0.0634	0.1783	0.2791	0.9998	0.9996	0.9899	0.7657	0.3831	0.2511
37	6.500	L	0.0071	0.0078	0.0755	0.2098	0.3246	0.9998	0.9998	0.9858	0.8289	0.1017	0.0074
38	4.200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
39	6.900	L	0.0022	0.0025	0.0243	0.0712	0.1159	0.9995	0.9995	0.9995	0.9995	0.9201	0.4207
4	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	6.500	L	0.0034	0.0035	0.0346	0.1004	0.1616	0.9995	0.9995	0.9995	0.9995	0.6633	0.1600
41	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
42	6.500	L	0.0286	0.0330	0.2850	0.6345	0.8132	0.9896	0.9069	0.1502	0.0310	0.0027	0.0002
43	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
44	2.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
45	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
46	6.500	L	0.0062	0.0070	0.0678	0.1900	0.2961	0.9998	0.9997	0.9824	0.7271	0.3570	0.2320
47	2.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
48	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
49	4.600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	6.500	L	0.0169	0.0189	0.1734	0.4353	0.6142	0.9995	0.9635	0.6186	0.2093	0.0781	0.0314
50	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
51	3.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
52	4.800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
53	3.500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
54	3.520		0.0677	0.0682	0.5067	0.8799	0.9708	0.8978	0.2221	0.0614	0.0227	0.0113	0.0083
55	6.500	L	0.0050	0.0058	0.0564	0.1599	0.2520	0.9997	0.9997	0.9914	0.8356	0.4177	0.2448
56	6.500	L	0.0058	0.0066	0.0641	0.1801	0.2818	0.9997	0.9997	0.9853	0.7716	0.3678	0.2179
57	3.630		0.0539	0.0614	0.4693	0.8506	0.9579	0.7595	0.4048	0.1965	0.0927	0.0414	0.0273
58	3.250		0.0787	0.0770	0.5512	0.9096	0.9818	0.6121	0.2831	0.1520	0.0732	0.0313	0.0202
6	4.000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	6.500	L	0.0066	0.0075	0.0721	0.2010	0.3121	0.9996	0.9996	0.9848	0.8281	0.1421	0.0124
8	6.500	L	0.0066	0.0075	0.0721	0.2010	0.3121	0.9996	0.9996	0.9848	0.8281	0.1421	0.0124
9	6.500	L	0.0066	0.0075	0.0725	0.2020	0.3135	0.9997	0.9997	0.9856	0.8287	0.1405	0.0104

Table 74
Project Performance by Study Area Reach
Levee Alignment C
Without Project
2070

Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10.0000	30.0000	50.0000	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
SA 1	6.2300		0.0857	0.0898	0.6097	0.9405	0.9909	0.6030	0.1602	0.0031	0.0000	0.0000	0.0000
SA 10	6.1500		0.0397	0.0547	0.4304	0.8152	0.9401	0.8949	0.5254	0.0097	0.0027	0.0000	0.0000
SA 11	9.2900		0.0236	0.0233	0.2104	0.5078	0.6931	0.9998	0.9889	0.3481	0.0730	0.0207	0.0122
SA 12	8.0700		0.0382	0.0469	0.3816	0.7636	0.9096	0.9802	0.6079	0.0253	0.0050	0.0021	0.0000
SA 13	7.2300		0.0358	0.0399	0.3344	0.7052	0.8694	0.9875	0.8281	0.0237	0.0068	0.0031	0.0025
SA 14	8.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 15	10.2400		0.0667	0.0709	0.5209	0.8900	0.9748	0.7878	0.2351	0.0238	0.0000	0.0000	0.0000
SA 16	8.4200		0.0336	0.0353	0.3022	0.6603	0.8346	0.9987	0.8391	0.0827	0.0288	0.0136	0.0089
SA 17	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 18	3.4600		0.9675	0.9627	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 19	5.1400		0.1045	0.1012	0.6559	0.9593	0.9952	0.4612	0.0922	0.0000	0.0000	0.0000	0.0000
SA 2	7.1200		0.1398	0.1292	0.7492	0.9842	0.9990	0.3165	0.0495	0.0000	0.0000	0.0000	0.0000
SA 20	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 21	5.0000		0.1685	0.1599	0.8250	0.9946	0.9998	0.1458	0.0101	0.0000	0.0000	0.0000	0.0000
SA 22	5.6100		0.4914	0.4893	0.9988	1.0000	1.0000	0.0146	0.0058	0.0000	0.0000	0.0000	0.0000
SA 23	8.4400		0.0338	0.0356	0.3043	0.6633	0.8371	0.9984	0.9013	0.0398	0.0086	0.0026	0.0019
SA 24	7.0700		0.0551	0.0615	0.4699	0.8510	0.9581	0.8974	0.3353	0.0213	0.0085	0.0044	0.0033
SA 25	4.0700		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 26	4.6500		0.1540	0.1478	0.7980	0.9918	0.9997	0.1359	0.0049	0.0000	0.0000	0.0000	0.0000
SA 27	3.5400		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 28X	4.5200		0.1665	0.1618	0.8288	0.9950	0.9999	0.0864	0.0026	0.0000	0.0000	0.0000	0.0000
SA 28Y	3.5600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 29	6.4500		0.0611	0.0741	0.5371	0.9008	0.9787	0.6809	0.3003	0.0000	0.0000	0.0000	0.0000
SA 29C	5.2300		0.1395	0.1339	0.7626	0.9866	0.9992	0.1952	0.0128	0.0000	0.0000	0.0000	0.0000
SA 3	13.6000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 30	5.0600		0.1436	0.1389	0.7758	0.9887	0.9994	0.1455	0.0039	0.0000	0.0000	0.0000	0.0000
SA 30C	4.3200		0.1820	0.1847	0.8703	0.9978	1.0000	0.0359	0.0000	0.0000	0.0000	0.0000	0.0000
SA 31	6.2400		0.0874	0.0884	0.6036	0.9377	0.9902	0.5680	0.1547	0.0000	0.0000	0.0000	0.0000
SA 31C	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 32	5.5800		0.1320	0.1246	0.7357	0.9815	0.9987	0.2755	0.0338	0.0000	0.0000	0.0000	0.0000
SA 33	5.9800		0.1070	0.1033	0.6640	0.9621	0.9957	0.4407	0.0819	0.0027	0.0000	0.0000	0.0000
SA 34	5.1500		0.1631	0.1541	0.8124	0.9934	0.9998	0.1505	0.0148	0.0000	0.0000	0.0000	0.0000
SA 35	5.1500		0.1628	0.1541	0.8124	0.9934	0.9998	0.1553	0.0162	0.0000	0.0000	0.0000	0.0000
SA 36	5.9700		0.1075	0.1043	0.6676	0.9633	0.9959	0.4435	0.0805	0.0038	0.0000	0.0000	0.0000
SA 37	11.3900		0.0175	0.0168	0.1555	0.3977	0.5705	0.9997	0.9997	0.5809	0.2455	0.1021	0.0583
SA 38	5.5500		0.1492	0.1363	0.7690	0.9877	0.9993	0.2672	0.0393	0.0044	0.0027	0.0020	0.0000
SA 39	8.0500		0.0368	0.0423	0.3507	0.7263	0.8846	0.9873	0.6508	0.0699	0.0268	0.0140	0.0100
SA 39C	9.6200		0.0271	0.0262	0.2329	0.5486	0.7344	0.9997	0.9615	0.2294	0.0909	0.0425	0.0276
SA 4	11.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 40P	3.5000		0.9989	0.9989	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 41	4.7400		0.1968	0.2175	0.9140	0.9994	1.0000	0.0736	0.0057	0.0000	0.0000	0.0000	0.0000
SA 41P	5.0500		0.1392	0.1344	0.7638	0.9868	0.9993	0.1833	0.0100	0.0000	0.0000	0.0000	0.0000
SA 42P	6.1700		0.0951	0.0940	0.6272	0.9482	0.9928	0.5257	0.1167	0.0019	0.0000	0.0000	0.0000
SA 43P	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 44C	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 5	11.6600		0.8540	0.8509	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 6	12.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 7	7.9000		0.0359	0.0402	0.3367	0.7081	0.8716	0.9897	0.7947	0.0261	0.0070	0.0030	0.0024
SA 8	9.3700		0.0298	0.0294	0.2578	0.5911	0.7747	0.9998	0.9997	0.0329	0.0023	0.0000	0.0000
SA 9	5.6400		0.0656	0.0738	0.5357	0.8999	0.9784	0.7281	0.2632	0.0034	0.0000	0.0000	0.0000

Table 74 cont.
Levee Alignment C
With Project
2070

Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10.0000	30.0000	50.0000	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
SA 1	5.4800		0.8360	0.8345	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 10	4.7100		0.0078	0.0080	0.0767	0.2129	0.3290	0.9996	0.9996	0.9996	0.6860	0.1637	0.0496
SA 11	7.6000		0.0403	0.0416	0.3461	0.7204	0.8804	0.9977	0.4958	0.1890	0.0968	0.0452	0.0277
SA 12	6.5100		0.6189	0.6192	0.9999	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 13	5.7400		0.0678	0.0687	0.5094	0.8819	0.9716	0.7980	0.2121	0.1191	0.0654	0.0109	0.0024
SA 14	8.1000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 15	9.3700		0.8521	0.8502	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 16	5.3400		0.9221	0.9147	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 17	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 18	3.5500		0.0082	0.0080	0.0769	0.2134	0.3297	0.9997	0.9997	0.9997	0.7405	0.0776	0.0153
SA 19	4.9500		0.0001	0.0001	0.0010	0.0031	0.0052	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 2	5.8000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 20	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 21	4.0100		0.1733	0.1723	0.8491	0.9966	0.9999	0.0576	0.0037	0.0000	0.0000	0.0000	0.0000
SA 22	5.1300		0.9821	0.9771	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 23	6.4000		0.7989	0.7982	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 24	6.5100		0.0583	0.0606	0.4646	0.8466	0.9560	0.8991	0.2452	0.0992	0.0195	0.0035	0.0000
SA 25	4.0800		0.4751	0.4716	0.9983	1.0000	1.0000	0.0059	0.0000	0.0000	0.0000	0.0000	0.0000
SA 26	4.2200		0.0004	0.0011	0.0105	0.0312	0.0514	0.9998	0.9998	0.9998	0.9980	0.9466	0.8295
SA 27	3.0600		0.0070	0.0107	0.1024	0.2768	0.4173	0.9997	0.9788	0.8094	0.6296	0.3306	0.2015
SA 28X	4.0400		0.0007	0.0015	0.0148	0.0438	0.0720	0.9998	0.9998	0.9995	0.9935	0.9017	0.7495
SA 28Y	3.6400		0.0018	0.0032	0.0314	0.0912	0.1473	0.9998	0.9998	0.9898	0.9457	0.7227	0.5232
SA 29	5.1700		0.0001	0.0005	0.0054	0.0160	0.0265	0.9998	0.9998	0.9998	0.9998	0.9995	0.9922
SA 29C	3.5000		0.8639	0.8610	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 3	13.6000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 30	4.1700		0.0005	0.0012	0.0119	0.0353	0.0581	0.9997	0.9997	0.9996	0.9963	0.9341	0.8082
SA 30C	4.2900		0.0003	0.0009	0.0092	0.0275	0.0454	0.9998	0.9998	0.9998	0.9989	0.9590	0.8562
SA 31	5.9600		0.0001	0.0002	0.0024	0.0073	0.0121	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 31C	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 32	4.7800		0.0003	0.0006	0.0064	0.0190	0.0315	0.9998	0.9998	0.9998	0.9998	0.9896	0.9338
SA 33	5.4600		0.0001	0.0001	0.0010	0.0030	0.0050	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 34	4.7700		0.0010	0.0031	0.0304	0.0885	0.1431	0.9998	0.9954	0.9799	0.9273	0.7760	0.6418
SA 35	4.8800		0.0001	0.0004	0.0038	0.0115	0.0191	0.9997	0.9997	0.9997	0.9997	0.9997	0.9988
SA 36	5.5100		0.0001	0.0002	0.0017	0.0052	0.0086	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
SA 37	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 38	5.3200		0.0003	0.0004	0.0036	0.0108	0.0180	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
SA 39	6.5600		0.0001	0.0002	0.0022	0.0066	0.0109	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
SA 39C	8.2200		0.0001	0.0002	0.0020	0.0061	0.0102	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
SA 4	11.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 40P	3.5600		0.0022	0.0037	0.0364	0.1051	0.1690	0.9997	0.9997	0.9836	0.9256	0.6769	0.4781
SA 41	4.5600		0.0001	0.0005	0.0051	0.0152	0.0252	0.9998	0.9998	0.9998	0.9998	0.9965	0.9787
SA 41P	5.0300		0.0001	0.0005	0.0050	0.0149	0.0247	0.9998	0.9998	0.9998	0.9998	0.9987	0.9859
SA 42P	6.1400		0.0001	0.0004	0.0043	0.0128	0.0213	0.9998	0.9997	0.9997	0.9997	0.9997	0.9997
SA 43P	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 44C	1.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 5	11.7200		0.7625	0.7615	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 6	12.1000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SA 7	5.9200		0.1958	0.2049	0.8991	0.9990	1.0000	0.0522	0.0035	0.0000	0.0000	0.0000	0.0000
SA 8	8.0200		0.0265	0.0353	0.3022	0.6603	0.8346	0.9450	0.7091	0.3644	0.1318	0.0208	0.0037
SA 9	4.2000		0.2056	0.2130	0.9089	0.9992	1.0000	0.0253	0.0000	0.0000	0.0000	0.0000	0.0000

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Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10.0000	30.0000	50.0000	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
1.0000	3.0200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10.0000	10.0400		0.0173	0.0165	0.1533	0.3930	0.5649	0.9997	0.9997	0.6115	0.2116	0.0635	0.0298
11.0000	4.8800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12.0000	10.0200		0.0178	0.0173	0.1604	0.4082	0.5829	1.0000	0.9996	0.6738	0.0560	0.0000	0.0000
13.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.0000	10.8800		0.0138	0.0140	0.1316	0.3452	0.5062	0.9997	0.9997	0.7332	0.3297	0.0959	0.0435
16.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.0000	4.2700		0.1739	0.1683	0.8417	0.9960	0.9999	0.1146	0.0063	0.0000	0.0000	0.0000	0.0000
20.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24.0000	3.0800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25.0000	11.0100		0.0131	0.0133	0.1252	0.3306	0.4877	1.0000	0.9996	0.9317	0.2343	0.0090	0.0000
26.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31.0000	6.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
33.0000	4.0900		0.1912	0.2039	0.8978	0.9989	1.0000	0.0807	0.0028	0.0000	0.0000	0.0000	0.0000
34.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
36.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
37.0000	10.0400		0.0179	0.0169	0.1570	0.4010	0.5744	0.9997	0.9997	0.5813	0.1991	0.0610	0.0299
38.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
39.0000	11.0100		0.0132	0.0135	0.1269	0.3344	0.4926	0.9997	0.9997	0.7607	0.3553	0.1054	0.0481
4.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40.0000	11.0100		0.0131	0.0135	0.1266	0.3338	0.4919	0.9997	0.9997	0.7617	0.3558	0.1058	0.0484
41.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
42.0000	10.4400		0.0152	0.0152	0.1417	0.3678	0.5343	1.0000	0.9996	0.8518	0.1237	0.0025	0.0000
43.0000	9.4200		0.0212	0.0205	0.1875	0.4636	0.6459	1.0000	0.9998	0.3424	0.0144	0.0000	0.0000
44.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
45.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
46.0000	5.1400		0.1041	0.0998	0.6504	0.9573	0.9948	0.4675	0.0974	0.0022	0.0000	0.0000	0.0000
47.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
48.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
49.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
51.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
52.0000	10.3200		0.0159	0.0157	0.1464	0.3781	0.5469	1.0000	0.9996	0.8140	0.1029	0.0024	0.0000
53.0000	9.1800		0.0222	0.0209	0.1906	0.4697	0.6525	0.9997	0.9997	0.3632	0.1023	0.0288	0.0147
54.0000	3.6100		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
55.0000	7.2200		0.0325	0.0337	0.2904	0.6426	0.8200	0.9954	0.9385	0.0484	0.0107	0.0025	0.0014
56.0000	5.9700		0.0462	0.0599	0.4608	0.8432	0.9544	0.8505	0.4333	0.0083	0.0024	0.0000	0.0000
57.0000	3.5600		0.4469	0.4459	0.9973	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
58.0000	3.2800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7.0000	3.7000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8.0000	6.0300		0.0433	0.0566	0.4413	0.8256	0.9455	0.9056	0.4623	0.0113	0.0032	0.0000	0.0000
9.0000	10.2800		0.0159	0.0155	0.1446	0.3741	0.5420	0.9997	0.9997	0.6712	0.2496	0.0766	0.0367

Table 74 cont.
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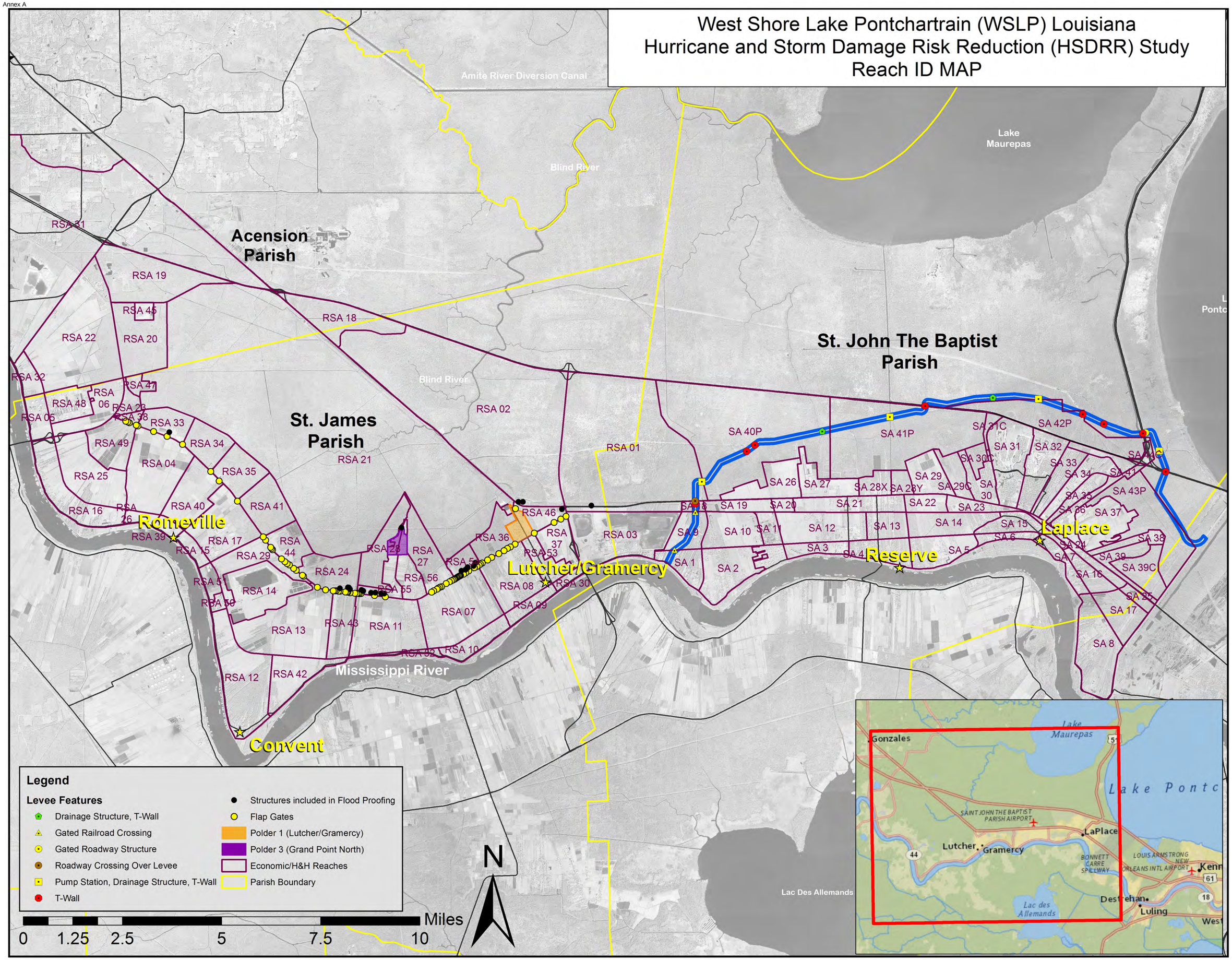
Study Area Reach	Target Stage	Geo Tech	Target Stage Annual Exceedance Median	Target Stage Annual Exceedance Expected	Long-Term Risk (years) 10.0000	Long-Term Risk (years) 30.0000	Long-Term Risk (years) 50.0000	Conditional Non-Exceedance Probability by Events 0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
1.0000	2.9800		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10.0000	6.5000	L	0.0372	0.0479	0.3876	0.7704	0.9139	0.9785	0.7047	0.0185	0.0043	0.0016	0.0010
11.0000	6.5000	L	0.0385	0.0553	0.4337	0.8184	0.9418	0.8287	0.7765	0.0000	0.0000	0.0000	0.0000
12.0000	6.5000	L	0.0385	0.0667	0.4983	0.8737	0.9682	0.8146	0.7647	0.0000	0.0000	0.0000	0.0000
13.0000	4.8000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14.0000	4.8000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.0000	6.5000	L	0.0374	0.0543	0.4277	0.8126	0.9386	0.9462	0.7020	0.0125	0.0033	0.0011	0.0005
16.0000	6.5000	L	0.0380	0.0681	0.5058	0.8793	0.9705	0.8871	0.8523	0.0000	0.0000	0.0000	0.0000
17.0000	3.2000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.0000	3.3600		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.0000	6.5000	L	0.0372	0.0525	0.4166	0.8014	0.9324	0.9523	0.7071	0.0176	0.0041	0.0015	0.0005
22.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23.0000	4.2000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24.0000	3.0700		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25.0000	6.5000	L	0.0380	0.0683	0.5069	0.8801	0.9708	0.8844	0.8501	0.0000	0.0000	0.0000	0.0000
26.0000	6.5000	L	0.0380	0.0681	0.5058	0.8793	0.9705	0.8874	0.8533	0.0000	0.0000	0.0000	0.0000
27.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.0000	3.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30.0000	6.5000	L	0.0373	0.0506	0.4048	0.7891	0.9253	0.9776	0.7077	0.0170	0.0039	0.0014	0.0008
31.0000	6.8000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
33.0000	3.7100		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
34.0000	2.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35.0000	2.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
36.0000	6.5000	L	0.0372	0.0525	0.4166	0.8014	0.9324	0.9523	0.7071	0.0176	0.0041	0.0015	0.0005
37.0000	6.5000	L	0.0373	0.0483	0.3905	0.7736	0.9159	0.9761	0.7032	0.0174	0.0044	0.0018	0.0011
38.0000	4.2000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
39.0000	6.9000	L	0.0349	0.0474	0.3849	0.7673	0.9119	0.9829	0.8597	0.0235	0.0058	0.0017	0.0010
4.0000	4.6000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40.0000	6.5000	L	0.0374	0.0543	0.4277	0.8125	0.9386	0.9462	0.7020	0.0125	0.0033	0.0011	0.0005
41.0000	2.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
42.0000	6.5000	L	0.0385	0.0698	0.5149	0.8858	0.9731	0.8144	0.7641	0.0000	0.0000	0.0000	0.0000
43.0000	4.8000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
44.0000	2.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
45.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
46.0000	6.5000	L	0.0373	0.0454	0.3718	0.7520	0.9021	0.9510	0.7065	0.0168	0.0039	0.0016	0.0006
47.0000	2.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
48.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
49.0000	4.6000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.0000	6.5000	L	0.0374	0.0604	0.4635	0.8456	0.9556	0.9340	0.7995	0.0016	0.0002	0.0000	0.0000
50.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
51.0000	3.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
52.0000	4.8000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
53.0000	3.5000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
54.0000	3.5200		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
55.0000	6.5000	L	0.0373	0.0460	0.3755	0.7564	0.9050	0.9509	0.7056	0.0145	0.0035	0.0012	0.0005
56.0000	6.5000	L	0.0372	0.0450	0.3693	0.7491	0.9002	0.9556	0.7140	0.0190	0.0043	0.0012	0.0004
57.0000	3.6300		0.1979	0.2485	0.9425	0.9998	1.0000	0.0387	0.0000	0.0000	0.0000	0.0000	0.0000
58.0000	3.2500		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6.0000	4.0000		0.9990	0.9990	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7.0000	6.5000	L	0.0372	0.0448	0.3674	0.7469	0.8987	0.9783	0.7079	0.0203	0.0052	0.0021	0.0013
8.0000	6.5000	L	0.0372	0.0442	0.3640	0.7427	0.8959	0.9783	0.7079	0.0203	0.0052	0.0021	0.0013
9.0000	6.5000	L	0.0372	0.0499	0.4008	0.7848	0.9227	0.9789	0.7082	0.0185	0.0040	0.0015	0.0009

Annex A

West Shore Lake Pontchartrain (WSLP) Louisiana Hurricane and Storm Damage Risk Reduction (HSDRR) Study Reach ID MAP



West Shore Lake Pontchartrain, Louisiana
Feasibility Report
Annex B: Other Social Effects Appendix

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I. INTRODUCTION

This appendix presents a socioeconomic evaluation of the alternatives being considered for storm surge risk reduction for the West Shore of Lake Pontchartrain study area, which includes portions of three parishes in the state of Louisiana. It was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies, and Engineering Circular (EC) 1105-2-409.

Purpose

The purpose of this appendix is to describe the Other Social Effects (OSE) account of the the project. The OSE account considers the potential social ramifications of Corps actions so that decision makers and stakeholders are able to evaluate the social implications of each alternative and choose an alternative that will be judged as complete, effective, and fair.

Study Area

The study area is located in Louisiana about 30 miles west of the city of New Orleans and includes parts of St. Charles, St. John the Baptist, and St. James Parishes. Communities in the study area include the Montz, Laplace, Gramercy, Lutcher, Grand Point, Reserve, Convent and Romeville. Parts of the parishes have historically suffered hurricane and tropical storm surge damages due to insufficient hurricane and storm damage risk reduction features. The impact of preparing for, mitigating, and recovering from these damages has placed a significant physical and emotional burden on individuals and has been devastating for impacted communities. The goals of the proposed project are to reduce property damage risks in the study area from the effects of hurricane/tropical storm surges.

Overview of Other Social Effects

While federal water resources planning guidance has long called for an examination of the social effects associated with USACE water resources projects, the tendency has been to discount the social impacts of Corps projects during the planning process and focus instead on the economic analysis (USACE, 2008). EC 1105-2-409, however, states that "all Corps planning studies will evaluate, display and compare the full range of alternative plans' effects across all four Principles and Guidelines' accounts (National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE)" (USACE, 2008 pg. 4).

The OSE account ensures that adequate attention is paid to the beneficial and adverse social effects of Corps projects during the planning process. This appendix follows the guidance set forth by the USACE Institute for Water Resources (IWR) in the Handbook on Applying "Other Social Effects" Factors in Corps of Engineers Water Resources Planning (USACE, 2008). The handbook describes the procedures for analyzing and using OSE criteria in the planning process and identifies social factors that affect individual and group definitions of satisfaction and well-being.

Organization of Appendix

The OSE appendix is organized as follows:

- Section 1 provides an introduction to OSE.
- Section 2 describes the existing and future without-project socioeconomic characteristics and other social factors of the study area.
- Section 3 provides an OSE analysis of the project alternatives.

II. OTHER SOCIAL EFFECTS STUDY AREA CHARACTERISTICS

This section provides a description of the existing and future without-project socioeconomic characteristics and other social factors of the study area.

Socioeconomic Characteristics of the Study Area

In this section, socioeconomic data for St. Charles, St. John the Baptist, and St. James Parishes are presented in order to provide a context from which to evaluate the potential social impacts of the proposed project.

Population and Households.

Population characteristics such as size and change constitute important areas of consideration in that they determine consumption patterns, land uses, and future development patterns. Table 1 displays the population in each of the parishes for the years 1970, 1980, 1990, 2000, and 2010, as well as projections for the year 2020 and the year 2070, the years that were modeled and used to calculate damages and benefits. Population projections are based on the Moody's County Forecast Database, which has population projections to the year 2038. Moody's projections were extended by New Orleans District from the year 2030 to the year 2080 based on the growth rate forecasted by Moody's for the years 2018 through 2038. As shown in Table 1, St. Charles, St. James and St. John Parishes experienced a steady increase in population between 1980 and 2010.

Table 1: Parish-wide populations (in 1000s). (U.S. Census 2013)

Parish	**1970**	**1980**	**1990**	**2000**	**2010**
St. Charles	29.5	37.5	42.5	48.2	52.8
St. John the Baptist	23.8	32.3	40.1	43.1	45.9
St. James	19.7	21.6	20.8	21.4	22.1
Total	**73.0**	**91.4**	**103.4**	**112.7**	**120.8**

According to U.S. Census data, the population of St. Charles Parish was 48,200 in 2000 and 52,800 in 2010, an increase of 4,600 residents. During the same time, the population of St. John the Baptist Parish increased from 43,100 to 45,900, an increase of 2,800 residents. During the same period, the population of St. James Parish increased from 21,400 to 22,100, an increase of 700 residents.

Parish populations are projected to maintain this steady growth, with St. Charles Parish expected to have roughly 56,200 residents in 2020 and approximately 65,500 residents in the year 2070. St. John the Baptist Parish is expected to grow with an estimated population of roughly 51,700 in 2020 and 60,200 in 2070. The total population in the study area is projected to grow to 95,900 by 2080.

Table 2: Number of households in study area (in 1000s). (U.S. Census 2013)

Parish	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**	**2080**
St. Charles	7.59	11.6	14.4	16.5	17.2	18.3	22.0
St. James	4.63	6.1	6.4	7.0	6.9	7.2	8.7
St. John the Baptist	5.77	9.4	12.7	14.3	15.1	16.3	19.6
Total	**17.99**	**27.1**	**33.5**	**37.8**	**39.2**	**41.8**	**50.3**

Table 2 shows the number of households in each parish in 1970, 1980, 1990, 2000, and 2010 and projections for the years 2020 and 2080. The projected number of households was based on Moody's County Forecast Database and extended from the year 2038 to 2080 by the New Orleans District based on the growth rate forecasted by Moody's for the years 2018 through 2038.
The total number of households in the three Parishes experienced a steady increase between 1970 and 2010, which parallels the growth in population. This increase, which was commensurate with the population growth experienced by the entire Gulf Coast region during the same period, can be attributed to increases in the petrochemical industry and area ports. Similar to the projected population growth in the area, the number of households is expected to continue increasing through the year 2080. St. Charles Parish is projected to have approximately 18,300 households in the year 2020, while St. John the Baptist Parish is projected to have 16,300 households, and St. James Parish is projected to have 7,200 households. By the year 2080, the number of households in St. Charles Parish is expected to reach approximately 22,000 while the number in St. John the Baptist Parish is expected to reach to approximately 19,600 and St. James Parish is expected to reach 8,700. In total, the parishes are projected to have approximately 50,200 households in the year 2080.

Employment.
Table 3 shows the total non-farm employment by parish for the years 1970, 1980, 1990, 2000, 2010. Employment trends in the area have historically moved with the activity of the petrochemical industry, river ports and agriculture.

Table 3: Historical parish-wide non-farm employment (in 1000s). (Moody's 2013)

Parish	**1970**	**1980**	**1990**	**2000**	**2010**
St. Charles	9.0	18.1	18.5	20.1	24.3
St. John the Baptist	5.4	9.8	9.4	7.6	8.1
St. James	4.2	9.4	11.0	13.4	15.0
Total	**18.5**	**37.2**	**39.0**	**41.1**	**47.4**

In addition to the petrochemical industry, there are two other sectors of the economy that are important to the region: ports and agriculture. The Port of South Louisiana is the largest volume port in the western hemisphere. The area grows and processes sugarcane and other farm products that are used both domestically and abroad.

Social Profile of the Study Area

This section provides a baseline profile of the social characteristics of the study area. Data for the profile are from a variety of sources including 2010 U.S. Census records, the 2006-2010 U.S. Census Bureau's American Community Survey (ACS) estimates, ESRI data, and aerial photography. Baseline characteristics are considered the existing and future-without project conditions.

Health and Safety

Severe flood events threaten the health and safety of residents living in the study area. Loss of life, injury, and post flood health hazards may occur in the event of catastrophic flooding. For example, while the study area was not directly impacted by Hurricane Katrina, the Louisiana Recovery Authority estimated (as of November 2006) that 1,464 fatalities occurred associated with Hurricane Katrina with 135 more residents declared missing. Hurricanes Gustav and Ike were less costly in terms of lives lost, but still claimed 98 deaths. When facilities that provide critical care or emergency services are impacted by flood events, residents are at an even greater risk for experiencing negative health outcomes. Hurricanes reduce the previous availability of health facilities and services and require additional fire and police protection. During storms, some police stations are required to relocate because of flooding. In addition to the damages to hospitals, police stations, and fire stations, many employees providing related services lost their homes reducing the staff needed to operate health and safety services.

The number of medical facilities, police stations, and fire stations located in the study area were obtained using 2010 ESRI data (latest year available).

Medical Care Facilities

There are no hospitals, nursing homes, or health care service facilities in the part of St. Charles Parish included in the study area. St. John the Baptist Parish has 8 medical care facilities (e.g., 2 hospitals, 1 Outpatient Clinic, and 5 nursing homes). St. James Parish has 4 medical care facilities.

Police Stations

St. Charles Parish has no police stations in the study area, St. John the Baptist Parish has 2 police stations, and St. James Parish has 3 police stations/sheriff's offices, according to ESRI data.

Fire Stations

There are 23 fire stations located in the study area; 1 in St. Charles Parish, 12 in St. John the Baptist Parish, and 10 in St. James Parish.

Social Connectedness

The degree to which communities are able to instill a shared sense of belonging and purpose among residents is in large part determined by the community's civic infrastructure. The presence of social institutions such as libraries, places of worship, and schools provide residents an opportunity for civic participation and engagement which allows residents to come together and work toward a common goal. The number of libraries, places of worship, and schools located within the study area were obtained using 2010 ESRI data (latest year available).

Civic Infrastructure

According to Google Earth's Mapping data and individual parish governmental websites, the portion of St. Charles Parish in the study area has no libraries, 1 place of worship, and no schools.

The data shows 3 libraries, 32 places of worship, and 19 schools within the study area in St. John the Baptist Parish. St. James Parish has 1 library, 11 places of worship, and 6 schools located in the study area

Leisure and Recreation

Having personal leisure time available and having access to recreational areas contributes to residents' quality of life and is therefore an important aspect of well-being. The number of recreational areas within the study area was obtained using individual parish governmental websites.

Recreational Areas

St. Charles Parish has 1 recreational area located in the study area, Montz Park. St. John the Baptist Parish has 8 recreational areas in the study area; Regala Park; Emily C. Watkins Park; Cambridge Park; Hwy 51 Park; Stephanie Wilking Park; Greenwood Park; Belle Pointe Park and Ezekiel Jackson Park. St. James Parish has 5 recreational areas in the study area; St. James Parish Fitness Center; Gramercy Park; Lutcher Park; Paulina Park; and Romeville Park.

Recreational fishing and hunting are very important in the area. The high quality of the recreational fishery, especially an abundance of freshwater and estuarine species, has made this an important leisure activity for residents. Inland saltwater fish species, crabs, and shrimp are available in nearby lakes. Game species hunted in the area include waterfowl, deer, rabbit, and squirrels.

Social Vulnerability/Resiliency

The devastation of Hurricane Katrina brought attention to the salience of the related concepts of social vulnerability and resiliency when evaluating water resources projects (USACE, 2008). Social vulnerability is a characteristic of groups or communities that limits or prevents their ability to withstand adverse impacts from hazards to which they are exposed. Resiliency, in turn, refers to the ability of groups or communities to cope with and recover from adverse events. The factors that contribute to vulnerability often reduce the ability of groups or communities to recover from a disaster; therefore, more socially vulnerable groups or communities are typically less resilient.
Several factors have been shown to contribute to an area's vulnerability/resiliency, including poverty, racial/ethnic composition, education levels and proportion of the population over the age of 65.

Poverty Rate

High poverty rates negatively impact the social welfare of residents and undermine the community's ability to assist residents in times of need. The 2006-2010 U.S. Census data indicate that 13 percent of the population of St. Charles Parish, 15 percent of the population in St. John the Baptist Parish and 15 percent of the population in St. James Parish fell below the poverty line. In contrast, 18.1 percent of the population in the state of Louisiana and 13.8 percent in the nation overall fell below the poverty line during the same period.

Table 4: St. Charles Parish communities percent minority and low income.

	St. Charles Parish*	**Montz**
Total Population	52,880	1,918
% Minority	35%	22%

% Low Income	13%	0%

*Includes total parish percent minority and low income.

Table 5: St. John the Baptist Parish communities percent minority and low income.

	St. John the Baptist Parish*	Laplace	Reserve	Garyville
Total Population	45,824	29,872	9,766	2,811
% Minority	61%	59%	65%	54%
% Low Income	15%	9%	20%	8%

*Includes total parish percent minority and income.

Table 6: St. James Parish communities percent minority and low income.

	St. James Parish*	Gramercy	Lutcher	Grand Point	Convent
Total Population	22,102	3,613	3,559	2,473	711
% Minority	53%	49%	54%	27%	69%
% Low Income	15%	13%	21%	8%	10%

*Includes total parish population demographics.

Racial / Ethnic Composition

Race/ethnicity plays an important role in the everyday lives of Americans. Unequal access to social resources and language barriers may affect preparing for and recovering from flood events for certain groups. Tables 4, 5, and 6 show the racial and ethnic characteristics of the Parishes, according to the 2010 U.S. Census. In St. John the Baptist and St. James Parishes, the majority of the population is minority. In St. Charles Parish the majority of the population is non-minority.

Education Attainment

Education attainment has important implications for the social vulnerability/resiliency of communities. More educated individuals have less difficulty accessing information and navigating the sometimes complex process of recovery after flood events (e.g., obtaining government assistance, insurance claims, permits, etc.) According to 2006-2010 ACS data, the percentage of the population age 25 and older in St. Charles Parish with a high school diploma is 86.3 percent and 20 percent have a bachelor's degree or higher. Similarly, 82.2 percent of the population 25 and older in St. John the Baptist Parish has a high school diploma and 12.7 percent have a bachelor's degree or higher. In St. James Parish 82.2 percent of the population 25 and older has a high school diploma and 12.7 percent have a bachelor's degree or higher. In Louisiana 81.0% have a high school diploma and 20.9% have a bachelor's degree or higher and the nation overall 85.0% have a high school diploma and 27.9% have a bachelor's degree or higher.

Age

Age is another important factor to consider when examining the social vulnerability/resiliency of a community. For example, elderly residents may have special needs or mobility issues and require

more social resources before, during, and after flood events. According to 2010 U.S. Census data, the proportion aged 65 and older in St. Charles Parish is 10.7 percent, in St. John the Baptist Parish is 11.4 percent, and 14.1 percent in St. James Parish. The state of Louisiana and the nation overall have roughly the same proportion of the population over the age of 65 (12.3% and 13.0%, respectively).

Social Vulnerability Index

The University of South Carolina's Hazards and Vulnerability Research Institute created an index that compares the social vulnerability of U.S. counties/parishes to environmental hazards. The variables in the index are based on previous research which has found that certain characteristics (e.g., poverty, racial/ethnic composition, educational attainment, and proportion over the age of 65) contribute to a community's vulnerability when exposed to hazards. According to the IWR OSE handbook (USACE, 2008), the Social Vulnerability Index (SoVI®) is a valuable tool that can be used in the planning process to identify areas that are socially vulnerable and whose residents may be less able to withstand adverse impacts from hazards.

The SoVI® is a comparative measure of social vulnerability for all counties/parishes in the U.S., with higher scores indicating more social vulnerability than lower scores. St. Charles Parish has a SoVI® 2005-09 score of -1.20 (0.29 national percentile), St. John the Baptist Parish has a SoVI® 2005-09 score of -1.20 (0.29 national percentile), and St. James Parish has a SoVI® 2005-09 score of -1.08 (0.31 national percentile). Stated another way, St. Charles and St. John the Baptist Parishes are less socially vulnerable than roughly 70 percent of counties/parishes in the U.S. In comparison, Orleans Parish-known for enduring levels of high poverty—has a SoVI® 2005-09 score of 2.06 with only 18 percent of counties/parishes in the nation ranked more socially vulnerable.

The study area's social vulnerability, however, is expected to increase over time if subsidence and sea level rise continue to occur, and the population in the study area increases as it is projected to do. The absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for flood events will increase. This, in turn, may lead to an increased burden placed on local, state, and federal agencies to ensure that these socially vulnerable populations have access to resources before, during, and after flood events.

III. OTHER SOCIAL EFFECTS EVALUATION OF ALTERNATIVES

Social Implications of the Alternatives

This section provides an OSE analysis of the project alternatives. The evaluation is based on the differential impact that each alternative is expected to have on the socioeconomic characteristics and other social factors of the study area presented in the previous section.

The analysis was conducted based on a comparison of without-project conditions to each of three alternative plans. The performance of the alternatives is summarized generally as follows:

- No Action - provides no additional risk reduction to any study area communities.
- Alternative A – reduces risk to St. Charles and St. John the Baptist communities with a levee system and to parts of St. James Parish through earthen berms, culvert flap gates, elevating structures, and limited property acquisitions.
- Alternative C – provides the same risk reduction as Alternative A.
- Alternative D – reduces risk to three parishes with a levee system.

Table 7 shows the risk reduction of the No Action Alternative, and Alternatives A, C, and D.

Table 7: Performance comparison of plans

Alternative	**Structures in the System**	**Communities in the System**
No Action	0	None
A	16,919	Montz, Laplace, Reserve, Garyville
C	16,919	Montz, Laplace, Reserve, Garyville
D	21,840	Montz, Laplace, Reserve, Garyville, Lutcher, Grammercy, Grand Point

Population and Housing

No Action Alternative

Under this scenario all structures in the study area would remain vulnerable to hurricane/tropical storm surge impacts. The No Action Alternative would not reduce risk in the study area. Risks would increase over time due to sea level rise. A catastrophic flood would result in severe negative impacts to residents and significantly damage structures. Communities would not be able to benefit from discounted flood insurance premiums offered by the National Flood Insurance Program (NFIP) should the flood rate insurance maps be updated to reflect increases in flood risk over time due to sea level rise.

Alternative A

Under this alternative, 16,919 structures would be at a reduced risk for adverse impacts as a result of 1% ACE events. Additionally, many residents in these communities would be able to benefit from discounted flood insurance premiums offered by the NFIP (should the flood insurance rate maps be updated to reflect increases in flood risk over time due to sea level rise).

Alternative C

Under this alternative, 16,919 structures would be at a reduced risk for adverse impacts as a result of 1% ACE events. Additionally, many residents in these communities would be able to benefit from discounted flood insurance premiums offered by the NFIP (should the flood insurance rate maps be updated to reflect increases in flood risk over time due to sea level rise).

Alternative D

Under this alternative, 21,840 structures would be at a reduced risk for adverse impacts as a result of 1% ACE events. Additionally, many residents in these communities would be able to benefit from discounted flood insurance premiums offered by the NFIP (should the flood insurance rate maps be updated to reflect increases in flood risk over time due to sea level rise).

Health and Safety

No Action Alternative
All medical care facilities (e.g., hospitals, medical centers, home health care services, and nursing homes), police/sheriff offices, and fire stations in the area would remain at risk. The potential for loss of life and injuries for any residents that remain in the area during storms, and the risks of post flood health hazards, are greater under the No Action Alternative as compared to the action alternatives. Residents are at an even greater risk for experiencing negative health outcomes when facilities that provide critical care or emergency services are impacted by flood events. The No Action Alternative has a higher potential for reducing the availability of health facilities and services and requiring additional fire and police protection than the project alternatives.

Alternative A
Medical care facilities, police/sheriff offices, and fire stations in the area would face lower hurricane/tropical storm surge damage risks. The potential for loss of life and injuries for any residents that remain in the area during storms, and the risks of post flood health hazards, remains. The Alternative would increase the availability of health facilities and services and fire and police protection after storms as compared to the No Action Alternative.

Alternative C
This alternative would reduce risk for the same number of facilities as Alternative A.

Alternative D
This alternative would reduce risk for all of the health and safety facilities in the study area.

Social Connectedness

No Action Alternative
The study area includes 4 libraries, 44 places of worship, and 25 schools. Under the No Action alternative all of these structures would remain at risk to hurricane/tropical storm surge damages. The risk would increase over time due to relative sea level rise.

Alternative A
This alternative would reduce risk for libraries, places of worship and schools within the levee system. Facilities outside of levees would remain vulnerable.

Alternative C
This alternative would reduce risk for the same number of libraries, places of worship and schools as Alternative A.

Alternative D

This alternative would reduce risk for all libraries, places of worship and schools in the area.

Leisure and Recreation

No Action Alternative
Under this alternative all area recreational sites and facilities would remain at risk to hurricane/tropical storm surge damages. The risk would increase over time due to relative sea level rise.

Alternative A
This alternative would reduce risk for sites within the levee system. Facilities outside of levees would remain vulnerable.

Alternative C
This alternative would reduce risk for the same number of recreation sites as Alternative A.

Alternative D
This alternative would reduce risk for all of the recreation sites in the study area.

Social Vulnerability and Resiliency

No Action Alternative
Social vulnerability in the area is expected to increase over time as the absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for flood events increases with subsidence, sea level rise, and population growth. Under the No Action Alternative, the area would remain vulnerable to flooding, and long term resiliency would be hampered by the continued local efforts necessary to prepare for, and react to, flood events.

Alternative A
This alternative would reduce risk to socially vulnerable populations in St. Charles Parish, St. John the Baptist Parish, and parts of St. James Parish covered by the localized storm surge risk reduction measures. Over time the communities covered be the localized storm surge risk reduction measures will experience increasing storm surge flooding risks as relative sea level rise impacts the area.

Alternative C
This alternative would reduce risk to socially vulnerable populations to the same degree as Alternative A.

Alternative D
This alternative would reduce risk to socially vulnerable populations in St. Charles Parish, St. John the Baptist Parish, and St. James Parish.

Summary of Alternative Analysis
The study examined four alternatives: the No Action Alternative, Alternative A, Alternative C, and Alternative D. The OSE analysis evaluated the differential impact that each alternative is expected to have on the socioeconomic characteristics and other social factors of the study area. After first providing a description of the existing and future without-project socioeconomic characteristics and other social factors of the study area, an analysis of the impacts to population and housing,

medical/emergency facilities, civic infrastructure, and recreational areas under the three alternatives was conducted. The analysis was conducted based on without-project overflow and depth-of-flooding data for the years 2020 and 2070. Results show significant differences between the alternatives with important implications for the overall social well-being of the study area.

The No Action Alternative would not reduce the risk associated with hurricane and tropical storm damage to the study area. Therefore, there is a high potential for hurricane and tropical storm damage to continue in the area. The relative sea level rise that is taking place in the area, coupled with the anticipated population growth, is expected to magnify future flooding problems. As a result, subsequent flooding events could cause even more damage to housing units, public facilities, and commercial structures than has previously been experienced. Under this alternative, residents would remain at a higher risk for adverse health impacts such as loss of life and injury, as well as post flood health hazards. The area would remain vulnerable to flooding, and long term resiliency would be hampered by the continued local efforts necessary to prepare for, and react to, flood events.

Alternative A

The alternative would reduce the risk associated with hurricane and tropical storm surge damage to the study area. There is a lower potential for hurricane and tropical storm surge damages in the area with the levee alignment. Flooding events could still cause damage to housing units, public facilities, and commercial structures. Under this alternative, residents would remain at risk for adverse health impacts such as loss of life and injury, as well as post flood health hazards. As with all other alternatives, residents should heed public safety warnings and evacuate to avoid storm hazards, However, the area would be less vulnerable to flooding, and long term resiliency would be enhanced with a levee in place.

Alternative C

This alternative would reduce risk in the study area to the same degree as Alternative A.

Alternative D

This alternative would result in the greatest potential for reduced flooding in the study area. It would reduce the risks associated with damages to housing units, public facilities, and commercial structures and provide increased protection to the health and safety of residents. The area's social vulnerability would be reduced under this alternative, and thus, the potential for long-term growth and sustainability would be enhanced. Also, under this alternative, the area would be at a reduced risk of incurring the costs associated with clean-up, debris removal, and building and infrastructure repair as a result of flood events.

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WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

PLAN FORMULATION
APPENDIX E

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INTRODUCTION

This appendix provides supplemental plan formulation information on the West Shore Lake Pontchartrain, Louisiana Hurricane and Storm Damage Risk Reduction Feasibility study. It supplements the information in Chapter 3 of the main report and includes tables and maps used in the development, screening, and evaluation of management measures and alternative plans.

Per the study authority, as identified in Chapter 1, the study area includes portions of St. Charles, St. John the Baptist, and St. James Parishes. It is bounded on the east by the Bonnet Carré Spillway upper guide levee, on the north by Lakes Pontchartrain and Maurepas, on the west by the Ascension/St. James Parish line, and on the south by the Mississippi River Levee (**Figure 1**).

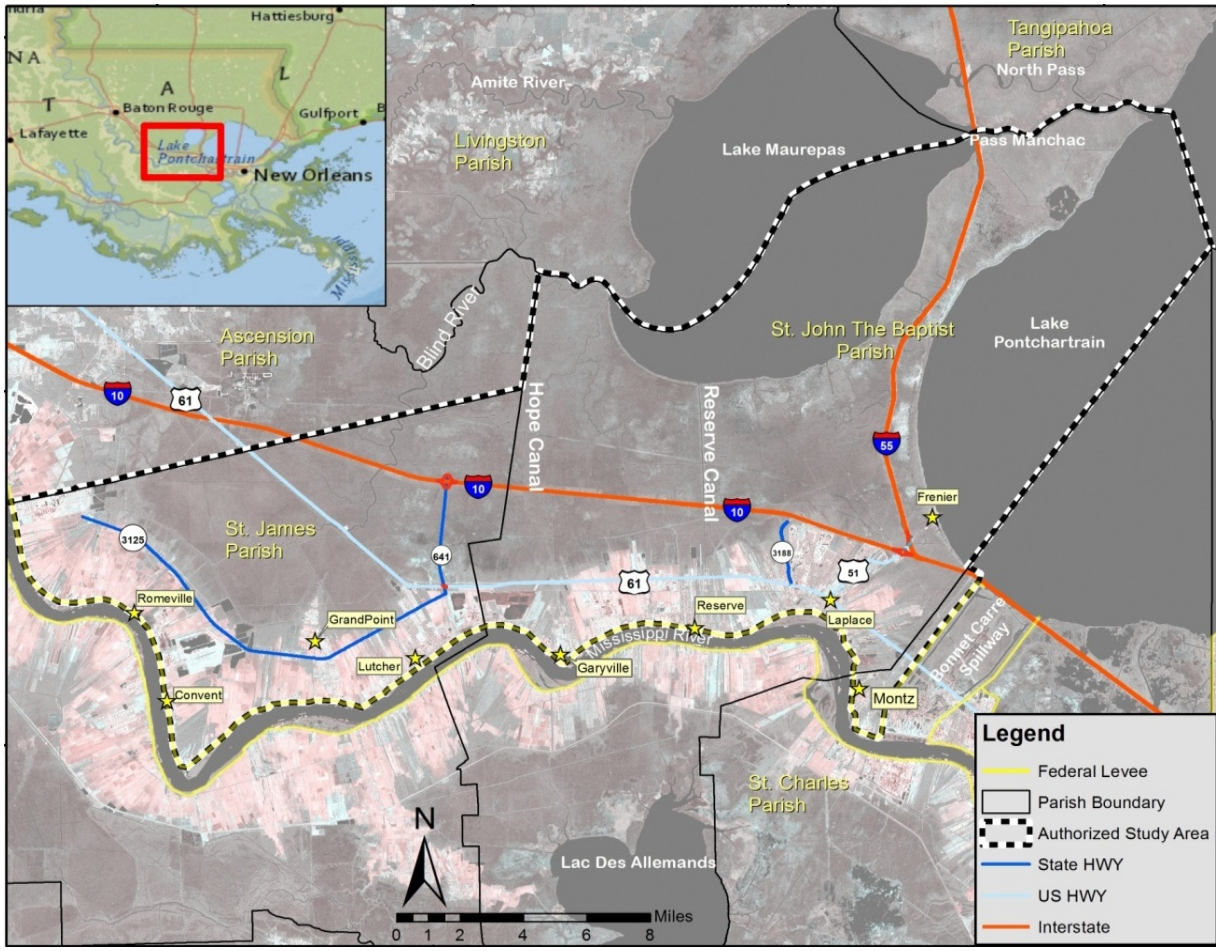

Figure 1: Study Area

The study goals, objectives and constraints are identified in Chapters 1 and 3 of the draft report. They are included as a point of reference for understanding details of the screening process (**Table 1**).

Table 1: Objectives and Constraints

OBJECTIVES	CONSTRAINTS
1. Reduce hurricane storm surge related damages through 2070.	1. Minimize impacts to wetlands.
2. Reduce risk to residents' life and health by decreasing flooding to the maximum extent practical.	2. Minimize impacts to the Small Diversion at Convent/Blind River project and River Reintroduction into Maurepas Swamp Project.
3. Increase public awareness of hurricane risks in developed flood prone areas.	3. No loss of flood protection from existing flood damage risk reduction projects.
4. Enhance public awareness of the risk to life and property of development in flood prone areas.	4. Minimize impacts to the Maurepas Swamp Wildlife Management Area and surrounding wetlands.
5. Reduce the risk of damage and loss of critical infrastructure, specifically the I-10/I-55 hurricane evacuation routes.	5. Minimize infrastructure impacts (pipelines, highways, hospitals, schools, fire stations, and police stations).

MANAGEMENT MEASURES

Measures considered for this study are outlined in **Chapter 3, Section 3.3**. This section provides additional information about those measures that were evaluated and removed from further consideration during the planning process. As discussed in Chapter 3, these measures were screened and evaluated based on their ability to meet the planning objectives while avoiding the study constraints (see **Table 1**). Additional criteria of effectiveness and efficiency were used.

Cypress Reforestation: This measure would enhance and/or restore cypress forest on the Maurepas Landbridge and in the Maurepas Swamp to reduce surge heights. The measure did not meet objectives to reduce the risk of damages to structures and to residents' life and health. Structures would still be damaged from the increased still water levels during storms. Consequently, the measure was screened because it was ineffective. **Figure 2** demonstrates the storm surge flow through cypress vegetation.

Seawall: This measure would construct a seawall along the rim of Lakes Maurepas and Pontchartrain. This measure would have adverse impacts to the existing environmental systems and drainage system. This measure would enclose the Maurepas Swamp and would stop water exchanges between Lake Maurepas and the swamp (see **Figure 3**). The mitigation features for this measure would be cost prohibitive. The measure was screened because it was not cost effective.

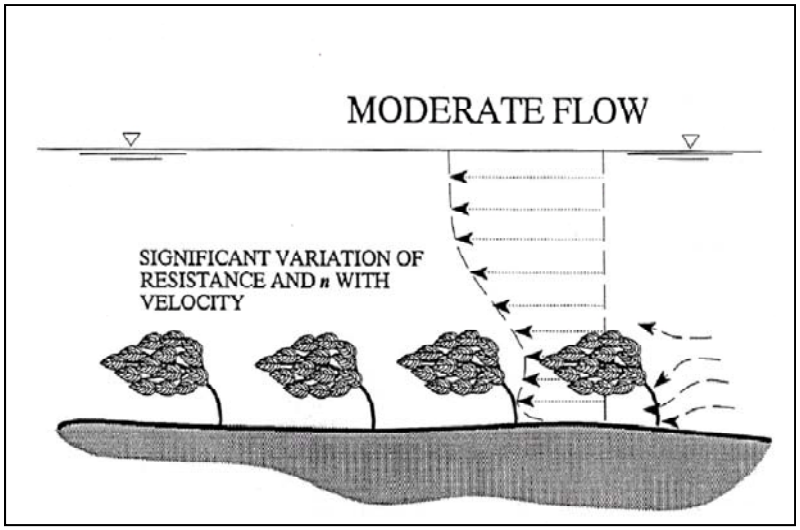

Figure 2: Storm Surge through Vegetation

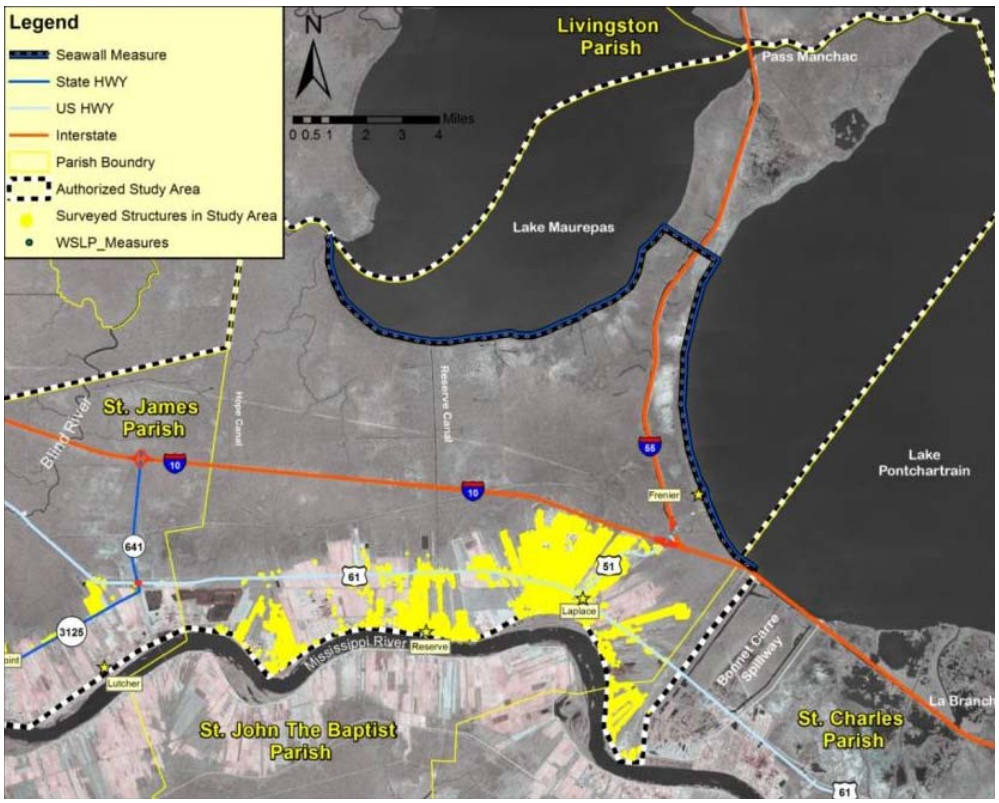

Figure 3: Seawall Measure

Flood Forecast and Warning: The area has an ample Forecast/Warning System. NOAA, FEMA, and the USACE already take the responsibility for producing the storm surge maps under existing floodplain management authorization.

Floodgates on Tidal Passes: This measure would place a large tide control structure on Pass Manchac, and potentially North Pass, to prevent storm surge from entering the area. It would have adverse impacts to the

environment and drainage system. A control structure would restrict tidal flows under normal conditions and limit the upper basin's ability to drain during storms. The mitigation features would be cost prohibitive (inefficient). Additionally, it would be ineffective due to surge flanking.

Highway/Levee: This measure would raise the I-10 roadbed to serve as a levee to reduce risk of surge damage. Using the roadbed as a levee system would require massive changes to the existing highway system. In addition, future levee lifts would require the highway to be replaced at each event.

Control Structures (Canals and Bayous): Control structures were evaluated as both a stand-alone measure and in combination with other measures. It was removed as a standalone measure because at higher storm surge events, surge heights are higher than the existing banks, making a canal closure alone ineffective (see **Figure 4 and 5**). However portions of the feature were carried forward in combination with other measures.

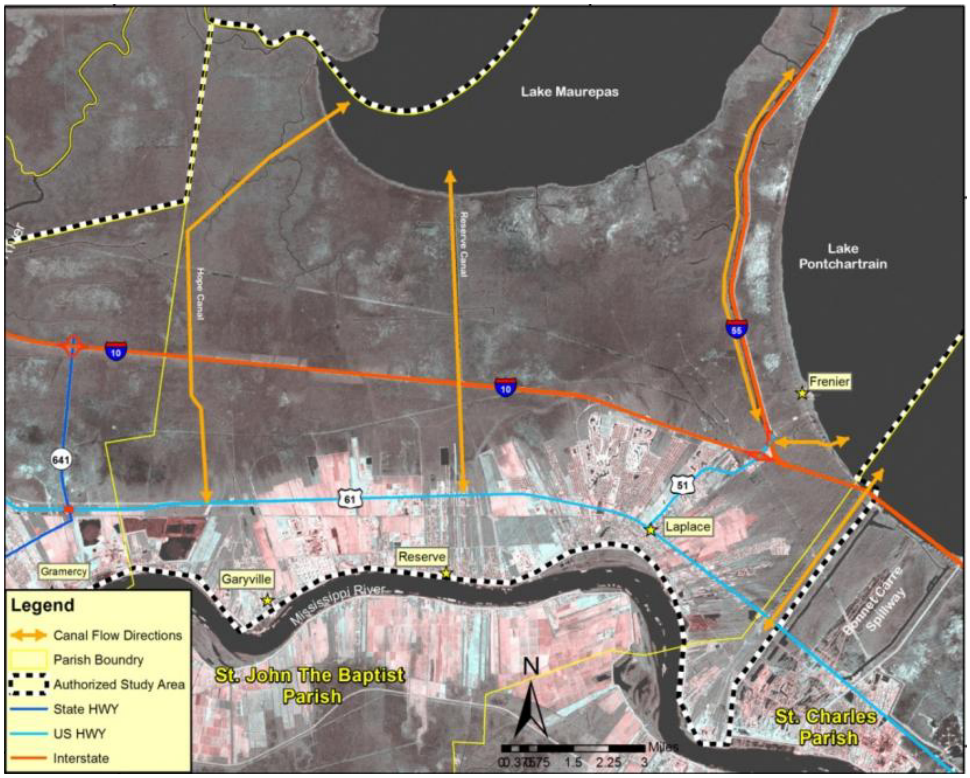

Figure 4: Canal Drainage Patterns

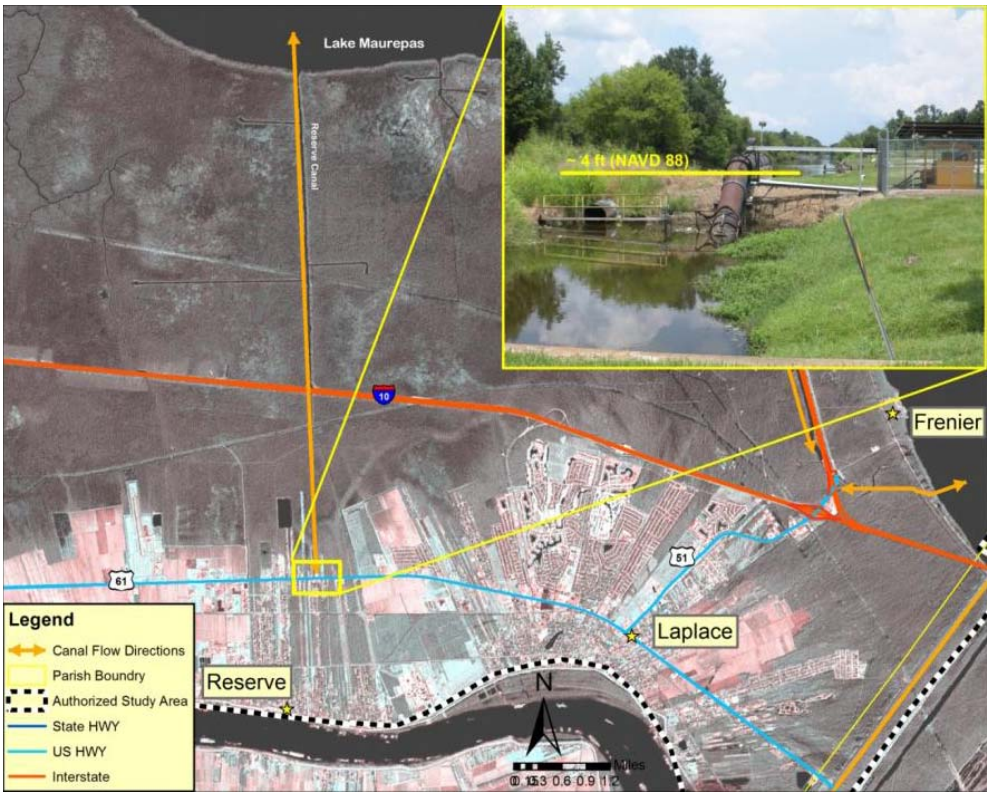

Figure 5: Reserve Canal Cross Section View

INITIAL ARRAY OF ALTERNATIVE PLANS

As discussed in **section 3.4** of the Final Report, structural plans developed from earlier study efforts were incorporated into the plan formulation process as documented in this report. Structural alternative plans typically included an earthen levee with control structures which extend from the west guide levee of the Bonnet Carré Spillway in St. Charles Parish to various points west in the area. **Table 2** outlines the structural plans considered in this study and **Figures 6 through 17** maps the alignments.

Table 2: Initial Array of Structural Plans

Condensed Plan ID	Linkages to Past WSLP efforts
Plan 1: Spillway to Reserve Canal	1987 Reconnaissance Report: Alignment #2 1997 Reconnaissance Report: Alignment 2 1998 Scoping Report: Alignment #2
Plan 2: Spillway to East St. John High School (ESJHS)	1985 Initial Evaluation Report: Alignment #2 1997 Reconnaissance Report: Alignment 1 1998 Scoping Report: Alignment # 1
Plan 3: Spillway to ESJHS (wetland/non-wetland)	1997 Reconnaissance Report: Alignment # 5 1998 Scoping Report: Alignment # 3
Plan 4: Spillway to ESJHS (I-10 Offset)	1997 Reconnaissance Report: Alignment # 5 1998 Scoping Report: Alignment # 1

Plan 5: Spillway to Marathon	1997 Reconnaissance Report: Alignment 2 1998 Scoping Report: Alignment #2 2006 Evaluation of Draft FS Report : USACE Plan A 2007 Screening Assessment: Alignment A
Plan 6: Spillway to Reserve (US-51 Protection)	1985 Initial Evaluation Report: Alignment #4 1997 Reconnaissance Report: Alignment 1A/B 1998 Scoping Report: Alignment # 1
Plan 7: Spillway to Marathon (wetland/non-wetland)	1997 Reconnaissance Report: Alignment 1A/B 1998 Scoping Report: Alignment # 1 2006 Evaluation of Draft FS Report : USACE Plan A 2007 Screening Assessment: Alignment A
Plan 8: Spillway to Ascension Parish/MS River	1985 Initial Evaluation Report: Alignment #3 1997 Reconnaissance Report: Alignment 2A/B 2007 Screening Assessment: Alignment D
Plan 9: Spillway to Hope Canal/MS River	1997 Reconnaissance Report: Alignment # 5 2006 Evaluation of Draft FS Report : USACE Plan A 2007 Screening Assessment: Alignment A
Plan 10: Spillway to Hope Canal/MS River (I-10 Protection)	1985 Initial Evaluation Report: Alignment #3 2006 Evaluation of Draft FS Report : St. John Plan B 2007 Screening Assessment: Alignment B
Plan 11: Spillway to Hope Canal/MS River (Pipeline Avoidance)	1985 Initial Evaluation Report: Alignment #1 1987 Reconnaissance Report: Alignment #1 2006 Evaluation of Draft FS Report : St. John Revised 2007 Screening Assessment: Alignment C
Plan 12: Spillway to Ascension Parish (I-10 Protection)	1985 Initial Evaluation Report: Alignment #3 2007 Screening Assessment: Alignment D

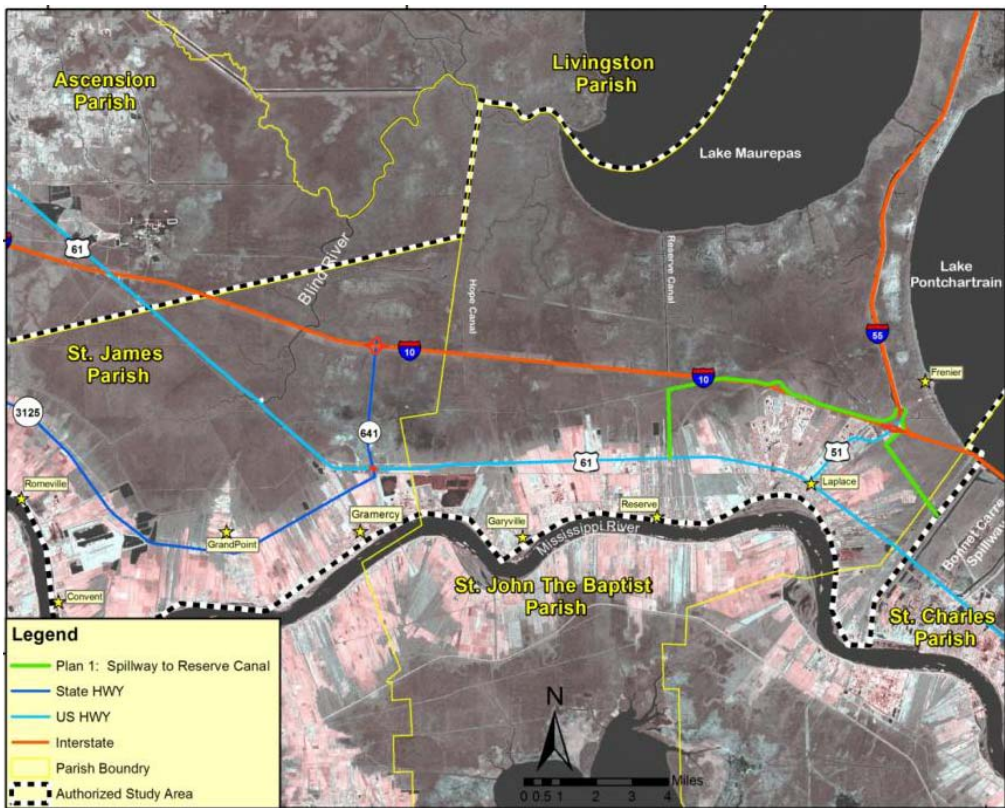

Figure 6: Plan 1 - Bonne Carré Spillway to Reserve Canal

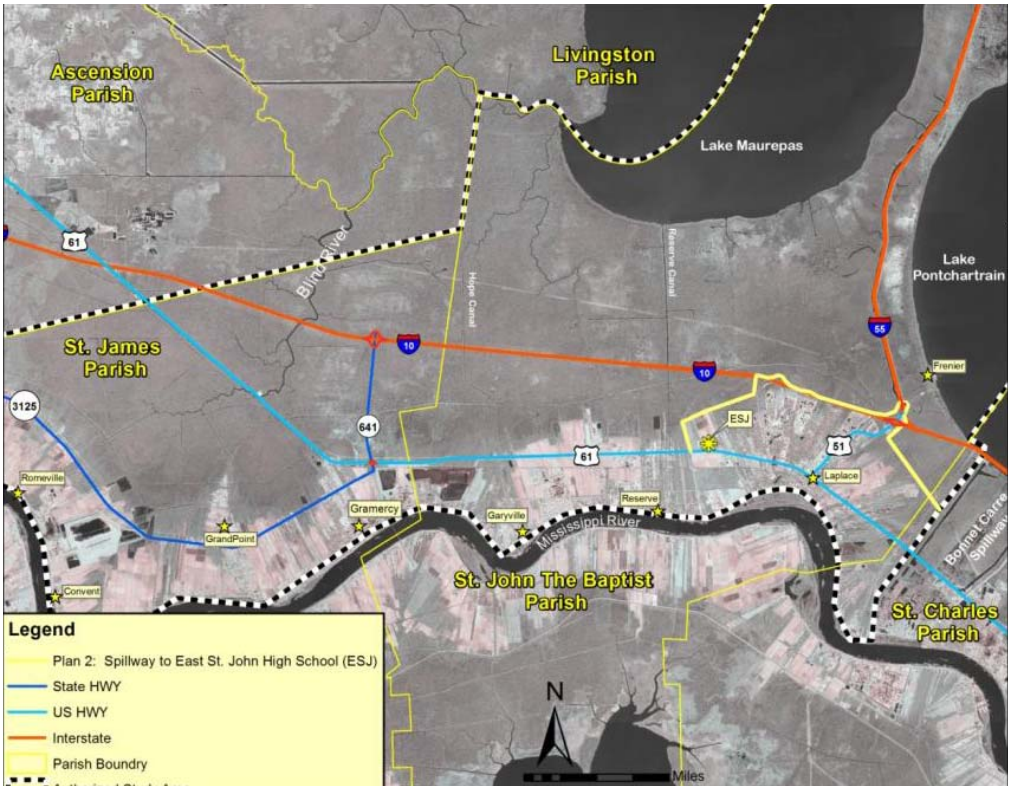

Figure 7: Plan 2 - Bonnet Carré Spillway to ESJHS

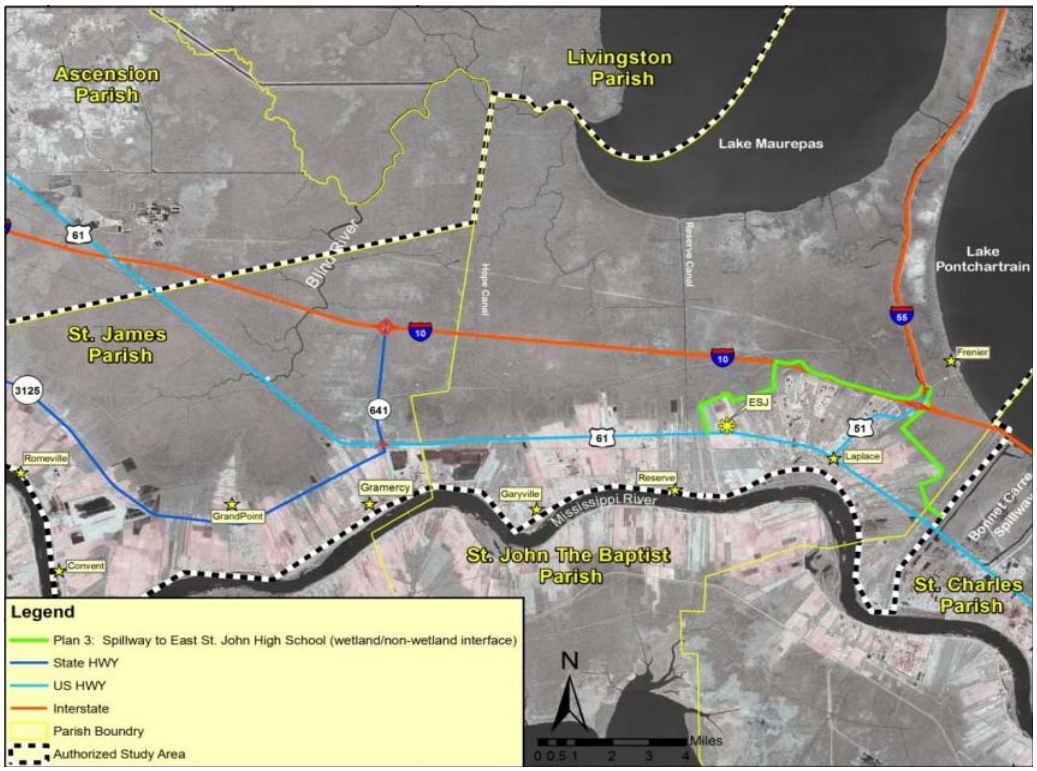

Figure 8: Plan 3 - Bonnet Carré Spillway to ESJHS (wetland interface)

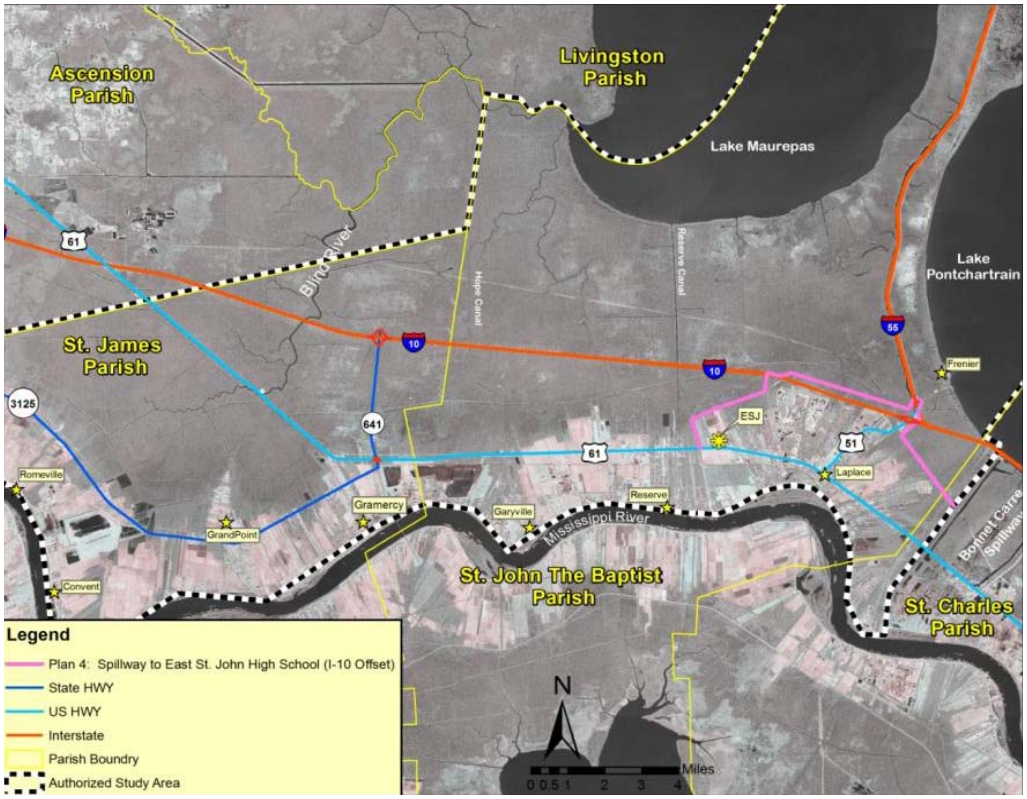

Figure 9: Plan 4 - Bonnet Carré Spillway to ESJHS (I-10 Offset)

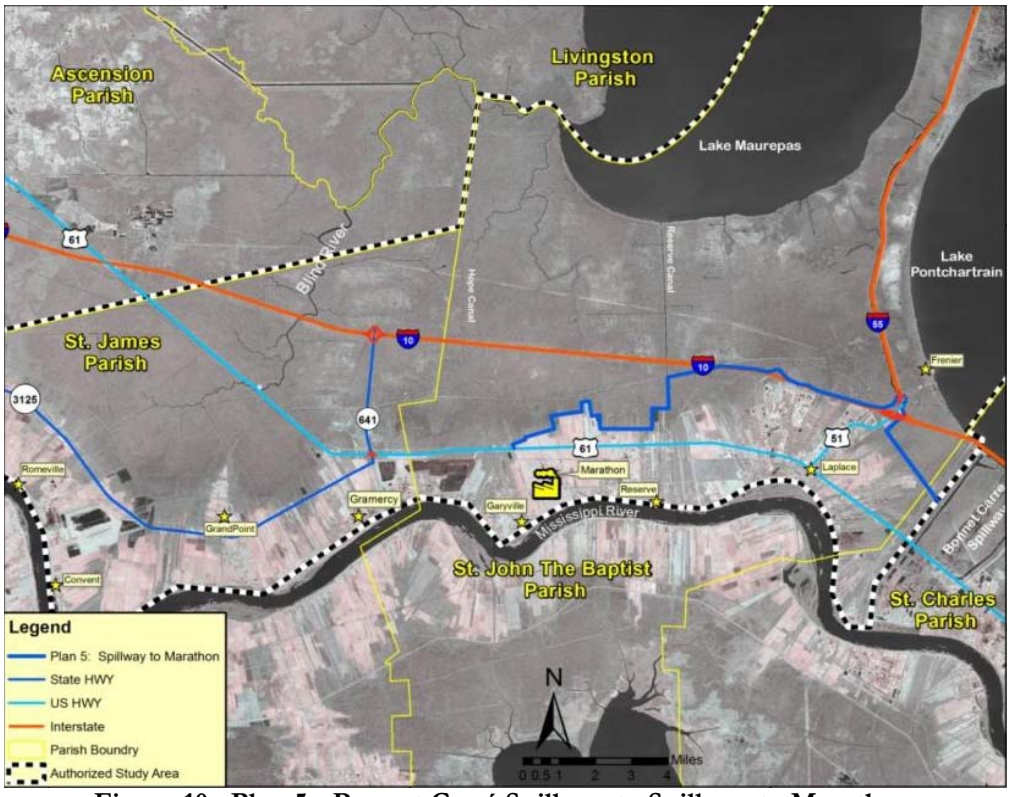

Figure 10: Plan 5 - Bonnet Carré Spillway to Spillway to Marathon

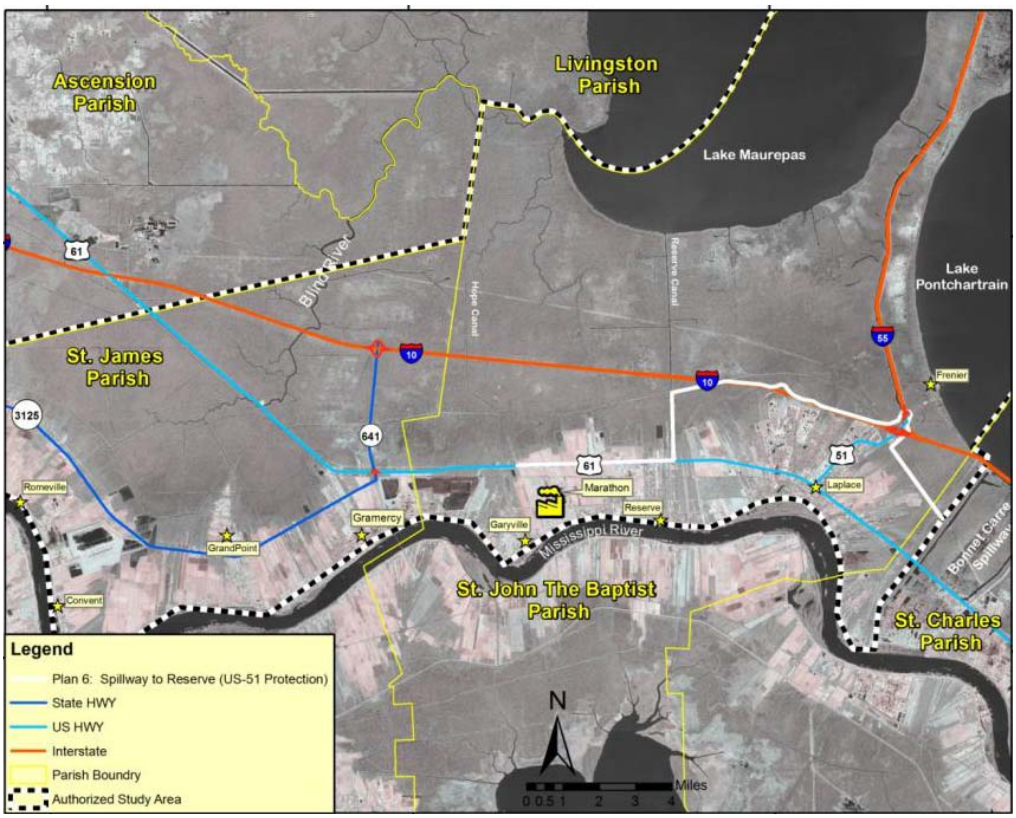

Figure 11: Plan 6 - Bonnet Carré Spillway to Reserve (US-51 Risk Reduction)

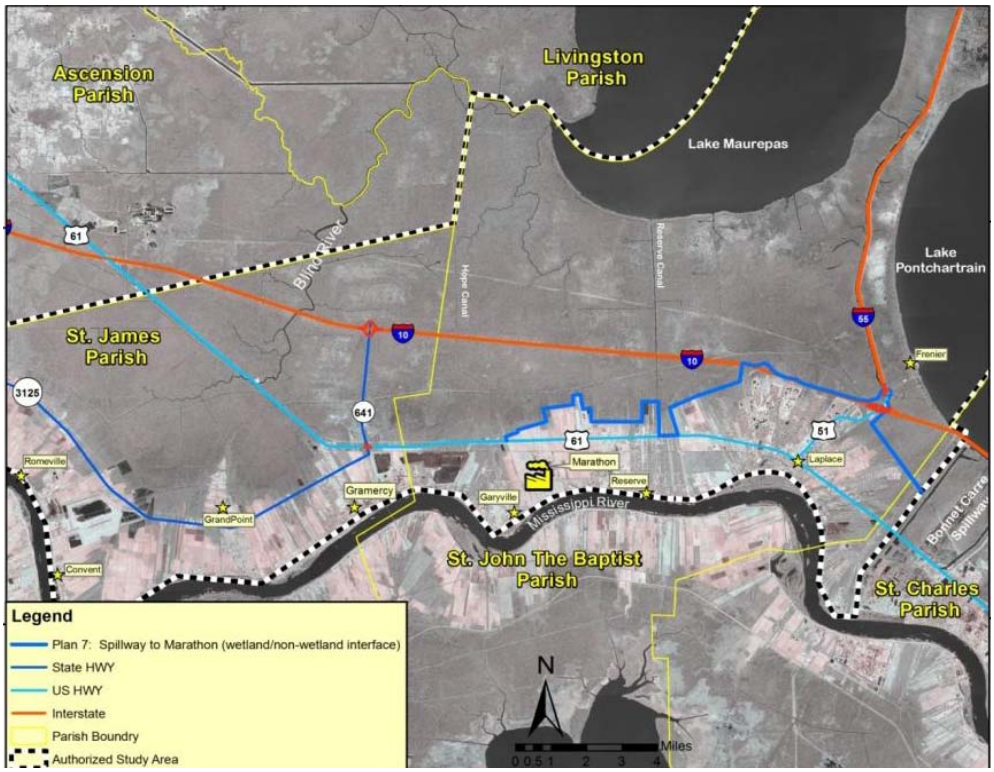

Figure 12: Plan 7 - Bonnet Carré Spillway to Marathon (wetland interface)

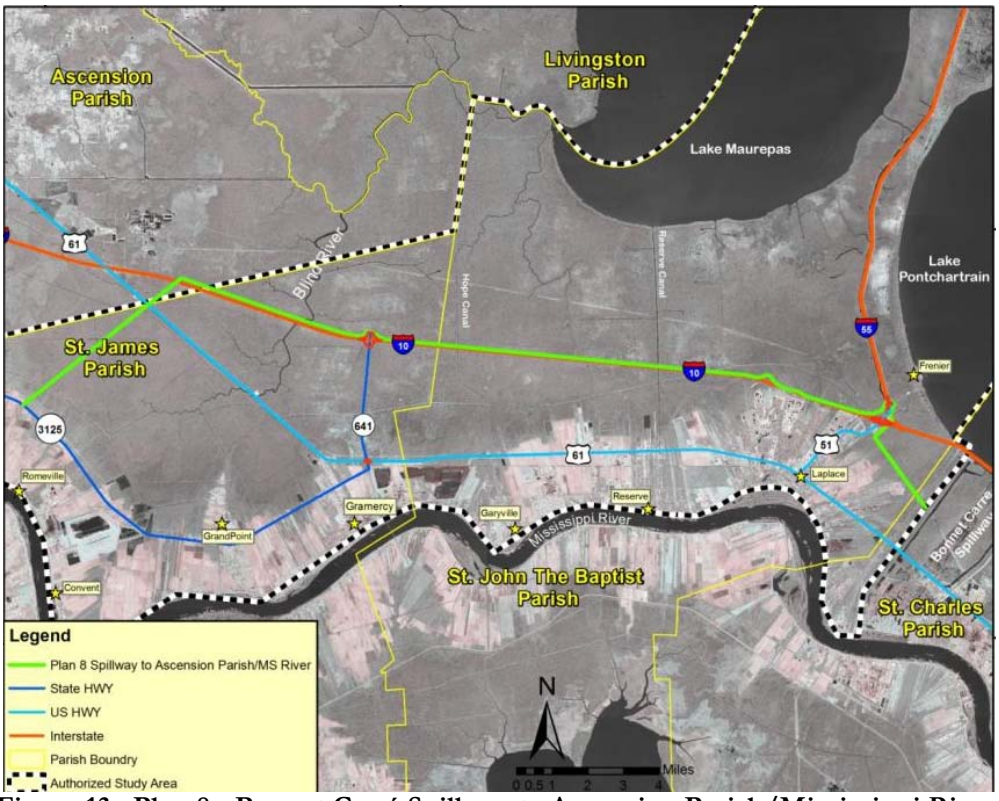

Figure 13: Plan 8 - Bonnet Carré Spillway to Ascension Parish/Mississippi River

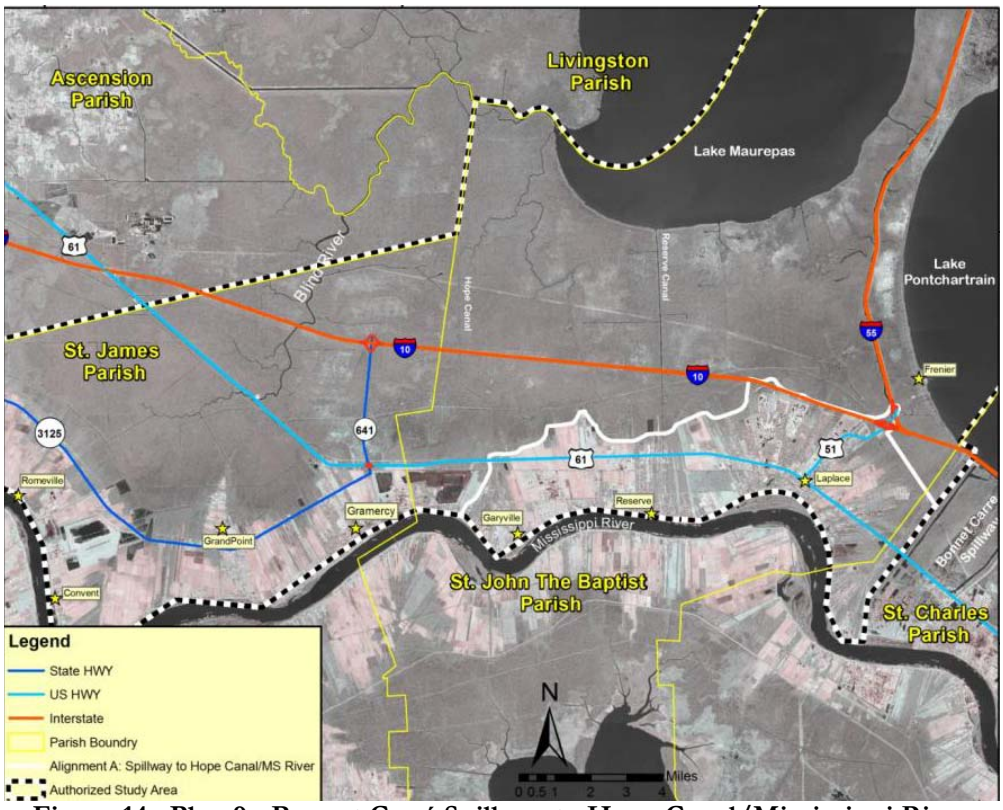

Figure 14: Plan 9 - Bonnet Carré Spillway to Hope Canal/Mississippi River

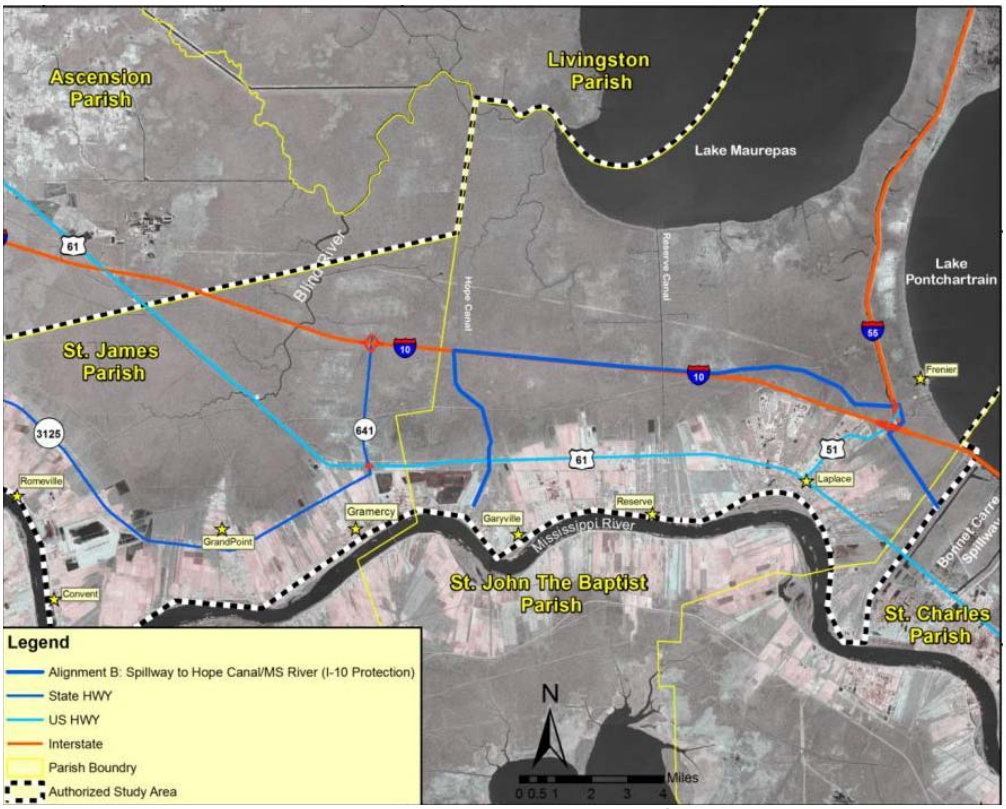

Figure 15: Plan 10 - Bonnet Carré Spillway to Hope Canal/MS River (I-10 Risk Reduction)

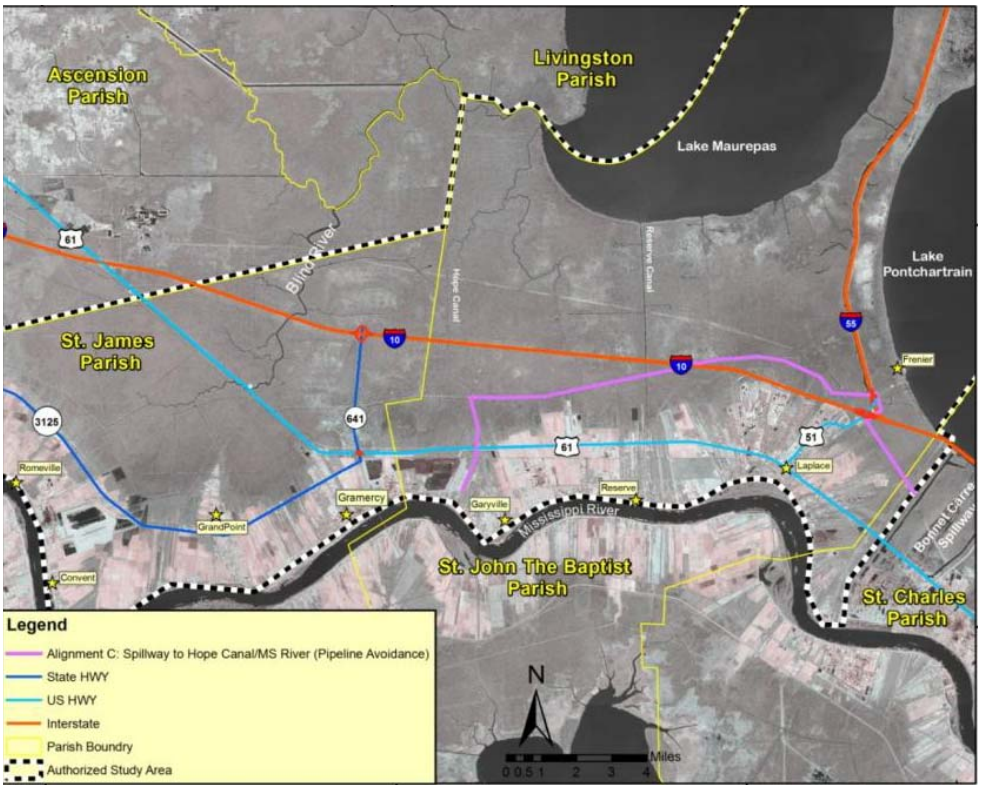

Figure 16: Plan 11 - Bonne Carré Spillway to Hope Canal/MS River (Pipeline Avoidance)

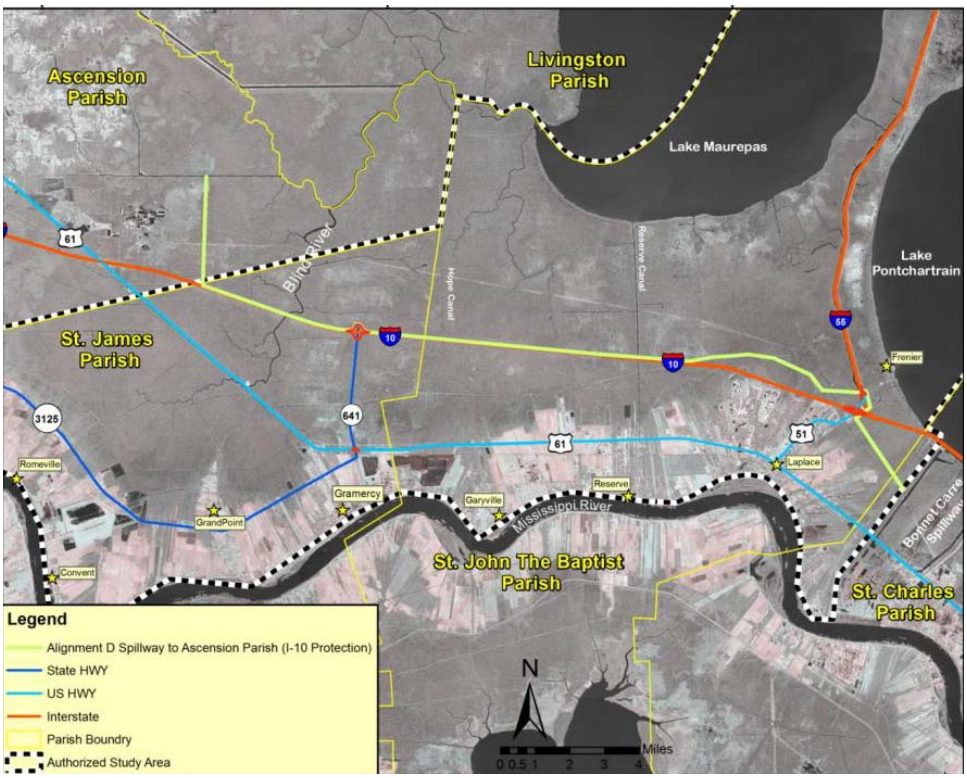

Figure 17: Plan 12 - Bonnet Carré Spillway to Ascension Parish (I-10 Risk Reduction)

To determine the plans to evaluate further, each plan was scored from 5 (high performing) to 1 (low performing) based on how well it met objectives and avoided constraints. Objectives 3 and 4 were not used in the screening of the initial array; do to the fact that all plans would meet Objectives 3 and 4 equally. The scores were totaled and the plans were compared, evaluated and screened. Scores for meeting the objectives and avoiding constraints were developed by reviewing existing available data sources and newly modeled storm surge impacts **(Table 3)**.

Table 3: Screening and Ranking of Initial Array Plans against Objectives and Constraints

	Objectives Ranked (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)			Avoids Constraint (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)					
Condensed Plan ID	#1 Storm damages	#2 Reduce risk to life and health	#5 Reduce the risk of damage and loss of critical infrastructure	#1 Min. impacts to wetlands	#2 Min. impacts to diversion projects	#3 No loss of existing flood protection	#4 Avoid impacts to WMA & wetlands	#5 Min. impacts to critical infrastructure	SUM
Plan 11: Spillway to Hope Canal/MS River (Pipeline Avoidance)	4 Received a 4 due to the fact that under the existing conditions there were significant flooding of structures until you reached Hope Canal. 95% of the FWOP equivalent annual damages would be addressed by this plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding of areas which saw depths of flooding greater than 2.5 ft deep. It was assumed that areas that received a greater than 2.5 feet of flooding above the ground would create a hazard to life. Also, the team reviewed the potential for plans to increase water depths outside of the system. Due to the tie in points of the plan there would be limited impacts to structures outside of the plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and US-61. The Plan did not receive a 5 because these highways would flood in the future west of the plan.	3 Received a 3 due to the fact that it minimized the indirect impacts to the wetlands where possible. The plan did not score higher because there is still ~16 sq miles of wetlands behind the alignment.	3 Received a 3 due to the fact that it would parallel the Hope Canal Diversion and would not interfere with the proposed lateral discharges. The plan did not receive a 4 because the plan would still have to coordinate the design of a drainage structure at Hope Canal.	3 Received a 3 due to the fact that the plan did not risk disruptions to the local drainage patterns northward.	3 Received a 3 due to the fact that it minimized the indirect impacts to the WMA where possible.	5 Received a 5 due to the fact that it avoided a large # of pipelines.	29

	Objectives Ranked (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)			Avoids Constraint (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)					
Condensed Plan ID	#1 Storm damages	#2 Reduce risk to life and health	#5 Reduce the risk of damage and loss of critical infrastructure	#1 Min. impacts to wetlands	#2 Min. impacts to diversion projects	#3 No loss of existing flood protection	#4 Avoid impacts to WMA & wetlands	#5 Min. impacts to critical infrastructure	SUM
Plan 9: Spillway to Hope Canal/MS River	4 Received a 4 due to the fact that under the existing conditions there were significant flooding of structures until you reached Hope Canal. 95% of the FWOP equivalent annual damages would be addressed by this plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding of areas which saw depths of flooding greater than 2.5 ft deep. It was assumed that areas that received a greater than 2.5 feet of flooding above the ground would create a hazard to life. In addition, the team reviewed the potential for plans to increase water depths outside of the system. Due to the tie in points of the plan there would be limited impacts to structures outside of the plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and US-61. The Plan did not receive a 5 because these highways would flood in the future west of the plan.	5 Received a 5 due to the fact that it minimized the direct and indirect impacts to the wetlands by following the wet/dry interface.	4 Received a 4 due to the fact that it would parallel the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	1 Received a 1 because the plan would disrupt the local drainage patterns northward. A pump station would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	5 Received a 5 due to the fact that it avoided all indirect and direct impacts to the WMA.	1 Received a 1 because it did not avoid a large # of pipelines. There are over 70 pipeline crossings. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	28
Plan 10: Spillway to Hope Canal/MS River (I-10 Protection)	4 Received a 4 due to the fact that under the existing conditions there were significant flooding of structures until you reached Hope Canal. 95% of the FWOP equivalent annual damages would be addressed by this plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding of areas which saw depths of flooding greater than 2.5 ft deep. It was assumed that areas that received a greater than 2.5 feet of flooding above the ground would create a hazard to life. Also the team reviewed the potential for plans to increase water depths outside of the system. Due to the tie in points of the plan there would be limited impacts to structures outside of the plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and US-61. The Plan did not receive a 5 because these highways would flood in the future west of the plan.	2 Received a 2 due to the fact that it minimized the indirect impacts to the wetlands where possible, but Plan 10 would reduce risk to the same number of structures as Plan11 and would enclose approximately 4,000 more acres of wetlands.	3 Received a 3 due to the fact that it would parallel the Hope Canal Diversion and would not interfere with the proposed lateral discharges. The plan did not receive a 4 because the plan would still have to coordinate the design of a drainage structure at Hope Canal.	3 Received a 3 due to the fact that the plan did not risk disruptions to the local drainage patterns northward.	2 Received a 2 due to the fact that it minimized the indirect impacts and direct impacts to the WMA where possible.	5 Received a 5 due to the fact that it avoided a large # of pipelines	27

	Objectives Ranked (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)			Avoids Constraint (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)					
Condensed Plan ID	#1 Storm damages	#2 Reduce risk to life and health	#5 Reduce the risk of damage and loss of critical infrastructure	#1 Min. impacts to wetlands	#2 Min. impacts to diversion projects	#3 No loss of existing flood protection	#4 Avoid impacts to WMA & wetlands	#5 Min. impacts to critical infrastructure	SUM
Plan 12: Spillway to Ascension Parish (I-10 Protection)	5 Received a 5 due to the fact it addressed all flooding under the existing conditions and future conditions. 100% of the of the FWOP equivalent annual damages would be addressed by this plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding of areas which saw depths of flooding greater than 2.5 ft deep. It was assumed that areas that received a greater than 2.5 feet of flooding above the ground would create a hazard to life. Also the team reviewed the potential for plans to increase water depths outside of the system. Due to the tie in points of the plan there would be limited impacts to structures outside of the plan.	5 Received a 5 due to the fact that under the existing and future conditions the plan would prevent surges from flooding I-10 and US-61.	1 Received a 1 due to the fact that it would enclose ~79 sq miles of wetlands.	1 Received a 1 due to the fact that it would cross the Hope Canal Diversion and would enclose the Convent Blind River Diversion.	4 Received a 4 due to the fact that the plan did not risk disruptions to the local drainage patterns northward. The plan received a higher # than 3 due to the fact there is a large drainage basin to capture and hold rainfall during a storm event.	1 Received a 1 due to the fact that it directly impacted to the WMA across large areas.	4 Received a 4 due to the fact that it avoided a large # of pipelines. The plan did not receive a 5 because the plan would have to avoid additional impacts on the far western end of the plan.	25
Plan 8: Spillway to Ascension Parish/MS River	5 Received a 5 due to the fact it addressed all flooding under the existing conditions and future conditions. 100% of the of the FWOP equivalent annual damages (EAD) would be addressed by this plan.	4 Received a 4 due to the fact that under the existing conditions the plan would prevent surges from flooding of areas which saw depths of flooding greater than 2.5 ft deep. It was assumed that areas that received a greater than 2.5 feet of flooding above the ground would create a hazard to life. Also the team reviewed the potential for plans to increase water depths outside of the system. Due to the tie in points of the plan there would be limited impacts to structures outside of the plan.	5 Received a 5 due to the fact that under the existing and future conditions the plan would prevent surges from flooding I-10 and US-61.	1 Received a 1 due to the fact that it would enclose ~79 sq miles of wetlands.	1 Received a 1 due to the fact that it would cross the Hope Canal Diversion and would enclose the Convent Blind River Diversion.	4 Received a 4 due to the fact that the plan did not risk disruptions to the local drainage patterns northward. The plan received a higher # than 3 due to the fact there is a large drainage basin to capture and hold rainfall during a storm event.	1 Received a 1 due to the fact that it directly impacted to the WMA across large areas.	4 Received a 4 due to the fact that it avoided a large # of pipelines. The plan did not receive a 5 because the plan would have to avoid additional impacts on the far western end of the plan.	25

	Objectives Ranked (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)			Avoids Constraint (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)					
Condensed Plan ID	#1 Storm damages	#2 Reduce risk to life and health	#5 Reduce the risk of damage and loss of critical infrastructure	#1 Min. impacts to wetlands	#2 Min. impacts to diversion projects	#3 No loss of existing flood protection	#4 Avoid impacts to WMA & wetlands	#5 Min. impacts to critical infrastructure	SUM
Plan 3: Spillway to ESJ (wetland/non-wetland)	2 Received a 2 due to the fact that it only addressed a limited portion of the FWOP equivalent annual damages. Damages EAD . Two of the highest EAD reaches, SA-27 and SA-21 would have left be left outside of the plan.	1 Received a 1 due to the fact that the plan's tie-in point would be directly through a developed area. There would be a high risk that stages outside of the plan could be higher with the plan in place.	3 Received a 3 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 because US-61 could still flood under the existing conditions west of ESJ.	5 Received a 5 due to the fact that it minimized the direct and indirect impacts to the wetlands by following the wet/dry interface.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	1 Received a 1 because the plan would disrupt the local drainage patterns northward. There would be limited storage for rainfalls events. Very efficient pump stations would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	5 Received a 5 due to the fact that it avoided all indirect and direct impacts to the WMA.	2 Received a 2 because it did not avoided a large # of pipelines.. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	23
Plan 2: Spillway to East St. John High School (ESJ)	2 Received a 2 due to the fact that it only addressed a limited portion of the FWOP equivalent annual damages. Damages EAD . Two of the highest EAD reaches, SA-27 and SA-21 would have left be left outside of the plan.	1 Received a 1 due to the fact that the plan's tie-in point would be directly through a developed area. There would be a high risk that stages outside of the plan could be higher with the plan in place.	3 Received a 3 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 because US-61 could still flood under the existing conditions west of ESJ.	4 Received a 4 due to the fact that it in most areas minimized the direct and indirect impacts to the wetlands by following the wet/dry interface. It did not receave a 5 because it still enclosed wetlands between the Belle Terre Exit and ESJ.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	2 Received a 2 because the plan would disrupt the local drainage patterns northward. In most areas, a pump station would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	4 Received a 4 due to the fact that it minimized the indirect impacts to the WMA where possible.	2 Received a 2 because it did not avoided a large # of pipelines.. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	22
Plan 7: Spillway to Marathon (wetland/non-wetland)	2 Received a 2 due to the fact that it left the community of Garyville, structures in Reserve and a portion Marathon refinery outside of the plan. Both these areas would see significant flooding under the existing conditions.	2 Received a 2, because the plan did reduce flooding depths to a larger area, but the plan still could increase stages in the community of Garyville.	3 Received a 3 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 because US-61 could still flood under the existing conditions west of Marathon.	4 Received a 4 due to the fact that it in most areas minimized the direct and indirect impacts to the wetlands by following the wet/dry interface. It did not receave a 5 because it still enclosed wetlands between the Belle Terre Exit and ESJ.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	1 Received a 1 because the plan would disrupt the local drainage patterns northward. There would be limited storage for rainfalls events, especially in the area of Reserve. Very efficient pump stations would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	4 Received a 4 due to the fact that it minimized the indirect impacts to the WMA where possible.	1 Received a 1 because it did not avoided a large # of pipelines. There are over 70 pipeline crossings. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	21

	Objectives Ranked (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)			Avoids Constraint (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)					
Condensed Plan ID	#1 Storm damages	#2 Reduce risk to life and health	#5 Reduce the risk of damage and loss of critical infrastructure	#1 Min. impacts to wetlands	#2 Min. impacts to diversion projects	#3 No loss of existing flood protection	#4 Avoid impacts to WMA & wetlands	#5 Min. impacts to critical infrastructure	SUM
Plan 4: Spillway to ESJ (I-10 Offset)	2 Received a 2 due to the fact that it only addressed a limited portion of the FWOP equivalent annual damages. Damages EAD . Two of the highest EAD reaches, SA-27 and SA-21 would have left be left outside of the plan.	1 Received a 1 due to the fact that the plan's tie-in point would be directly through a developed area. There would be a high risk that stages outside of the plan could be higher with the plan in place.	3 Received a 3 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 because US-61 could still flood under the existing conditions west of ESJ.	2 Received a 2 due to the fact that it in most areas minimized the direct and indirect impacts to the wetlands by following the wet/dry interface. It did not receave a 3 or 4 because it still enclosed wetlands between the Belle Terre Exit and ESJ and also had direct impacts to the wetlands north of I-10.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	2 Received a 2 because the plan would disrupt the local drainage patterns northward. In most areas, a pump station would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	4 Received a 4 due to the fact that it minimized the indirect impacts to the WMA where possible.	3 Received a 3 because it did not avoided a large # of pipelines.. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11. The plan did get an additional point for avoiding I-10.	21
Plan 5: Spillway to Marathon	3 Received a 3 due to the fact that it left the community of Garyville and the portion Marathon refinery outside of the plan. Both these areas would see significant flooding under the existing conditions.	2 Received a 2, because the plan did reduce flooding depths to a larger area, but the plan still could increase stages in the community of Garyville.	3 Received a 3 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 because US-61 could still flood under the existing conditions west of Marathon.	2 Received a 2 due to the fact that it in most areas minimized the direct and indirect impacts to the wetlands by following the wet/dry interface. It did not receave a 3 or 4 because it still enclosed wetlands between the Belle Terre Exit and Reserve Canal.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	1 Received a 1 because the plan would disrupt the local drainage patterns northward. There would be limited storage for rainfalls events, especially in the area of Reserve and Garyville. Very efficient pump stations would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	4 Received a 4 due to the fact that it minimized the indirect impacts to the WMA where possible.	1 Received a 1 because it did not avoided a large # of pipelines. There are over 70 pipeline crossings. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	20
Plan 1: Spillway to Reserve Canal	2 Received a 2 due to the fact that it only addressed a limited portion of the FWOP equivalent annual damages. Damages EAD . Two of the highest EAD reaches, SA-27 and SA-21 would have left be left outside of the plan.	1 Received a 1 due to the fact that the plan's tie-in point would be directly through a developed area. There would be a high risk that stages outside of the plan could be higher with the plan in place.	3 Received a 3 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 because US-61 could still flood under the existing conditions west of Reserve Canal.	2 Received a 2 due to the fact that it in most areas minimized the direct and indirect impacts to the wetlands by following the wet/dry interface. It did not receave a 3 or 4 because it still enclosed wetlands between the Belle Terre Exit and Reserve Canal.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	2 Received a 2 because the plan would disrupt the local drainage patterns northward. In most areas, a pump station would have to be placed on each drainage ditch to remove rainwaters during a storm surge event.	4 Received a 4 due to the fact that it minimized the indirect impacts to the WMA where possible.	2 Received a 2 because it did not avoided a large # of pipelines.. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	20

	Objectives Ranked (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)			Avoids Constraint (5=High, 4=Medium High , 3=Medium, 2=Medium-Low 1=Low)					
Condensed Plan ID	#1 Storm damages	#2 Reduce risk to life and health	#5 Reduce the risk of damage and loss of critical infrastructure	#1 Min. impacts to wetlands	#2 Min. impacts to diversion projects	#3 No loss of existing flood protection	#4 Avoid impacts to WMA & wetlands	#5 Min. impacts to critical infrastructure	SUM
Plan 6: Spillway to Reserve (US-51 Protection)	2 Received a 2 due to the fact that it only addressed a limited portion of the FWOP equivalent annual damages. Damages EAD . Two of the highest EAD reaches, SA-27 and SA-21 would have left be left outside of the plan.	1 Received a 1 due to the fact that the plan's tie-in point would be directly through a developed area. There would be a high risk that stages outside of the plan could be higher with the plan in place.	2 Received a 2 due to the fact that under the existing conditions the plan would prevent surges from flooding I-10 and parts of US-61. The plan did not receive a 4 or 3 because US-61 could still flood under the existing conditions west of west of Marathon, and the plan also leaves out Reach SA-27. This reach includes the Reserve Airport and the Louisiana Nation Guard's High Water response vehicle facility. These two facilities are critical to SE LA storm response teams.	4 Received a 4 because west of Reserve Canal it stayed on the developed areas. It did not receave a 5 because it still enclosed wetlands between the Belle Terre Exit and Reserve Canal.	4 Received a 4 due to the fact that it would stop before the Hope Canal Diversion and would not interfere with the proposed lateral discharges.	1 Received a 1 because the plan would disrupt the local drainage patterns northward. A pump station would have to be placed on each drainage ditch to remove rainwaters during a storm surge event	4 Received a 4 due to the fact that it minimized the indirect impacts to the WMA where possible.	1 Received a 1 because it did not avoided a large # of pipelines. There are over 70 pipeline crossings. Many of these pipelines are small feeder pipelines that join up with a mainline pipeline south of Plan 11.	19

Plans 1-6 were eliminated from further consideration because they did not maximize the planning objectives. (See Table 3-2, objectives ranked column.) Plans that could induce flooding to communities outside of the risk reduction system or divided communities were eliminated from consideration because they were considered unacceptable.

Plan 7 and Plan 9 alignments follow the wetland/non-wetland interface through St. John the Baptist Parish. However, Plan 7 would not provide risk reduction to the town of Garyville. By increasing the length of the levee by 500 feet, Plan 9 provided risk reduction to Garyville while only minimally increasing costs. Plan 7 was thus eliminated. Plan 8 and Plan 12 would provide risk reduction to the same area. The difference between the two Plans was the tie-in points at the two closest high ground areas to prevent storm surge from flanking the levee. Plan 12 would extend into Ascension Parish and tie into the Marvin Braud pump station. Plan 8 would tie into Hwy-70 in St. James Parish adding 4 miles to the alignment. Plan 12 was carried forward instead of Plan 8 because it was less costly and the direct environmental impacts were less than Plan 8.

The four remaining structural plans were carried forward: Plan 9, Plan 10, Plan 11 and Plan 12.

Descriptions of further analyses and screening are contained in Chapter 3 of the main report.

FURTHER DEVELOPMENT OF THE LOCALIZED STORM SURGE RISK REDUCTION COMPONENT

After the release of the draft report, the team received comments on both the public acceptability of the nonstructural measures proposed and the incremental benefits associated with the the components presented in the draft report. The indication from the public was that a raising or buyout program would get very little public participation if the program were voluntary. The original assumption for the cost and benefit analysis were based on 100% participation in the draft report. In addition to the participation rate, the team also had to investigate the incremental justification of the nonstructural component as a standalone feature.

In reviewing the nonstructural plan presented in the draft report, the team determined that the benefit to cost ratio (BCR) was less than 1 (below unity). In the draft report the cost of raising and/or acquiring structures located in the 2020 and 2070 100-year floodplains was evaluated by comparing the cost of elevating the structure to the cost of acquiring the structure. In subsequent discussions with the local stakeholders and experts in the field of storm surge risk reduction measures, we determined that lower cost localized storm surge risk reduction measures could have been implemented to achieve the same level of benefits. This in turn could have raised the BCR above unity.

The key to identifying which of these localized storm surge risk reduction measures would work best to reduce the risk of storm surge-related damage in this area lies in understanding the limits and characteristics of storm surge flooding and flooding in general in St. James Parish. Based on this understanding, the team determined that methods used to address tropical/hurricane storm surge in this area had to be focused in discrete locations and had to be implemented very near the base year where damages were occurring.

The team began its detailed evaluation by reviewing the existing and future tropical/hurricane storm surge flooding in the St. James Parish area. It was determined that in 2020, the 100 yr flooding in St. James Parish was between an elevation of 6.6. to 5.2 ft NAVD 88 (Figure 4).

Figure 4. 100 yr Surge Data and Reaches in St. James Parish with Structures

SA-Name	Index_Sta	FWP100yr2020	FWP100yr2070
RSA 01	102	6.6	12.1
RSA 02	104	5.8	11.8
RSA 24	148	5.5	11.6
RSA 27	154	5.7	11.7
RSA 33	166	5.2	11.8
RSA 34	168	5.2	11.8
RSA 35	170	5.2	11.8
RSA 44	188	5.5	11.6
RSA 46	192	5.8	11.8
RSA 54	208	5.7	11.7
RSA 55	210	5.5	11.6

Based on our surge modeling data, these stages would affect between 225 to 300 homes in 2020. These stages were also very similar to the stages seen from Hurricane Isaac, but less than 30 structures were impacted in St. James during that event. In discussions with local residents and stakeholder it was determined, due to the nature of the flooding and depths, the locals were able to sandbag a large number of homes over a 24 hour period and protect these homes from damage. Unlike the eastern portion of the study area, storm surges in St. James Parish typically enter the area slower and when it does flood, the depths in the developed areas are generally less than 2.5 ft deep. Most of the developed areas have a ground elevation of ~4.5 NAVD 88. As you can see from the pictures below from Hurricane Isaac, most the flooding is in the yards. Homes with a first floor less than 6.5 were typically sandbagged (Figure 18 and 19). In some cases, temporary berms made from sand bags were used to protect a group of structures (Figure 20).

Figure 18. Gramercy Area north of 3125 during Hurricane Isaac

Figure 19. Grand Point Hurricane Isaac

Figure 20. Grand Point Hurricane Isaac (Credit St. James Parish Sheriff's Office)

We also determined that flooding that occurred south of Highway 3125 had to pass under the highway. The lowest point of the highway was above a 6 ft elevation. Surge was flowing upstream through the drainage culverts under the highway and flooding structures south of the highway.

The team at that point began to investigate the feasibility of berms and flap gates on the culverts along the highway. We identified 5 major areas within St James parish that could be addressed through localized storm surge risk reduction risk reduction measures(Figure 21):

- Berm around a group of structures in the Gramercy area North of Hwy 3125.
- Berm around a group of structures in the Grand Point area North of Hwy 3125 near Longview Park. (Grand Point North).
- Berm around a group of structures in the Grand Point area north of Hwy 3125, near the Grand Point Boat Launch (Grand Point South).
- Flap Gates and Closures on drains under Hwy 3125 to reduce risk to structures south of the highway.
- Flood proof structures north of Hwy 3125 in St. James Parish outside of the berms with a first floor below the 2020 1% AEP event.

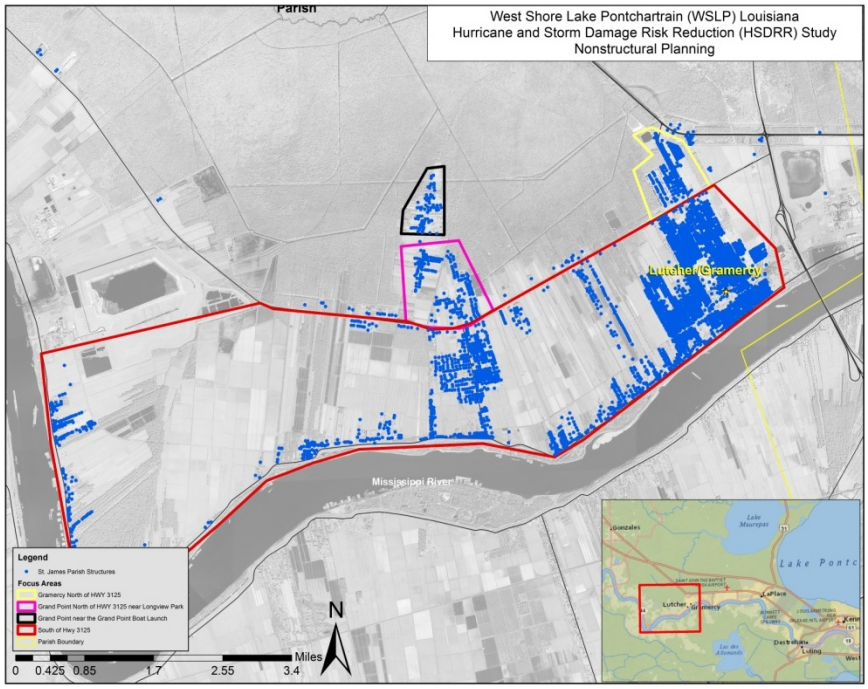

Figure 21. Areas of further development of Localized Sorm Surge Risk Reduction Plans.

Because individual berms around each structure would not be cost effective, consideration was given to small berms around a group of structures. For example, in the Gramercy area north of Hwy 3125, we reviewed the cost of three methods of localized storm surge risk reduction measures; raising each structure (Figure 22); berms around each structure; or one berm around a group of structures tying back into the Hwy 3125 (Figure 23).

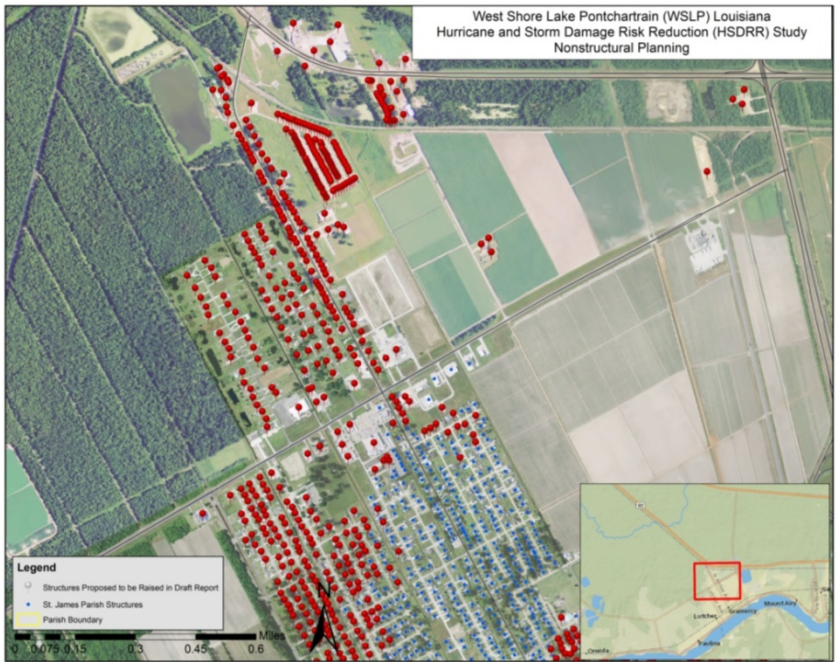

Figure 22. Structures Proposed to be raised in Draft Report.

Figure 23. Graphical Representation of a Berm around the Gramercy area.

Cost for raising structures were already developed for the draft report. Cost for berms around structures were developed based on a average perimeter around a structure and a cost per linear foot of berm. The cost for the berm around the group of structures was based on the same design of the structural as the levee, but an average ground elevation was used. In most areas, the required berm heights for a 2020 100yr level of risk reduction were less than 2.5 ft above ground level. In comparing the cost between the three options, a berm around a group of structures was the more cost efficient option (Table 5). In both the Gramercy area and in the Grand Point Areas berms around a group of structures were developed (Figure 24).

Table 5. Cost comparisons for Gramercy Area

	Top of Polder Elevation/or Targeted RR level for Existing conditions (ft NAVD88)	# Structures in Polder	# Structures with first floors less than the set polder height	Total polder construction cost	Structure by Structure Evaluation of Raising or Acquisitions (noURA)	Estimated cost for individual berms per Structures impacted (# Structures X (240 lf berm*X $800/lf) *Used ~3,500 sqft area (SQRT(3500)*4) = 240 lf
Polder 1 (Gramercy)	6.5	275	156	$15,000,000	$24,000,000	$30,000,000

To reduce risk to a large area south of Hwy 3125, it was determined, that Hwy 3125 could be used as a localized storm surge risk reduction feature (Figure 24). The roadway elevation is above a 6.5 'NAVD 88 elevation and currently under a 2020 100 yr event, tropical/hurricane storm surges only flow through the culverts under the roadway (Figure 24). By closing off the culverts with one-way flap gates and a drainage canal with a floodgate during tropical/hurricane storm surge events, the plan would provide risk reduction to 19,500 acres and 4,295 structures south of Hwy 3125.Although there are a limited number of structures that are impacted by a 6.5 'NAVD 88 surge event, this closure would prevent a large portion of the parish's critical sugarcane crops from flooding during tropical/hurricane storm surge events, although no estimates of damage and benefits to agricultural resources have been made. In addition, if the parish chooses to make future improvements to Hwy 3125, any additional height added to the highway could add to the structures risk reduction level. Currently 165 structures out of 4,295 structures south of Hwy 3125 would be impacted by a 6.5 'NAVD 88 surge event without the flapgate closures.

In order to include everyone in the evaluation the team also investigated the remaining structures that were not included in the 3 polders or in the area south of Hwy 3125. We determined that 80 structures would be outside the risk reduction provided by these features. Of these structures, only 23 of them have a first floor

elevation less than the 1% AEP storm stages in 2020 (Figure 24). The plan therefore includes elevation of 14 residential structures to the stage associated with the 2070 1% (100-year) ACE event; flood-proofing of 4 non-residential structures to 3 feet above the ground elevation; and constructing smaller berms for 5 light industrial/warehouse facilities.

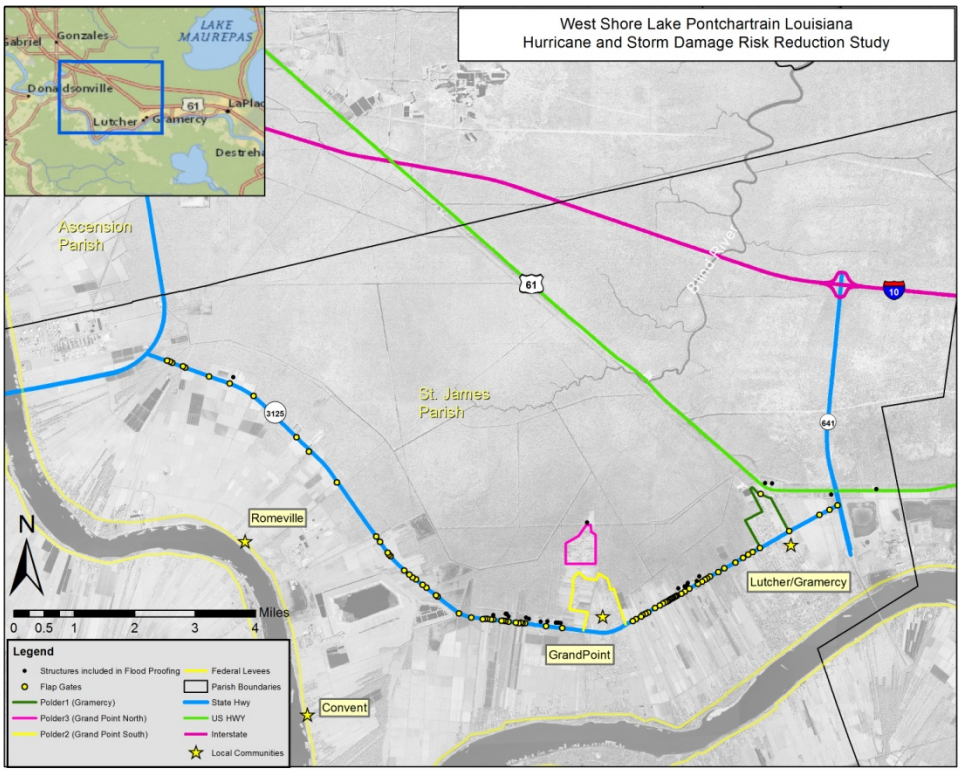

Figure 24. Final Localized Storm Surge Risk Reduction Plan for St. James

Including the optimized localized storm surge risk reduction components would reduce tropical/hurricane storm surge-related damages in St. James to the 1% AEP storm stages in 2020. The measures only provide a risk reduction above 1% AEP storm stages in 2020. In the future, the level of risk reduction provided by these measures would depend on the rate of RSLR. The level of risk reduction in year 2070 is estimated to fall between the 25 yr and 50 yr AEP storm stages. Additional efforts to investigate improvements to the berms over time were not investigated further due to the fact that the previous efforts under the draft report showed that larger localized storm surge risk reduction plans based on the 2070 1% AEP storm stages was below unity.

ENGINEERING DETAILS OF THE LOCALIZED STORM SURGE RISK REDUCTION FEATURES

Polder 1 (Gramercy Berm)

In the Gramercy area, north of Hwy 3125, a 10,100 LF berm is proposed. The berm would be constructed to a +6.5' NAVD 88 elevation. The berm would parallel both sides of Hwy 20, and parallel the railroad track

along US-61 (Airline Highway). On the south, the berm would tie into Hwy 3125 to close off the system. Hwy 3125 is key feature for all of the localized storm surge risk reduction features. The entire roadway is above a 6.5‘ NAVD 88 elevation and will be used as a tie in point for the berm. The design of the berm is based on with a 4' wide crown and 3:1 side slopes. Using local Light Detection and Ranging (LIDAR) data it was assumed that the existing ground elevation under the berm would be at an elevation of approximately 4.3 ft NAVD88. Using this assumption, the proposed berm would have an average height of 2.2 ft with an average width of 18 ft, and require 237,000 cy of compacted fill for construction. The berm would also include two floodgates to allow existing drainage to flow through the berm when not under surge events. A pump system to operate and remove rainwaters during tropical/hurricane storm events will be included in the features. The pump system will be approximately 217 cfs. The berm would be placed in a location so as not to interfere with existing local drainage.

Mobilization & Demolition	1	L.S.
Clearing and Grubbing (Area of berm location)	4	Ac.
100% Compacted Fill	237,021	C.Y.
Turf Establishment	4	Ac.
Flood Gate (10' to 14' Height)	50	LF
Pump Station (217 CFS)	1	Each
Flap Gate (36" circular)	1	Each

Polder2 (Grand Point South Berm)

In the Grand Point Area near Hwy 3125, a 14,488 LF a berm would be built, and would include a 4' wide crown and 3:1 side slopes. Similar to the Gramercy berm, it would tie into Hwy 3125 and be constructed to a 6.5' NAVD 88 elevation. Using LIDAR data it was assumed that the existing ground elevation under the berm would be approximately 4.5' NAVD 88. Using this assumption the proposed berm would have an average height of 2 ft with an average width of 16 ft, and require 273,900 cy of compacted fill for construction. The berm would also include one floodgate to allow existing drainage to flow through the berm when not under surge events. A pump system to operate and remove rain waters during tropical/hurricane storm events will be included in the features. The pump system will be approximately 382 cfs. The berm would be placed in a location so as not to interfere with existing local drainage. The berm would also be placed very near the edge of the property owners’ parcels where feasible. This would minimize the loss of use of any property.

Mobilization & Demolition	1	L.S.
Clearing and Grubbing (Area of berm location)	5	Ac.
100% Compacted Fill	273,823	C.Y.
Turf Establishment	5	Ac.
Flood Gate (10' to 14' Height)	50	LF
Pump Station (382 CFS)	1	Each

Note: A review of each component determined that every component considered for the localized storm surge *risk reduction plan, except for Polder 2 (Grand Point South), was economically justified on its own (See Table 3-8 of the main report). The USACE’s ER 1105-2-100 states that separable elements have to be incrementally justified to be included in the final recommendation. Polder 2 (Grand Point South) BCR’s was less than unity when evaluated separately. Polder 2 (Grand Point South) was removed from the overall system associated with the final recommendation.*

Polder3 (Grand Point North Berm)

In the Grand Point Area a berm proposed around the structures in the northern portion of Grand Point, near the Grand Point Boat Lunch. The berm would be 10,400 LF, and would include a 4' wide crown and 3:1 side slopes. The berm would be constructed to a 6.5 ' NAVD 88 elevation. Using local LIDAR data it was assumed that the existing ground elevation under the berm would be approximately 4‘ NAVD 88. Using this

assumption, the proposed berm would have an average height of 2.5 ft with an average width of 20 ft, and require 286,800 cy of compacted fill for construction. A pump system to operate and remove rain waters during tropical/hurricane storm events will be included in the features. The pump system will be approximately 140 cfs. The berm would be placed in a location so as not to interfere with existing local drainage. The berm would also be placed very near the edge of the property owners' parcels where feasible. This would minimize the loss of use of any property.

Mobilization & Demolition	1	L.S.
Clearing and Grubbing (Area of berm location)	4	Ac.
100% Compacted Fill	286,729	C.Y.
Turf Establishment	4	Ac.
Pump Station (140 CFS)	1	Each

Storm Surge **Risk Reduction Under LA Highway 3125**

In addition to the berms north of Hwy 3125, the proposal is to use 13 miles of Hwy 3125 and its existing foundation as a localized storm surge risk reduction feature. Currently the roadway elevation is above a 6.5' NAVD88 elevation. Currently, the 1% AEP storm stages in 2020 flow through the culverts under the roadway in the opposite direction from natural drainage. By closing off the culverts with one-way flap gates and a drainage canal with a floodgate during surge events, the plan would provide risk reduction to 19,500 acres and 4,295 structures south of Hwy 3125. The plan includes 145 flap gated closures, two floodgates and two small berms (Noranda and Uncle Sam). The Noranda berm ties the highway into high ground east of Gramercy. The Uncle Sam berm divides the developed area behind Hwy 3125 from an area that is primarily agricultural land. The total length of the berms is approximately 645 LF. They would be built in the same methods as the Gramercy and Grand Point berms. Due to the nature of the flooding south of Hwy 3125, it is assumed that the 19,500 acres would have ample storage capacity to hold any rainfall during the surge events. Even if some acres of crops are flooded from rainfall it would be much less than if the surge was allowed to flow under Hwy 3125.

Flap Gate (30" circular)	69	Each
Flap Gate (36" circular)	19	Each
Flap Gate (48" circular)	3	Each
Aluminum Slide Gate (48" x 72")	1	Each
Flood Gate (10' to 14' Height)	90	LF
Noranda berm		
Mobilization & Demolition	1	L.S.
Clearing and Grubbing (Levee)	1	Ac.
100% Compacted Fill (3)	8,973	C.Y.
Turf Establishment	1	Ac.
Uncle Sam berm		
Mobilization & Demolition	1	L.S.
Clearing and Grubbing (Levee)	1	Ac.
100% Compacted Fill (3)	5,120	C.Y.
Turf Establishment	1	Ac.

Remaining Structures in St. James Parish

The plan includes 14 residential structures that would be raised to the stage associated with the 2070 1% (100-year) AEP event; 4 non-residential structures would be flood proofed to 3 feet above the ground elevation; and smaller berms would be constructed for 5 light industrial/warehouse facilities. The final design will be refined in PED once additional information each structures is collected. The table below provides the information used for cost estimating purposes. The 14 residential structures are being raised to the 2070 height because it is more cost effective to raise a home once. The final method for raising and flood proofing will be refined during PED and could differ between residential structures and non-residential structures. The pictures below provide examples of the different methods.

14 residential structures:

ID	Structure Type	Existing 1st Floor Elevation (NAVD88)	Final Raised Elevation (NAVD88)
1392	1STY-PIER	3.76	8
367	1STY-PIER	4.91	7
611	1STY-SLAB	5.37	6
612	1STY-SLAB	4.67	7
624	1STY-SLAB	3.24	8
622	1STY-SLAB	3.72	8
621	1STY-SLAB	3.7	8
1396	1STY-SLAB	3.53	8
1395	1STY-SLAB	3.34	8
1394	1STY-SLAB	4.41	7
237	1STY-SLAB	4.51	7
236	1STY-SLAB	4.5	7
232	1STY-SLAB	5.32	6
1393	1STY-SLAB	3.8	8

4 non-residential structures would be flood proofed to 3 feet above the ground elevation:

ID	Type of Structure	First Floor Elevation (NAD88)	~ Square Feet of Structure
617FP	EAT	3.71	3,251
1FP	PROF	3.76	22,800
618FP	PROF	4.95	22,800
3FP	PUBL	4.51	7,815

5 light industrial/warehouse facilities with berms:

ID	Type	First Floor Elevation (NAD88)	Estimated Square Feet	Perimeter	Perimeter With Buffer
615B	COM	5.02	10431.7	408.54	568.54
614B	COM	4.39	10431.7	408.54	568.54
638B	COM	4.73	10431.7	408.54	568.54
114B	IND	4.99	10431.7	408.54	568.54
111B	IND	5.65	10431.7	408.54	568.54

Structures Foundation walls extended:

Structures elevated on piers, post, piles, or columns:

Low Flood Wall:

Berm around non-residential structure:

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Acronyms

AAHUs	Average Annual Habitat Units
ACE	Annual Chance Exceedance Event
ACHP	Advisory Council on Historic Properties
ADCIRC	Advanced circulation modeling
AEP	Annual exceedance probability
AM&M	Adaptive Management & Monitoring
ARDC	Amite River Diversion Canal
ASACW	Assistant Secretary of the Army for Civil Works
ATV	All Terrain Vehicle
BCR	Benefit to cost ratio
BLH	Bottomland hardwood
BLH1	Bonnet Carre Bottomland Hardwood Restoration
BMP	Best management practices
BR	Baton Rouge
CAA	Clean Air Act
CBRD	Convent Blind River Diversion
CC	Coefficient of Conservatism
CEMVN	U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CIAP	Coastal Impact Assistance Program
CPRAB	Coastal Protection Restoration Authority of Louisiana Board
CRMS	Coastwide Reference Monitoring System
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
cy	Cubic yards
dBA	A-weighted decibels
DIVR	Division Regulation
DO	Dissolved oxygen

Draft Report	Draft Integrated Feasibility Report and Environmental Impact Statement
EAD	Equivalent annual damages
EFH	Essential Fish Habitat
EJ	Environmental Justice
EJView	Environmental Protection Agency Mapping
EO	Executive Order
EPA	Environmental Protection Agency
EQ	Environmental Quality
ER	Engineering Regulation
ESA	Environmental Site Assessment
ESA	Endangered Species Act
ESJHS	East St. John High School
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
Final Report	Final Integrated Feasibility Report and Environmental Impact Statement
FIRM	Insurance rate maps
FPPA	Farmland Protection Policy Act
FQI	Floristic Quality Indices
FRM	Flood risk management
ft	Feet
FWCA	Fish and Wildlife Coordination Act
FWCAR	Coordination Act Report
GIS	Geographical information system
HEC-FDA	Hydrologic Engineering Center Flood Damage Analysis
HHS	U.S. Department of Health and Human Services
HI	Hydrologic Indices
HIS	Habitat Suitability Index
HSDRRS	Hurricane and Storm Damage Risk Reduction System
HTRW	Hazardous, Toxic, and Radioactive Waste
Hwy	Highway

I-10	Interstate 10
I-55	Interstate 55
LaDOTD	Louisiana Department of Transportation and Development
LCA	Louisiana Coastal Area
LDWF	Louisiana Department of Wildlife and Fisheries
LERRD	Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas
LF	Linear foot
LIDAR	Light Detection and Ranging data
LNHP	Louisiana Natural Heritage Program
LPV	Lake Pontchartrain and Vicinity
MBI	Mitigation Banking Instrument
MII	Micro-Computer Aided Cost Estimating System
MOU	Memorandum of Understanding
MR&T	Mississippi River and Tributaries
MRGO	Mississippi River Gulf Outlet Canal
MRL	Mississippi River Levee
MS	Mississippi
NAAQS	National Ambient Air Quality Standards
NAVD	North American Vertical Datum
NCC	Notice of construction completion
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NFS	Non-Federal sponsor
NGO	Non-Governmental Organizations
NOAA	National Oceanic and Atmospheric Administration
NOLA	New Orleans
NORM	Naturally occurring radioactive materials
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places

OCPR	Office of Coastal Protection and Restoration, Louisiana
OMRR&R	Operation, maintenance, repair, rehabilitation and replacement
OSE	Other Social Effects
OSE	Other Social Effects
PED	Preconstruction engineering and design
PIER 36	Programmatic Individual Environmental Report for Pontchartrain and Vicinity
PLD	Pontchartrain Levee District
PMP	Project Management Plan
PO-29	River Reintroduction into Maurepas Swamp
PPA	Project Partnership Agreement
PPT	Parts per thousand
Principles and Guidelines	1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies
REC	Recognized environmental conditions
RED	Regional Economic Development
REP	Real Estate Plan
ROW	Right of way
RSLR	Relative sea level rise
SHPO	State Historic Preservation Office
SLR	Sea level rise
SMART	Specific, Measurable, Attainable, Risk Informed, Timely
STWAVE	Steady-State Spectral Wave
SVI	Submergence Vulnerability Indices
SWMP1	Swamp Mitigation Bank Credit Purchase
SWMP2	Blind River Swamp Restoration
SWMP3	Bonnet Carre Swamp Restoration
SWMP4	Maurepas Crawfish Ponds Restoration
SWMP6	Lutcher Polder Farmlands Swamp Restoration
SWPPP	Stormwater Pollution Prevention Plan
T&E	Threatened and Endangered
TMDL	Total maximum daily load
TSP	Tentatively selected plan

TY	Target Year
URA	Uniform Relocation Assistance
US-44	U.S. Highway 44
US-51	U.S. Highway 51
US-61	U.S. Highway 61
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WIK	Work-in-kind
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WSE	Water surface elevations
WSLP	West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction
WVA	Wetland value assessment

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St. John Parish ..... i, 1-1, 1-2, 1-4, 1-7, 2-7, 2-9, 2-11, 2-12, 2-13, 2-14,2-15, 2-16, 2-25, 3-3, 3-4, 3-7, 3-9, 3-13, 4-1, 4-3, 4-6, 4-8, 4-9, 4-10, 4-11, 4-12, 5-6, 5-7, 6-1, 6-4, 7-1, 7-2, 8-1
Sea leve change, sea level rise, relative sea level rise. i, 1-2, 2-2, 2-3, 2-5, 2-7, 2-9, 2-16, 2-17, 2-19, 2-20, 2-22, 2-23, 2-24, 2-26, 3-2, 3-5, 3-6, 3-10, 3-12, 4-15, 4-16, 4-18, 5-3
Storm surge.i, 1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 2-5, 2-7, 2-8, 2-9, 2-11, 2-12, 2-13, 2-14, 2-15, 2-16, 2-18 , 2-19, 2-20, 2-28, 2-29, 3-2, 3-3, 3-4, 3-5, 3-6, 3-7, 3-8, 3-10, 3-12, 4-1, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 4-10, 4-11, 4-15, 4-16, 4-17, 4-18, 4-19, 4-20, 4-22, 5-1, 5-3, 5-6, 6-4, 8-1
Levees .....i, ii, 1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 2-1, 2-3, 2-4, 2-5, 2-13, 2-14, 2-26, 2-27, 3-3, 3-4, 3-7, 3-8, 3-9, 3-10, 3-11, 3-12, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 4-10, 4-11, 4-12, 4-13, 4-15, 4-16, 4-17, 4-18, 4-19, 4-20, 4-21, 4-22, 5-1, 5-2, 5-3, 5-4, 5-5, 6-3, 6-5, 7-1, 8-1

WEST SHORE LAKE PONTCHARTRAIN
HURRICANE AND STORM DAMAGE RISK REDUCTION STUDY
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

VALUE ENGINEERING

APPENDIX G

U.S. ARMY CORPS OF ENGINEERS

NEW ORLEANS DISTRICT

VALUE ENGINEERING REPORT:

West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Feasibility Phase

(Update Supplement to VE Study CEMVN-00-10)

February 2014

CEMVN-VE-14-02

Point of Contact: Frank Vicidomina, PE, CVS-L

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VALUE ENGINEERING REPORT

West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction

Feasibility Phase

(Update Supplement to VE Study CEMVN-00-10)

February 2014

CEMVN-VE-14-02

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VALUE ENGINEERING REPORT

West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction

Feasibility Phase

(Update Supplement to VE Study CEMVN-00-10)

February 2014

CEMVN-VE-14-02

INTRODUCTION

This report documents Feasibility Phase Value Engineering (VE) application to this project. It serves as an update supplemental to a previous VE study (CEMVN-VE-00-10) that was performed in 2000, early in the planning phase. That study has exceeded its allowable 6-year viability per ER 11-1-321 and must be updated per this document.

In conducting this update, project functions, current issues as well as pertinent recommendations from the previous VE workshop were considered and documented below.

As a result of this review several original and new VE recommendations are presented as **Appendix A,** and should be further considered in further project development.

PROJECT DESCRIPTION

The proposed project provides flood risk reduction for a portion of the southwest Lake Pontchartrain Basin (see below project location map).

The Tentatively Selected Plan (TSP) levee and flood wall alignment starts form the east at the West Guide levee of the Bonnet Carré Spillway to the US-51 interchange, where it then tracks north across US-51 and along a pipeline transmission corridor. The approximately 18.27-mile alignment crosses I-10 and follows the pipeline corridor through wetlands near the Belle Terre exit until it reaches Hope Canal. The alignment then turns south and extends to the MRL (see below plan map). Elevation and/or acquisition of structures outside the alignment would reduce risk of storm surge-related damage to structures in areas west of the Hope Canal.

Construction of this plan will require 3,365,000 cubic yards of geotextile fabric; nearly 26,000 cubic yards aggregate limestone road; 5,300 linear feet of T-walls; 300 linear feet of

flood gates; 200 linear feet of drainage gates; 4 pump stations; and 2 railroad gates. Environmental structures (sluice gates) will be built at existing bayous/canals that intersect the proposed flood protection barrier.

Although mitigation planning was integrated into the overall plan formulation process, implementation of the TSP requires compensatory mitigation for unavoidable project-induced impacts that will require replacing or providing substitute resources. A mitigation plan for the TSP will be completed following the feasibility level design and analysis and will be included in the final feasibility report.

The current TSP cost estimate is as follows:

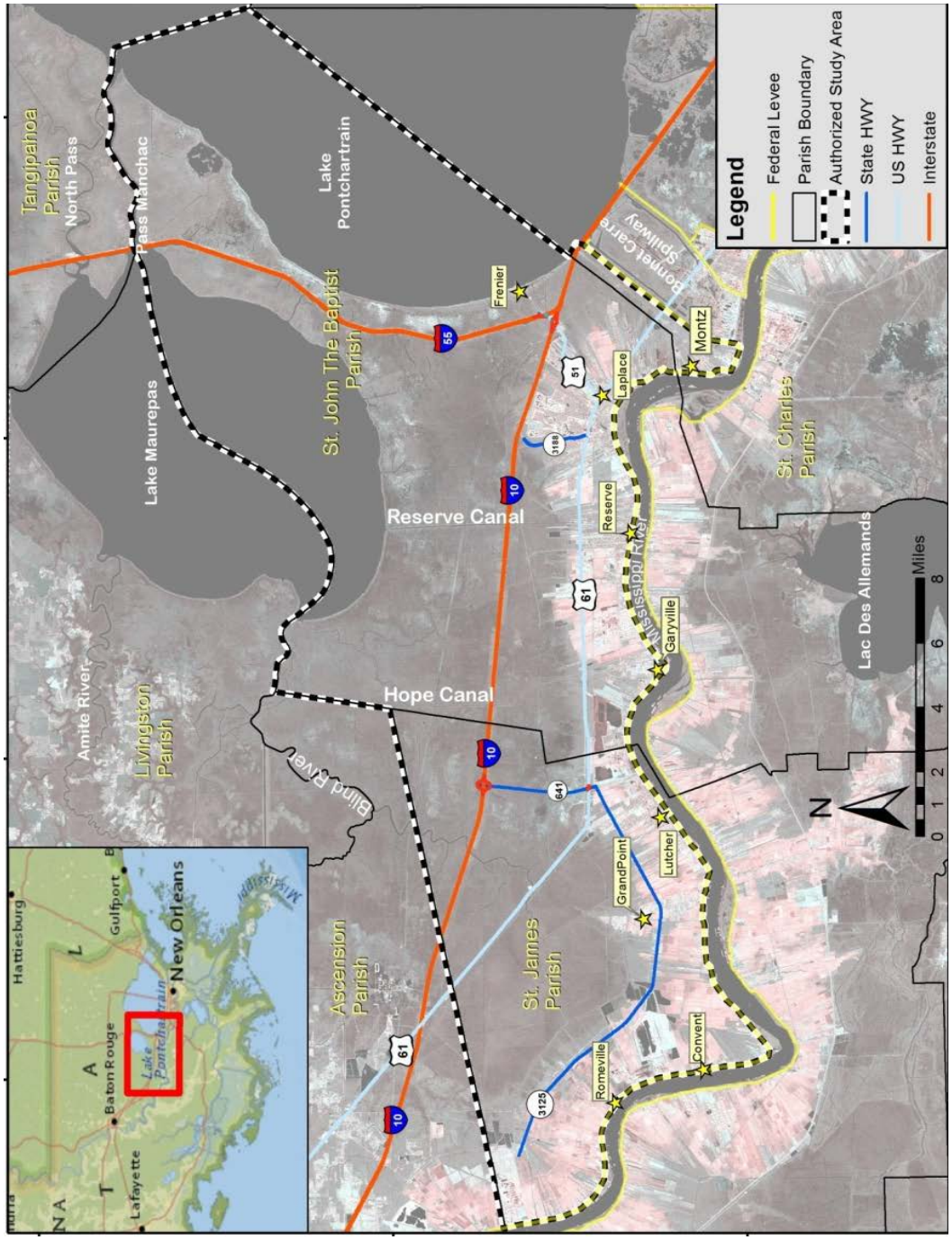
	Total	Federal	Non-Federal
PED	$7,500,000	$4,875,000	$2,625,000
Construction	$761,051,070	$557,500,446	$203,550,625
Pipeline Relocations	$35,100,000	-	$35,100,000
Lands, Easements, & ROW*	$84,700,000	$15,052,750	$69,647,250
Total First Costs**	**$888,351,070**	**$577,428,196**	**$310,922,875**

*** Federal costs are Administrative Cost of Non-Federal Sponsor Oversight**
**** Monitoring and Adaptive Management costs not included.**

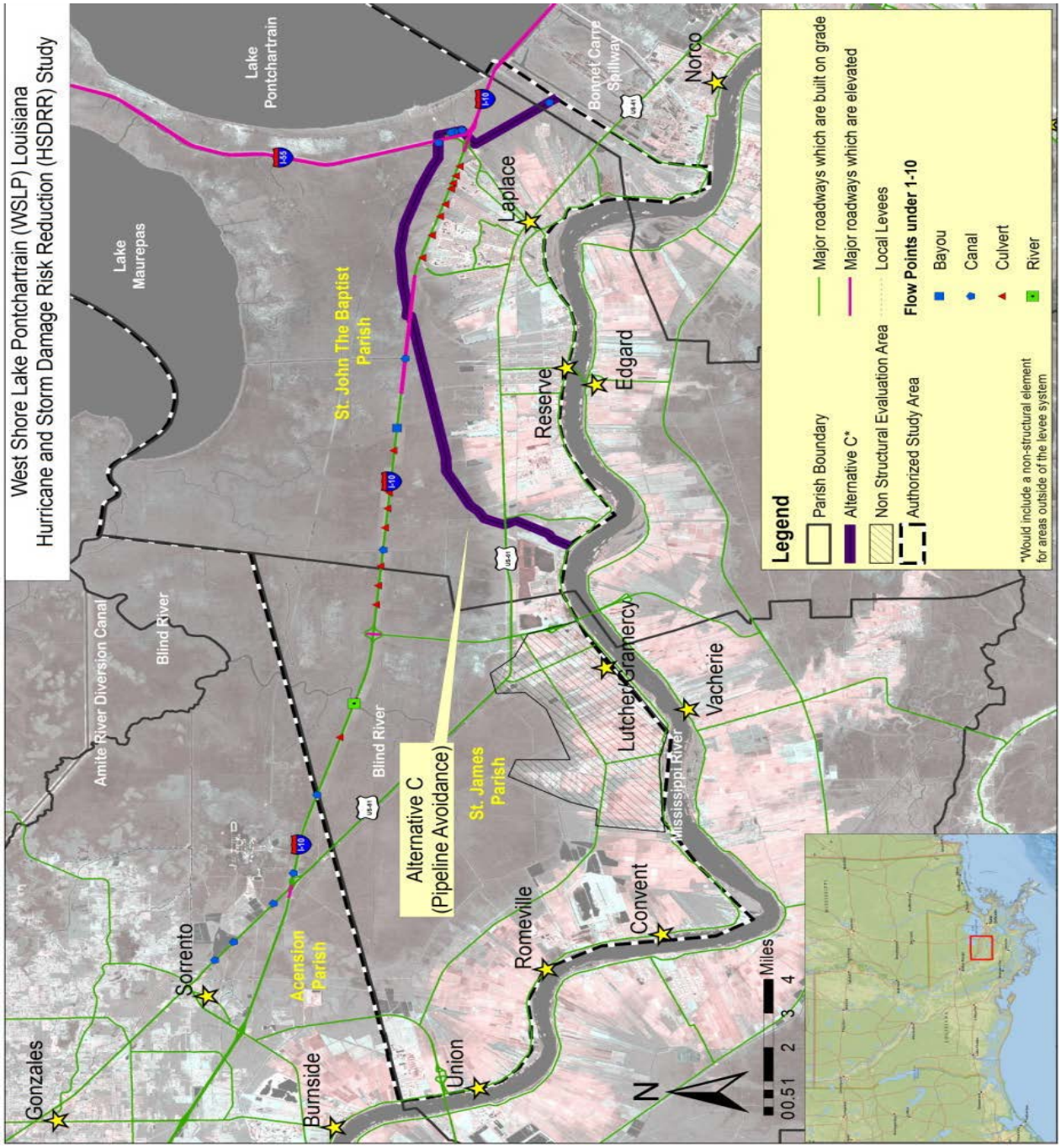
Future estimated annual operation, maintenance, rehabilitation and replacement costs for this plan are $520,000 for levee grass cutting and periodic repairs, plus $3,607,000 for pump stations and gate structures. Additional annual costs for environmental mitigation is also required and not included in the above.

Baseline information foe this VE update was obtained from the document, ***"West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study, Integrated Draft Feasibility Report and Environmental Impact Statement, August, 2013"*.** Further information extracted from this document regarding the TSP and other project alternatives (A&D) can be respectively found in **Appendices B and C.**

(Project Location Map)



(Plan Map of TSP)



RE-PROPOSED AND NEW VE SUGGESTIONS

The list below contains suggestions carried forward from the previous VE study (see next section) or newly identified items addressing project functions and/or current issues (Ref. **Appendix D**. The following are presented/discussed in **Appendix A:**

Item 1 – *Consider non-implemented features of the Amite River Diversion Canal Modification Project for mitigation*

Item 2 – *Designate permanent conservation areas inside proposed levee alignment*

Item 3 – *Consider internal water flow in mitigation feature design*

Item 4 – *Re-consider alignment to incorporate additional NER benefits*

Item 5 – *Address options for I-55 crossing*

Item 6 – *Evaluate pump station capacity requirements; address consistency with other CoE projects*

Item 7 – *Consider optimized pump station design*

CONSIDERATION OF VE PROPOSALS FROM PREVIOUS WORKSHOP

The 'parent' VE study document for this update supplemental is ***"West Shore Lake Pontchartrain, Louisiana Hurricane Protection Project, Value Engineering Study, September 2000, CEMVN-00-10".*** The following is a list of recommendations and design comments contained in that report with current disposition as applied to the current plan. As noted, items were integrated into the current design, eliminated for reasons noted or remain viable and are 're-proposed' for further consideration:

Recommendation 3,4,16,17- Use a pumped drainage system. Eliminated due to environmental need to have inflow/outflow on a constant basis for the proposed gated waterways

Recommendation 18,43 - Consolidate drainage structures. Integrated in current design.

Recommendation 11 - Use geotubes. Eliminated; geotube levee core determined not to be viable

Recommendation 29 – Incorporate reserve relief canal diversion guide levee. Eliminated; new expanded alignment selected.

Recommendation 12 – Compromise between Plans 1 & 3. Eliminated; new expanded alignment selected.

Recommendation 2- Eliminate Hwy. 51 protection. Eliminated; Hwy 51 and I-55 access determined to be a critical items.

Recommendation 6 – Construct north-south levee. Eliminated; open levee alignment would not be effective in long duration tidal event.

Recommendation 39 - Consider composite plan. Eliminated; new expanded alignment selected.

Design Comment (DC)-44 – Add interceptor canal. Integrated in current design.

DC-14 - Purchase environmental easements. Not defined in current plan; suggestion remains viable is carried forward. ***See Appendix A, Items 2 and 4.***

DC-21- Use "potato ridges" for wetland maintenance. Not defined in current plan; concept remains viable for consideration in potential mitigation feature design. Re-defined as, "Consider internal water flow in mitigation feature design". ***See Appendix A, Item 3***.

DC-26 - Use natural gas to fuel pump stations. Eliminated; natural gas supply interrupted in are during Hurricane Katrina and is now not considered a reliable fuel source.

DC-I 0 – Consider future development for pump station design capacities. There may be some issues with pump station capacity requirements; topic is carried forward. ***See Appendix A, Item 6.***

DC-15 - Incorporate a floodplain management plan. The PDT will address EO-11-988 "use of Floodplain" guidance.

DC-7 -Reconcile FEMA and corps flood data. New H&H modeling has been performed and calibrated with recent major storm event data (Hurricane Isaac).

DC-9 – Design for hurricane protection only. Eliminated; new expanded alignment determined to be cost-effective versus alignment bordering development (Alt. A).

DC-5 -Reduce levee heights (westward). **Implemented; (see ED Appendix; cost avoidance savings to be determined)**

DC-24-Design for larger hurricane event. Preliminary design is based on 0.01 probability event level of protection. This is in accordance with current regional design protection and appears to be slightly higher than the previous Cat. 3 model hurricane event. Future optimization may also be performed (recommendation partially implemented).

DC-30-Increase levee crown width to 10 feet. Implemented.

DC-8 - Revisit Airline Highway tie-in. Eliminated; new expanded alignment selected.

DC-41,42-Check I-55 crossing. Initial system elevation (2020) will not impact I-55 bridge; future 2070 will and there is no current design plan. Recommendation is carried forward. ***See Appendix A, Item 5.***

DC-22 – Revisit borrow material availability. New alignment assumes available/suitable borrow along protected reach of levee.

DC-45 - Revisit O&M requirements and costs. Implemented.

DC –6–Consider effects of Illinois Central Gulf Railroad (IGC). Model has incorporated this feature; railroad ballast embankment not suitable as a levee structure.

DC-1 - Consider levee location south of I-10 along Belle Terre reach. Eliminated; new expanded alignment selected.

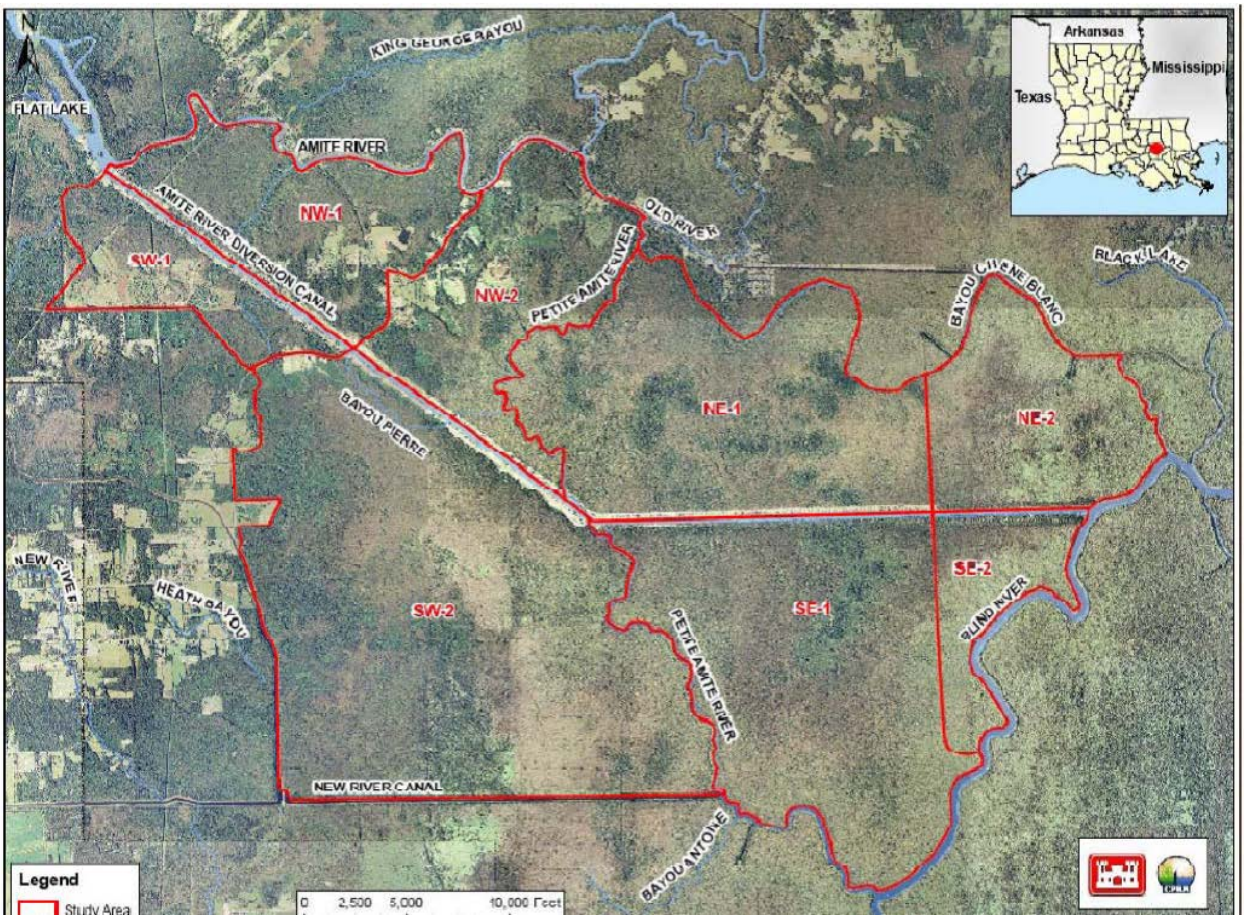
DC-35- Consider I-wall along 1-10 (Belle Terre reach). New alignment has ample right-of-way for less expensive earthen levee.

DC-38 - Consider floodgate on MRGO near Paris Road. Implemented for other HSDRRS project.

APPENDIX A

Re-Proposed and New Value Engineering Recommendations

Item 1 – Consider non-implemented features of the Amite River Diversion Canal Modification Project for mitigation - A recent change in the LCA program indicates that the State no longer supports the lower basin project features of the item subject project (see below map). The potential benefit areas of these features are in close proximity to Westshore and could potentially be targeted as mitigation for the project and likely be far less costly than other measures. Amite River Diversion Canal Modification project features are described below.



AMITE RIVER DIVERSION CANAL MODIFICATION PROJECT AREA MAP

Alternative Measures In Subunit NE-2

The measures currently being considered for Subunit NE-2 include the following:

Bank opening, north bank of Blind River, Location 1 (proposed by site reconnaissance team)

Channel dredging, pull boat trace, Location 2 (proposed by site reconnaissance team)

Bank opening, north bank of Amite River Diversion Canal, Location 3 (proposed as component of Measure BO14)

Bank opening, north bank of Amite River Diversion Canal, Location 5 (proposed by site reconnaissance team)

Bank opening, north bank of Amite River Diversion Canal, Location 6 (proposed as component of Measure BO14)

Two openings in railroad grade north of Amite River Diversion Canal, strategically located (proposed as component of Measure BO23)

Vegetative planting in degraded areas

Alternative Measures In Subunit SE-2

The measures currently being considered for Subunit NE-2 include the following:

Bank opening, south bank of Amite River Diversion Canal, Location 4 (proposed as component of Measure BO15)

Channel dredging and/or clearing and snagging of Blind River tributaries, north bank of Blind River (proposed by site reconnaissance team)

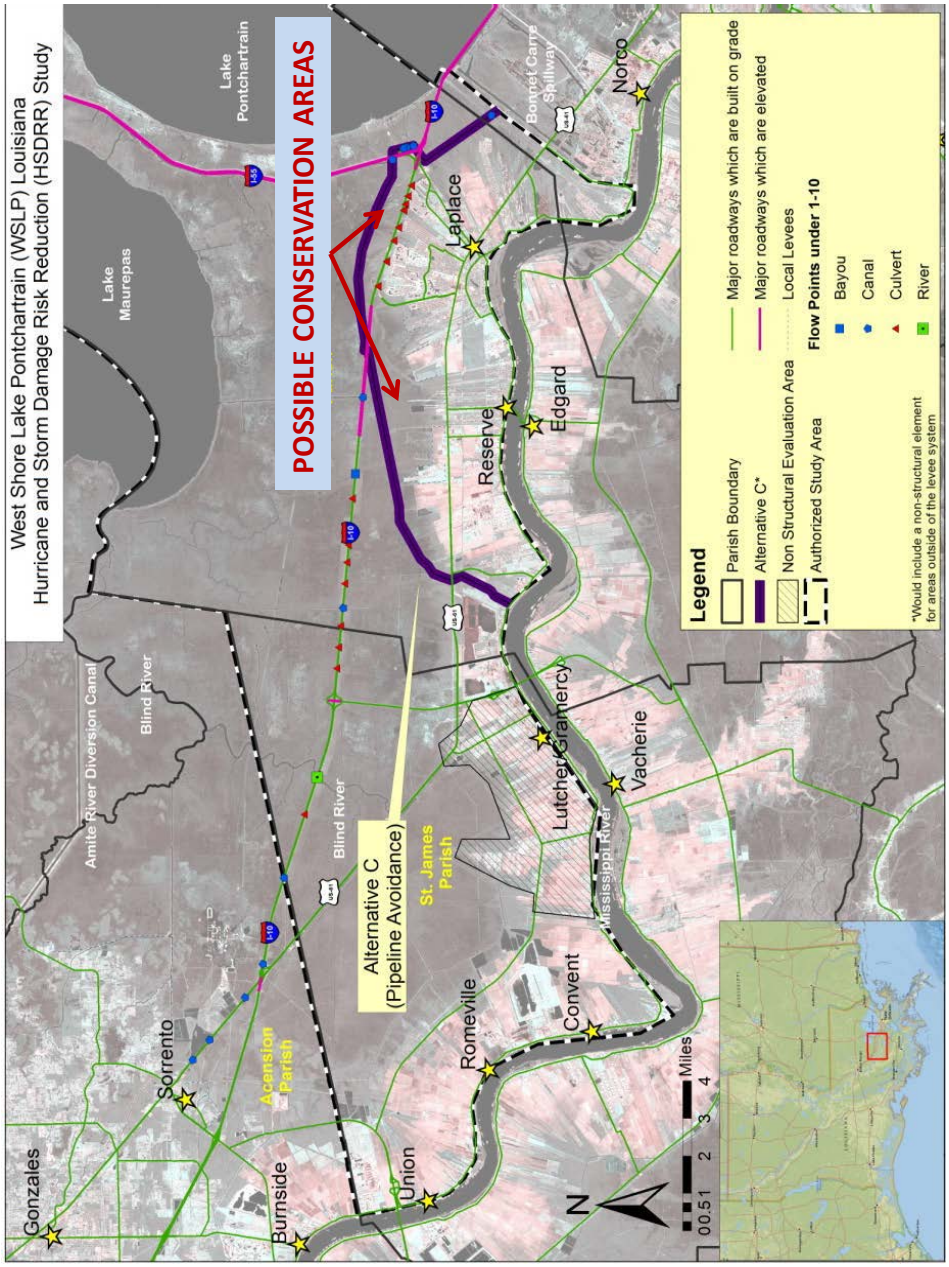
Two openings in railroad grade south of Amite River Diversion Canal, strategically located (proposed as component of Measure BO24)

Vegetative planting in degraded areas.

Openings in Railroad Grade, Strategically Located (Subunits NE-1/NE-2 and SE-1/SE-2)

In addition, locations for openings in the relic railroad grade north and south of the Amite River Diversion Canal were determined through LiDAR analysis. Two locations were determined to exhibit characteristics that would constitute ideal locations for establishing hydrologic connectivity between Subunits NE-1 and NE-2. These locations were selected because they occupy topographic low points between vegetated hummocks and/or channel banks.

Item 2 – Designate permanent conservation areas inside proposed levee alignment -
There appears to be the potential to reserve some of the areas that will be enclosed by the project. While the purchase of environmental easements may, or may not, necessary, assuming future development of all enclosed and mitigating for same does not appear prudent since wetland development permits would not be granted. Two such possible areas are suggested and shown on the map below (additional areas should also be investigated). Water flow through drainage gates should be adequate to maintain hydrologic conditions. Also, there is the potential for future trails and other appropriate interaction features. Designating these reserve areas reduces indirect mitigation cost.


West Shore Lake Pontchartrain (WSLP) Louisiana
Hurricane and Storm Damage Risk Reduction (HSDRR) Study
POSSIBLE CONSERVATION AREAS
Lake Pontchartrain
Lake Maurepas
Amite River Diversion Canal
Blind River
Blind River
Alternative C
(Pipeline Avoidance)
St. James Parish
Ascension Parish
Gonzales
Sorrento
Burnside
Union
Romeville
Convent
Lutcher
Cramercy
Vacherie
Mississippi River
Laplace
Reserve
Edgard
Norco
Bonnet Carre Spillway
Legend
Parish Boundary
Alternative C*
Non Structural Evaluation Area
Authorized Study Area
Major roadways which are built on grade
Major roadways which are elevated
Local Levees
Flow Points under 1-10
Bayou
Canal
Culvert
River
*Would include a non-structural element for areas outside of the levee system
N
0 0.5 1 2 3 4
Miles

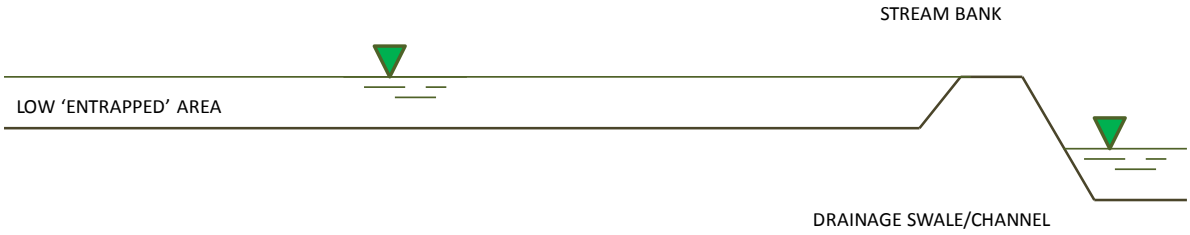
Item 3 – Consider internal water flow in mitigation feature design – Project mitigation areas will likely be located in area with hydrologic inflow and outflow. Investigation of existing local cypress swamps indicates the possibility of degradation due to flow entrapment. This is particularly evident in areas subject to tropical storm tidal flow events. It is therefore recommended that internal water flow modifications be considered for proposed mitigation areas. Such features mostly consist of berm excavation to connect apparent entrapment areas to drainage outlets as further described and depicted in schematics below.

(Description of Alternative Concept) Obtain further refined LiDAR and other data to identify 'trapped' low areas and/or possible unwanted collection points of freshwater diversion flow. Connect low areas to natural drainage outlets via strategically placed cuts in natural or man-made berms (such as canal spoil banks

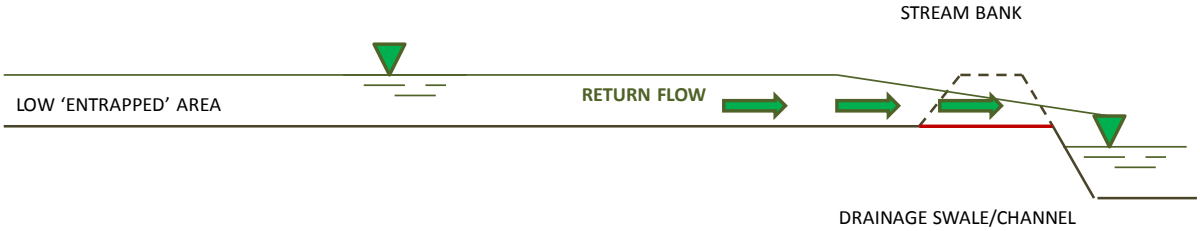
INITIAL NORMAL FLOW CONDITION

TIDAL SURGE FLOOD CONDITION

EXISTING CONDITIONS – POSSIBLE WATER ENTRAPMENT
(SCHEMATIC SECTION – NO SCALE)



POST TIDAL SURGE FLOOD CONDITION



POST TIDAL SURGE FLOOD CONDITION – **WITH PROPOSED BANK CUT**

PROPOSED BANK CUT

(SCHEMATIC SECTION – NO SCALE)

Item 4 – Re-consider alignment to incorporate additional NER benefits - The current philosophy and assumptions regarding levee placement and environmental impacts of this project appear to be as follows:

- Restricting open tidal flow, particularly sheet-flow, has negative impacts.
- It is assumed that all areas inside the levee system will be developed and eliminate habitat (indirect environmental impact).
- A key early assumption was that an adjacent proposed project – *'Convent/Blind River Diversion'* would have positive effects on major cypress swamps from the Mississippi River northward beyond US Highway 61 (US61). See below map.

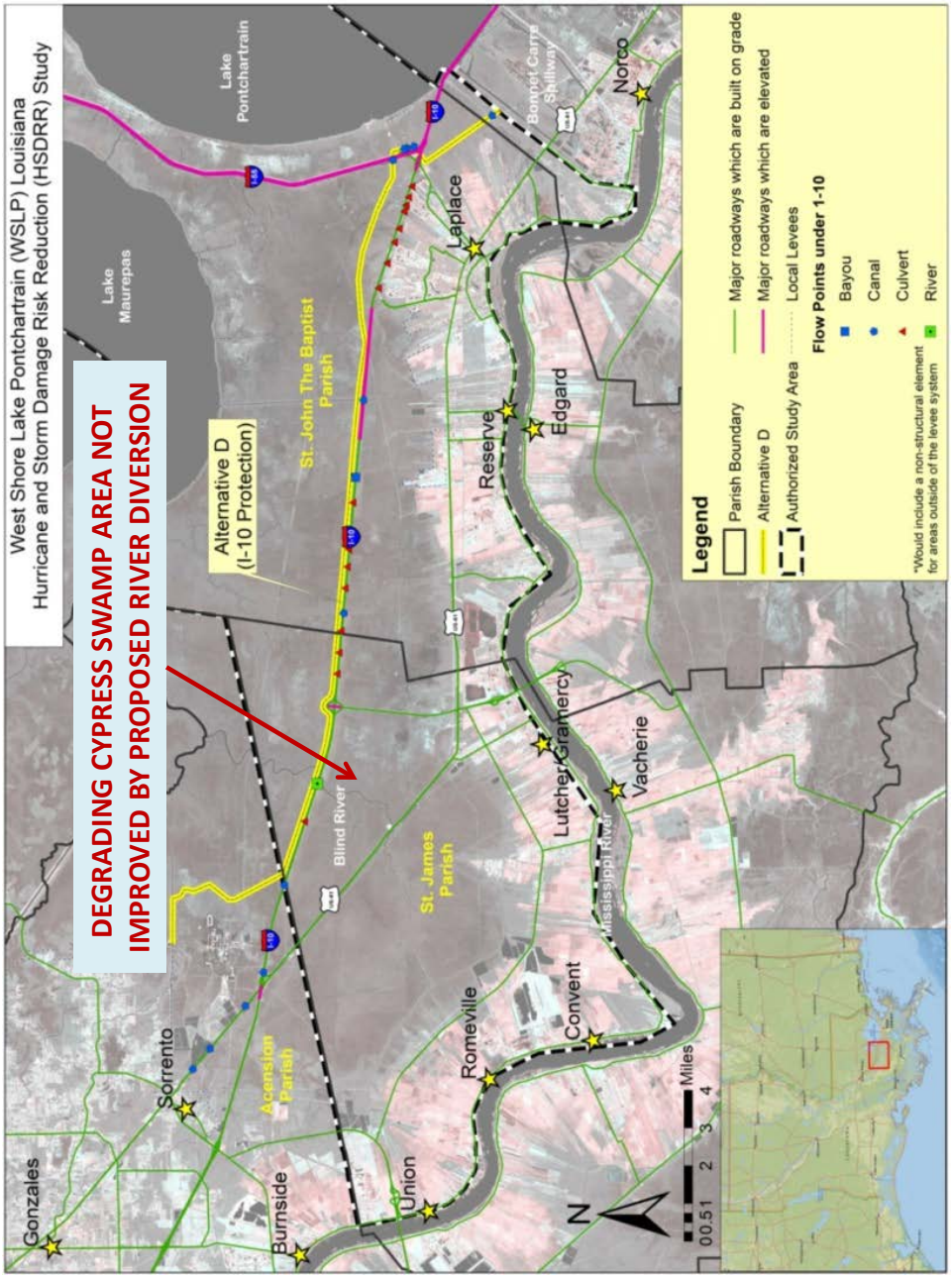
It is suggested that these above presumptions be re-visited with the following considerations:

- The current project design calls for gated drainage structures that will allow control of inflow and outflow to the interior; this 'leaky levee' concept is being embraced for the Morganza to the Gulf and other projects as environmentally sound. The control of saltwater intrusion, particularly when sea level rise is considered, may be a critical ***positive*** factor in maintaining area cypress swamps.

- It is possible to restrict development inside the levee system either by designating select areas as environmental reserves. This can be accomplished via purchase of an environmental easement (as required by CoE policy), by local ordinance or by simple designation since it appears very remote that a federal permit would ever be granted to develop these areas. While outright easement purchase may ***(or may not)*** be more expensive than mitigation, a waiver of CoE policy could be considered.

- Recent hydraulic analysis indicated the proposed Convent/Blind River Diversion Project will not have benefit to the part of the target area – that north of US61. As such, there is currently no proposed plan for protection of this significant cypress swamp area. Its primary degradation, apparently due in large part to saltwater intrusion and entrapment could be retarded with flow control such as a gated levee system could offer.

Given these reconsiderations, it may be determined that a westward extension of the proposed levee (similar to previous Alternative D) may actually produce net environmental benefits (NER) or at least not have nearly the negative impacts (and associated mitigation cost) as previously estimated. Without such an extension, continued loss of a vast area of significant cypress swamp will continue to degrade at its current rate of loss.


West Shore Lake Pontchartrain (WSLP) Louisiana
Hurricane and Storm Damage Risk Reduction (HSDRR) Study
DEGRADING CYPRESS SWAMP AREA NOT
IMPROVED BY PROPOSED RIVER DIVERSION
Alternative D
(I-10 Protection)
Lake Maurepas
Lake Pontchartrain
St. John The Baptist Parish
St. James Parish
Acension Parish
Blind River
Mississippi River
Gonzales
Sorrento
Burnside
Union
Romeville
Convent
Lutcher
Gramercy
Vacherie
Reserve
Edgard
Laplace
Norco
Legend
Parish Boundary
Alternative D
Authorized Study Area
Major roadways which are built on grade
Major roadways which are elevated
Local Levees
Flow Points under 1-10
Bayou
Canal
Culvert
River
*Would include a non-structural element for areas outside of the levee system
N
Miles
0 0.5 1 2 3 4

Item 5 – Address options for I-55 crossing – Current levee/floodwall design indicates that elevated I-55 is higher than the required 2020 flood height but not the 2070. In lieu if raising the bridge a wave-break structure could be placed just northwest and northeast of the bridge/levee intersection. This would reduce wave run-up and may allow levee/floodwall height reduction such that it passes under the bridge structure. Another option that can be implemented either independently of supplemental to a wave-break structure would be to design the low section of levee/floodwall as an actual weir. Conveyance to an acceptable drainage point cold be improved via concrete paved swales or small canals such that short period overtopping flow can be safely handled.

Item 6 – Evaluate pump station capacity requirements; address consistency with other CoE projects – Further design of proposed pump stations should carefully consider proper conveyance capacity and unit redundancy. Recent hurricane risk reduction projects have been constructed in areas already under pumped stormwater systems; replacement or maintenance of pump stations adhered to existing drainage capacity and system requirements. This project is different in that proposed pumps will replace an existing gravity system and should convey flow greater than or equal to current *under all conditions*.

MVN projects where conversion to pumped drainage has been implemented usually select an apparent 'reasonable' design flow event, such as a 0.04 annual probability. This practice is not uniformly used in other districts as Jacksonville (SAJ) uses 0.01 or greater for conversion systems in their Everglades Restoration Projects. Regardless of the above, an assessment of existing gravity drainage conveyance should be performed and matched or exceeded.

Conveyance design should be adequate under all conditions; existing gravity design should be calculated under low tide conditions (yields current maximum drainage capacity that should be maintained or exceeded). Also, proposed pumping plants should convey this flowrate under maximum design tidal conditions. In short, a design rainfall can be expected in conjunction with a major tropical storm (note that they are NOT statistically independent events).

Proper unit redundancy should also be considered. Local practice does not require an additional pump unit to meet maximum design capacity with one (largest) unit (including ancillary items such as screens, etc.) out of operation. This is not the case for SAJ/South Florida Water Management District where unit redundancy is included in their design. Consideration to unit redundancy should be applied to pump station design in this project.

It may be possible to combine unit redundancy with adjacent pump stations given that most (all) will be hydraulically connected via a manifold canal (borrow pit canal). As such, a single additional unit may be adequate at the middle pump station plus maybe one or two other stations.

Item 7 – Consider optimized pump station design - A number of new pump stations are proposed for this project. Preliminary design indicates 'traditional 'type facilities for this range of station capacity (see below preliminary design sketch). Major features include, but are not limited to the following:

- vertical pumps with direct diesel drive
- siphonic discharge
- climber intake screen cleaning mechanism
- closed interior station with a operator 'safehouse' contained in the station building
- internal permanent lifting crane

In addition to considerations of proper station capacity and unit redundancy discussed in the above recommendation, 'lessons learned' from recent District, other Corps and local projects offer a number of possible options that could significantly improve design cost-effectiveness. Items that should be fully evaluated are:

(Pump type)

Vertical pumps are generally cost-effective in most drainage applications. However, for stations in the capacity ranges designated in this project, other options are possible and may indirectly allow changes in total station configuration that could save significant cost. One option is electric submersible units powered by separate generators. Use of this type of pump offers much flexibility in the overall station structural design and can easily be automated (see comments below). This type of station has been recently constructed at Oakdale (see below photo) and is under consideration for permanent pumps at the Harvey Canal Sector Gates – 770 CFS (see design sketches below).

(Discharge configuration)

Given that these stations will not operate many hours power supply and energy savings afforded by lower operating head achieved via siphonic discharge do not warrant the cost of the discharge tubes. **It is important to note that these pumps must perform under near zero head conditions (gates closed tidal surge not yet arrived) as well as full flood elevation water levels.** As such, this would likely result in the need for induced head under normal tide levels via a 'saxophone' type (end turned upwards) discharge tube. This further increases the cost of the discharge tubes as well as reduces some of the desired power/energy recovery. Over top of wall open discharge requires a slight increase in driver power and very small added energy use but greatly simplifies the pumping system and first cost. This design concept has been successfully used for the East Ascension, Oakville and West Closure Complex pump stations.

(Screen cleaning mechanism)

Current local standards call for intake screen cleaning units to be fully operable under hurricane (wind conditions >120 mph) conditions. There appears to be very limited available units that can meet this requirement and is almost a sole-source condition. Units are very expensive relative to those that cannot achieve this criterion. Others in hurricane areas do not adhere to this standard and offer that it may not be practical or safe given that screen cleaning operation in very high wind conditions would either result in debris blowing right back into the intake or launched into the station structure. To address possible screen clogging during hurricane events, separated screen bridges are designed slightly wider. The possibility of Individual pump screens clogging is addressed in overall unit redundancy per discussed above. Cleaning mechanisms should, however, be designed to release debris away from the screen such that front-loader removal is not necessary to after the storm event.

(Equipment and operator housing structure)

Current local preference is to completely house all equipment and operation control in one large building. Post Katrina criteria also require an operator 'safehouse' capable of withstanding extreme hurricane conditions. Regardless of station size such a large containment structure is not necessary. Pump drivers and ancillary equipment can be protected via 'shell' covers with an independent qualified safehouse control room. Lifting crane(s) can either be brought in as needed or by external on an open frame or gantry track (see item below). A good example of such station configuration is the East Ascension Parish Pump Station. While the control room was not built to safehouse standards, the rest of the station utilizes such a shell cover concept (see below photo). *Also note that his station includes gravity gates integrated in the pump station structure (between each pump).*

(Lifting crane)

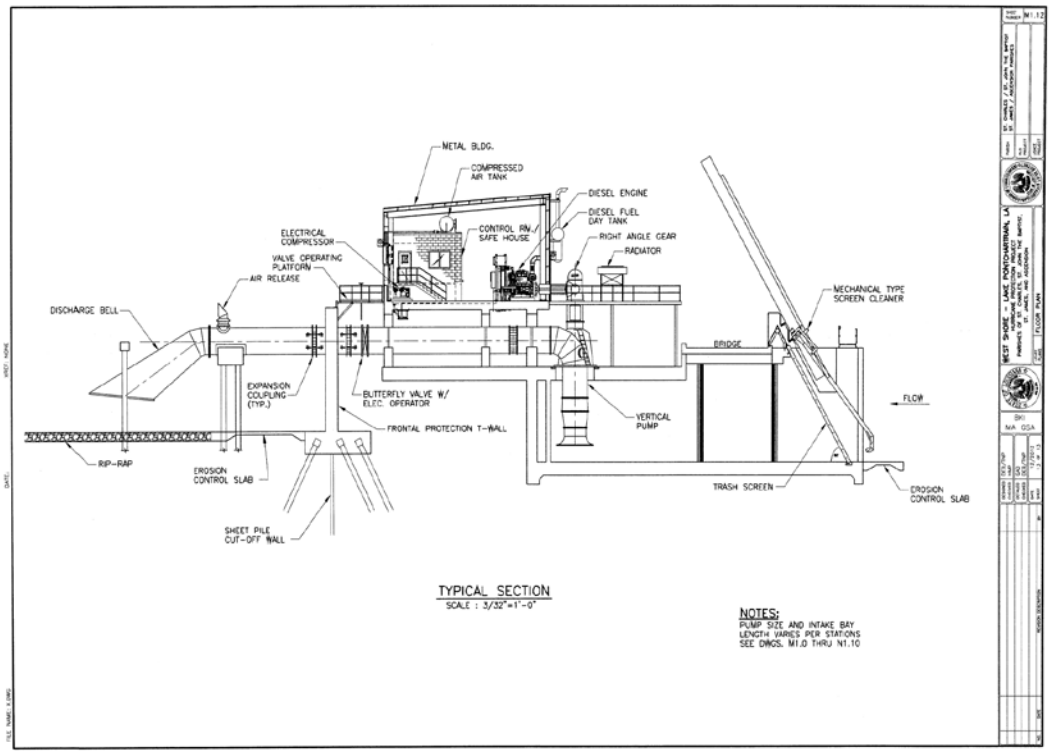
Current local preference is to have a crane, capable of lifting the largest piece of equipment, permanently installed inside the single station building. This requires that the building have excessive height (and cost) to both house and support the crane. Since lifting a pump must be a planned event, it is possible to bring in a locally owned or rented crane for each event. A more favorable option is to have an external crane on a frame and/or gantry track in conjunction with a removable cover shell or low-rise building (roof panel).

(Auto-operation of some stations)

Safehouses may be expensive, particularly if elevated above levee breach event water level. Also, manning each pump station in an event is not desired if a reliable alternative exists. It is proposed that perhaps only one or two stations be manned and have SCADA monitoring of the

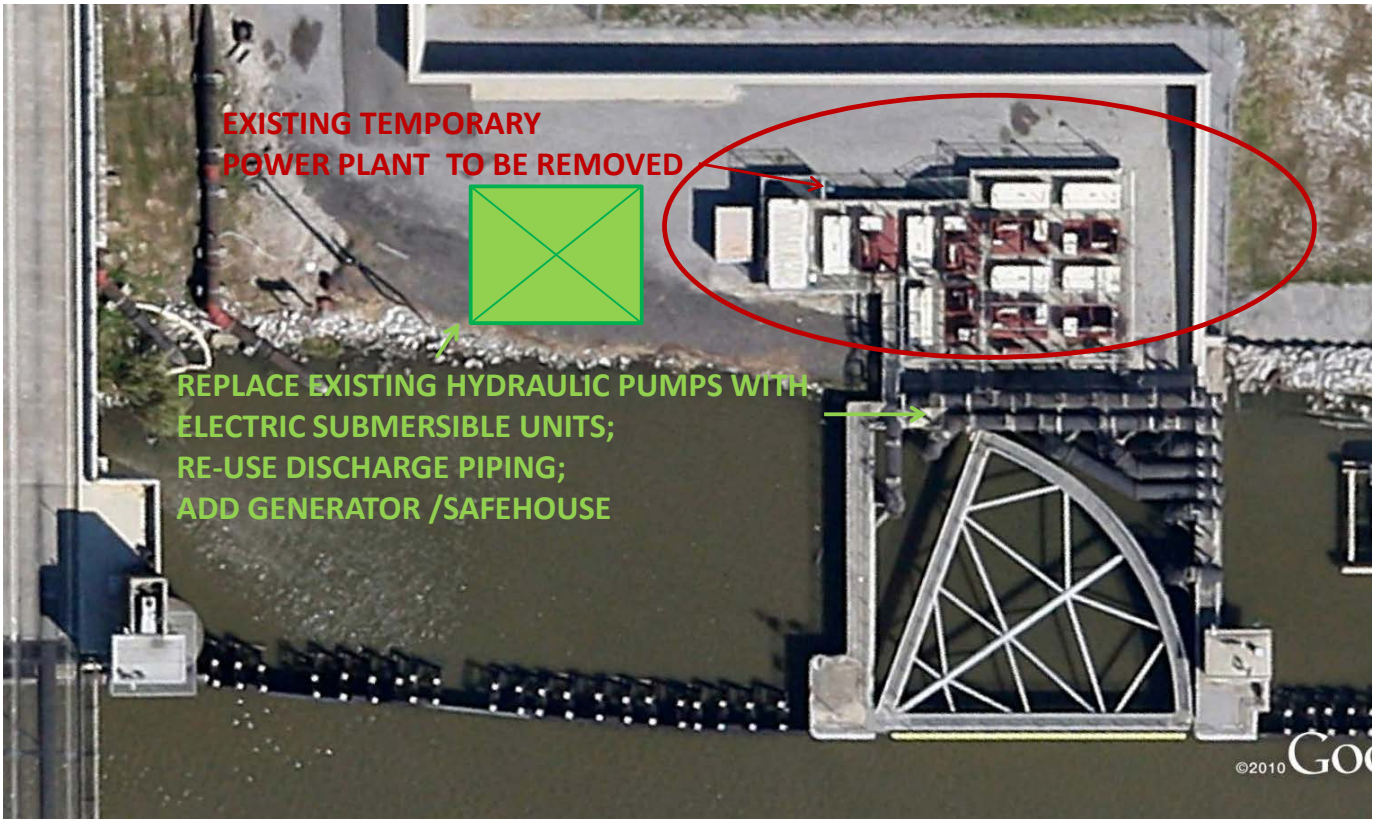
other facilities. The un-manned stations could be auto-control by a fairly simple and reliable float switch system. This becomes a more viable option in conjunction with alternative pump type and discharge options discussed above.

All of the above considerations may be integrated into a comprehensive cost-effective design. It is recommended that the above mentioned local pump stations utilizing these alternative concepts as well as other stations with similar function such as Jacksonville District / South Florida Water Management District.

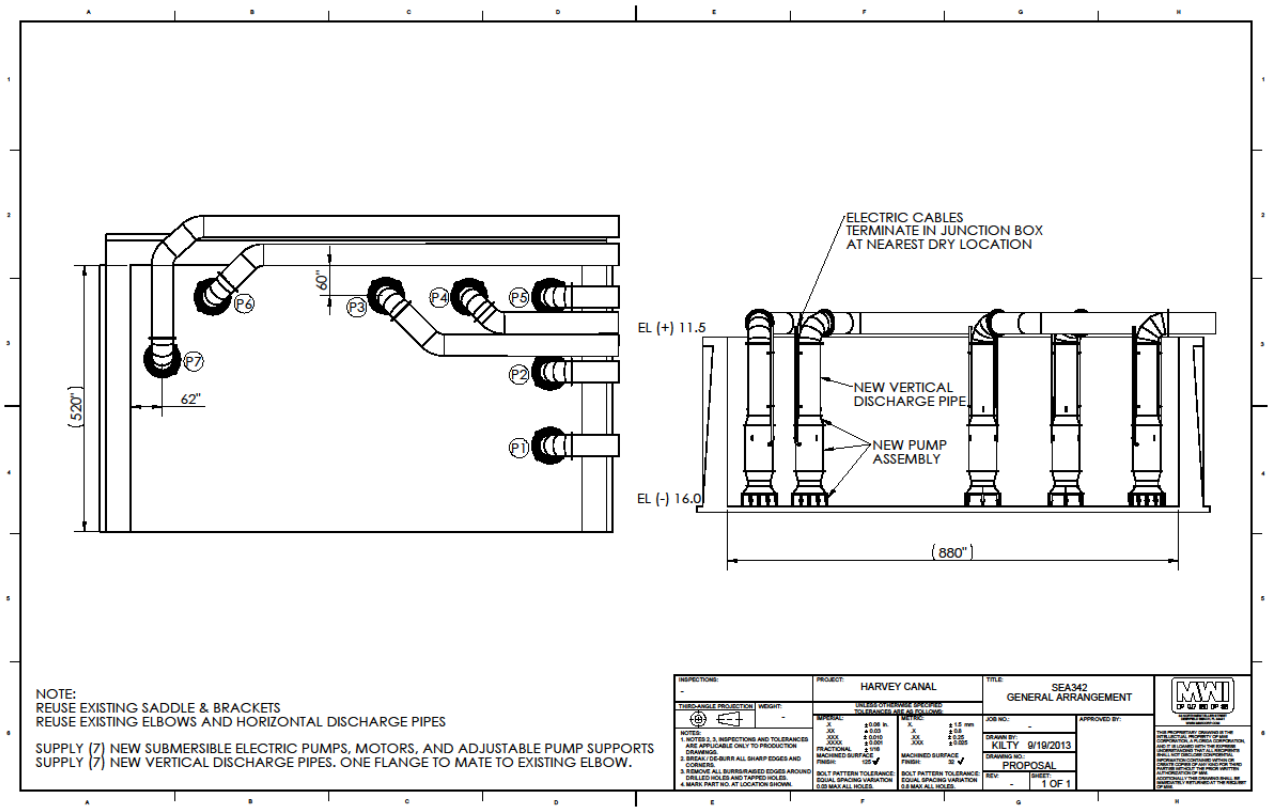


TRADITIONAL PUMP STATION

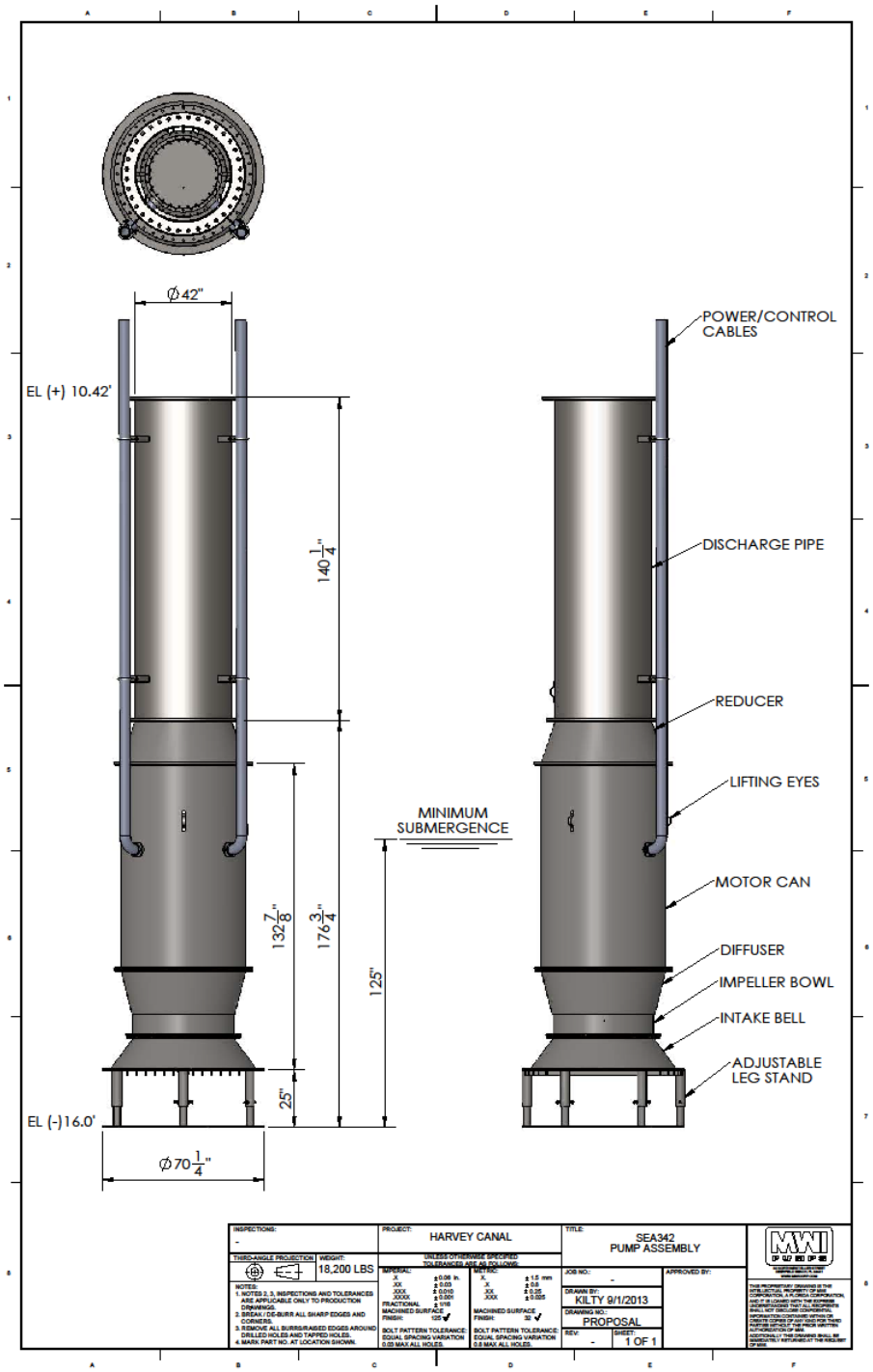
OAKVILLE PUMP STATION - ELECTRIC SUBMERSIBLE PUMPS WITH GENERATOR BUILDING



HARVEY CANAL SECTOR GATE - PROPOSED PUMP REPLACEMENT PLAN (ELECTRIC SUBMERSIBLES WITH GENERATOR BUILDING)



HARVEY CANAL SECTOR GATE - PROPOSED PUMP REPLACEMENT PLAN (ELECTRIC SUBMERSIBLES WITH GENERATOR BUILDING)



ELECTRIC SUBMERSIBLE PUMP

EAST ASCENSION PARISH PUMP STATION – 1,000 CFS PUMP UNITS

WITH DRAINAGE GATES BETWEEN PUMP UNITS

APPENDIX B

Description of the Tentatively Selected Plan from *"West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study, Integrated Draft Feasibility Report and Environmental Impact Statement, August, 2013"*

5.0 TENTATIVELY SELECTED PLAN (*NEPA Required)

Alternative C is the Tentatively Selected Plan (TSP). Feasibility-level design will commence after the SMART Planning Agency Decision Milestone and will finish before a Final Report.

5.1 Description of the Tentatively Plan

The TSP is an 18.27-mile risk reduction system around the communities of Montz, Laplace, Reserve and Garyville with non-structural components in St. James Parish. The alignment of the TSP is shown in Figure 3-4. The risk of storm surge damage would be reduced for over 7,000 structures and four miles of I-10 located in the system. Inclusion of this segment of I-10 would help maintain a major emergency evacuation and re-entry route for residents of southeast Louisiana, including residents in the New Orleans metropolitan area. The TSP also includes non-structural measures for 1,571 structures in the communities of Gramercy, Lutcher and Grand Point that are located outside of the proposed levee system. It is estimated that these non-structural measures would include elevation of 1,481 structures and acquisition of 90 structures. Implementation of non-structural features will be developed in more detail during feasibility level of design and analysis during which time an economic analysis will be conducted based on economic reaches. In developing the plan, consideration with be given to community cohesion and the requirements of EO 12898.

The structural component of the system would consist of earthen levees, floodwalls (T-walls), floodgates, drainage structures and pump stations located along the alignment. The preliminary level of design, based on modeling for a 1 percent AEP storm event includes levee elevations that would range from +13.5 NAVD88 on the eastern reaches near the Bonnet Carré Spillway to +7.0 NAVD88 in the western portion of the project area. They would be constructed with 3:1 side slopes with a 10-foot crown width. Construction of levees would involve the placement of 3,100,000 cubic yards of compacted and uncompacted clay (borrow) material on top of 3,400,000 square yards of geotextile fabric. Approximately 26,124 cubic yards of aggregate limestone would be used to build a road on the levee crown. A conveyance canal at a depth of -10 ft. NAVD88 would be situated along the levee. Floodwalls would be located under the I-10/I-55 interchange and other areas where space is limited. Nine floodwall sections would span 5,304 linear feet over the length of the system. The system would include 2,080 feet of drainage gates, 288 feet of roadway gates, two railway gates, and thirty-six pipeline crossings. Four pump stations would be located along the alignment to ensure the project does not adversely impact local drainage. Design parameters will be further refined during feasibility level design and analysis which may result in changes to the design parameters; however the TSP is anticipated to reduce risk for at minimum a 1 percent AEP storm event but not exceed a 0.5 percent AEP storm event.

The TSP would maintain hydrologic connectivity to the extent practicable through the use of water control structures except during closure for hurricane and tropical storm surge events. When the system is closed, pumps would operate on average for 1.7 storm events per year, which equates to closure of structures on average 8.5 days per year.

The structural alignment would directly convert approximately 856 acres to uplands including approximately 775 acres of hydric soils, 14.8 acres of water bottoms and 55.4 acres of prime farmlands. Approximately 8,424 acres of wetlands could be indirectly impacted due to enclosing the project area within the levee system. Further investigation is required to determine if cultural resources are located within any part of the footprint. Additional environmental investigations will be performed during feasibility-level design and analysis.

The estimated cost of the TSP is $880,851,070. The BCR for the TSP is equal to 1.63 to 1 with annualized net benefits equal to approximately $23,000,000.

5.1.1 Real Estate Requirements

A Real Estate Plan (REP) describing the real estate requirements and costs for the project can be found in Appendix C. The REP was prepared with estimated right-of-way (ROW) requirements based on available information. The REP and real estate cost estimates will be revised during feasibility-level design and analysis.

The estimated cost of real estate acquisition for structural features is $3,283,000. The alignment follows State-owned land and the property of approximately 120 owners. A standard perpetual levee easement for approximately 856 acres will be acquired for the construction of levees and floodwalls. A non-standard perpetual underground piling easement will also be acquired for all floodwalls. A standard Drainage Ditch Easement would be acquired for the areas needed for the conveyance canal. Borrow material for this project would come from the Bonnet Carré Spillway which is owned in fee by the Federal Government or from alternative sources not yet identified. A standard temporary work area easement will be acquired for staging areas. Mitigation land will be acquired in fee, excluding rights to minerals (with restrictions on use of surface). A non-material deviation will be made to the standard road easement to revise the rights necessary for a temporary non-exclusive road access (Appendix C).

The estimated cost of real estate acquisition for the non-structural feature is $81,417,000. Approximately 1,571 landowners may be impacted by this feature. The feature entails property acquisitions and structure raisings. At this time there has not been sufficient evaluation to determine particular structures to be included in the feature. A detailed evaluation of the work entailed in structure raising will be accomplished during the feasibility level design and analysis. At that time, the appropriate real estate interests to be acquired for non-structural measures will be determined, and the real estate costs will be refined. Displaced persons and businesses may be entitled to Public Law 91-646, Title II Relocations Assistance.

The total estimated cost of real estate for the project is $84,700,000. The CPRAB will have the responsibility of acquiring all necessary real estate interests for the project.

5.1.2 Relocation Assistance

Levee construction may cause relocations and/or temporary interruptions to pipelines. The existing carrier line would remain in operation while a bypass line would be constructed through a sleeve in the T-wall cutoff piles. When a bypass is complete and in place, the tie-in with the existing line would follow. Potential cost of this work is presented in Table 5-1. Detailed information will be developed during feasibility-level design and analysis.

Table 5-1: Unit cost of pipeline relocations.

Description	Estimated Quantity	Cost
≤6" Diameter	14	$515,000 each
>6" to ≤12" Diameter	16	$700,000 each
>18" to ≤24" Diameter	5	$1,550,000 each
> 24" Diameter	1	$1,920,000 each

5.1.3 Operation and Maintenance, Repair, Rehabilitation and Replacement

The purpose of operation and maintenance, repair, rehabilitation and replacement (OMRR&R) is to sustain the constructed project. The estimated annual OMRR&R cost is $4,128,075 (Table 3-4). This estimate will be further refined during feasibility-level design and analysis. After the

District Engineer provides notice of construction completion for the project, or functional portion of the project, the CPRAB will commence OMRR&R responsibilities associated with the project.

5.1.4 Benefit Analysis

Project Benefits

Models were run to determine the effects of storms on area resources. Hydrologic modeling results were developed to help establish the existing and future conditions and determine potential measures needed to address surge and storm-related damages. A database of values, types, and first floor elevations was developed for all structures in the area. This information was compared to the surge modeling to determine storm damages. Maps showing inundation of structures that could be damaged under FWP conditions will be developed.

Mitigation Plan Benefits

Habitat value analysis will be completed during feasibility-level design and analysis. Ecological model results will be combined with cost data to develop mitigation plans.

5.1.5 Risk & Uncertainty Analysis

Risk and uncertainty are intrinsic in water resources planning and design. This section describes various categories of risk and uncertainty pertinent to the study. Risk and uncertainty will be further considered during feasibility-level design and analysis.

5.1.5.1 Environmental Factors

Relative Sea Level Rise*:* There is uncertainty about how much sea level change (SLC) would occur in the region. Higher than estimated RSLR could cause salt water intrusion into the freshwater swamp causing significant changes to this habitat.

An assessment of RSLR was included in plan formulation and alternatives analysis. The evaluation of RSLR is documented in Appendix B and will be refined during feasibility level design and analysis. Calculations based on EC 1165-2-212 determined that the low, intermediate and high rates of RSLR at 2070 are 1.81 feet per year, 2.32 feet per year, and 3.95 feet per year, respectively (Table 2-2). The intermediate RSLR rate was applied.

RSLR could impact the benefits achieved by the TSP. Because the project was developed using the intermediate RSLR rate, the TSP would provide more benefits than anticipated should the low RSLR rate result and less benefits with the high RSLR rate. The non-structural component would be less effective because structures would have to be raised to a height that would increase their risk from wind damage during a storm.

Storms: Risks associated with the TSP are primarily related to the possibility of extreme weather events. The uncertainty of the size or frequency of storms and meteorological events, such as El Nino and La Nina, cannot be predicted over a set period of time. The storm record is constantly being updated and a large storm such as Hurricane Katrina or a slow moving storm such as Isaac can alter the expected return period for other storms. To reduce the uncertainties of storm events, storms with varying degrees of size, intensity, and path are included in the modeling. By using a long-term record of different storm scenarios, the effects of such storms are incorporated into the modeling. The team is then able to reduce the uncertainty in the determination of project benefits (Appendix B).

5.1.5.2 Engineering Factors

Levee/Structure Failure: The risk associated with the levee/structure system is its stability. Analysis of the earthen levee and associated T-walls and gates will be evaluated during feasibility-level design and analysis, and included in Appendix B. The levee and other features will be constructed to meet USACE standards.

Hydrologic Flows: There is uncertainty as to whether the levee system would potentially induce flooding internally and externally to the levee alignment. Modeling results will be analyzed during feasibility level design and included in the final report. Hydrologic modeling (ADCIRC and STWAVE) will show if the TSP could potentially induce flooding in these area and allow for more accurate engineering and design of the levee system. The project will incorporate features to mitigate for any potential induced flooding.

The risk of running the ADCIRC and STWAVE models is the assumption that the models appear to provide a specific response on the TSP in any given scenario; however it is only a representative point of reference in a complex system. While the analysis is enhanced by the models, application of the models can introduce error and uncertainty. Calibration and verification efforts are employed so that the models more closely replicate observed changes or at least provide insight into the limitations of the model.

Models are limited by basic, underlying assumptions and uncertainties. Some of the simplifying assumptions include the model parameters. A sensitivity discussion will be completed during feasibility-level design and analysis and included in Appendix B of the final report. Another uncertainty is that a limited number of storm scenarios are modeled. It is assumed that various storm scenarios over a number of years will represent a much higher indicator of the levees ability to withstand major storm events.

The models also use available historic data to extrapolate future storm conditions and frequency. The size and frequency of storms included in the model are based on statistical analysis but do not account for meteorological changes, such El Nino and La Nina effects, that can increase or decrease storms over a period of several years. Neither do the models account for the potential of increased storms due to climate change.

5.1.5.3 Economic Factors

The risk for economics is in under or overestimating the future benefits associated with the project alternatives. The with-project damages and overall benefits associated with the alternatives were estimated based on the existing and future without-project damages. This could potentially result in the TSP not being economically justified or preliminary estimates of the benefit cost ratios being overstated. A full economic analysis will be conducted during feasibly level design and documented in the final report. Additional uncertainty surrounding variables such as population growth, first floor elevations, structure value, depth damage relationships and additional inputs are consistent with typically accepted project uncertainty.

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.2.5a certified model was used to calculate the damages for the without project existing and future conditions. Economic and engineering inputs were necessary for the model to calculate damages for existing conditions (2012), the project base year (2020) and the final year in the period of analysis (2070). The inputs included structure inventory, future development, contents-to-structure value ratios, vehicles, first floor elevations and depth-damage relationships, ground elevations and without-project stage probability relationships.

The uncertainty surrounding each of the economic and engineering variables was 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.

5.1.5.4 Implementation Factors

Non-structural costs were based on a 100% structural survey of area improvements. Structures located in the 2020 and 2070 100-year floodplains were evaluated by comparing the cost of elevating the structure to the cost of acquiring the structure. The greater cost was used to determine an estimate of the cost of the non-structural feature. Relative sea level rise greatly impacts the number of structures to be raised, resulting in uncertainty as to how many structures would have to be raised. A minimum cost of the non-structural feature of $53,143,789 was developed based on the cost of reducing risk to structures in the 2020 100-year floodplain. A maximum cost of $305,256,794 was developed based on the cost of reducing risk to structures in the 2070 100-year floodplain. During feasibility level of design, the non-structural feature will be further evaluated by economic reach. The resulting evaluation may reduce the number of structures that would be included in the non-structural feature.

5.2 Implementation Requirements

5.2.1 Preconstruction Engineering and Design

Detailed design of the WSLP Project will be shared between CPRAB and the USACE. All detailed design will be in accordance with USACE's regulations and standards.

5.2.2 Construction and LERRD

Construction would be in accordance with the USACE's regulations and standards. Lands, easements, right-of-ways, relocations and disposal areas (LERRD) would be the responsibility of the CPRAB (Appendix C).

5.2.3 Cost Sharing

The State of Louisiana, acting through the PLD, is the non-Federal sponsor for the feasibility study. The cost-share during the feasibility phase is 50% Federal and 50% non-Federal. Following the feasibility phase, the CPRAB will be the non-Federal Sponsor for the planning, design, construction, operation, maintenance, repair, replacement and rehabilitation of the project. The cost share for the planning, design and construction of the project will be 65% Federal and 35% non-Federal. The CPRAB must provide all project LERRD required for the project. OMRR&R of the project would be a 100% CPRAB responsibility. A full description of the non-Federal and Federal responsibilities after the feasibility phase of the project is contained in Section 8.2 of this report. The OMRR&R costs are estimated to have a present value of $4,128,075 at 2012 price levels and include a 25% contingency. AM&M costs are not included in the estimate at this time; those costs will be included in the final report. Table 5-2 presents the cost apportionment.

Table 5-2: Cost apportionment of the TSP.

	Total	Federal	Non-Federal
PED	$7,500,000	$4,875,000	$2,625,000
Construction	$761,051,070	$557,500,446	$203,550,625
Pipeline Relocations	$35,100,000	-	$35,100,000
Lands, Easements, & ROW*	$84,700,000	$15,052,750	$69,647,250
Total First Costs**	**$888,351,070**	**$577,428,196**	**$310,922,875**

*** Federal costs are Administrative Cost of Non-Federal Sponsor Oversight**
**** Monitoring and Adaptive Management costs not included.**

5.3 Mitigation Plan

Although mitigation planning was integrated into the overall plan formulation process, implementation of the TSP requires compensatory mitigation for unavoidable project-induced

impacts that will require replacing or providing substitute resources. A mitigation plan for the TSP will be completed following the feasibility level design and analysis and will be included in the final report. Additional information is located in Appendix A.

5.4 Adaptive Management & Monitoring

Incorporation of AM&M activities into the mitigation plan will address ecological and other uncertainties that could prevent successful implementation of mitigation project measures. The AM&M Plan will establish a framework for decision-making that utilizes monitoring results and other information, as it becomes available, to update project knowledge and adjust mitigation management actions through adaptive management. Integration of AM&M into the mitigation project will ensure success under a wide range of conditions and enable implementing corrective actions in cases where monitoring demonstrates that the mitigation project or measures are not achieving ecological success. An AM&M plan will be developed and included as part of the mitigation plan in the final report. Additional information is located in Appendix A.

5.5 Views of the Non-Federal Sponsor

The PLD and the CPRAB support and recognize the importance of hurricane risk reduction in St. Charles, St. John the Baptist and St. James Parishes. This study is included in the 2012 Louisiana Comprehensive Master Plan for a Sustainable Coast and is supported by the Louisiana Congressional delegation. The USACE has worked as a team along with an interagency team and local stakeholders to develop a feasible comprehensive plan that would provide hurricane storm surge risk reduction to the citizens in the area. Construction of the proposed system would immediately allow for improved storm surge risk reduction in the three-parish area, which could potentially reduce life, health and safety risk to residents and interruptions to vital hurricane evacuation routes.

Figure 5-1: St. James Parish flooding after Hurricane Isaac.

APPENDIX C

Description of Project Alternatives A,C and D from *"West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study, Integrated Draft Feasibility Report and Environmental Impact Statement, August, 2013"*

Four plans with non-structural measures were carried forward and identified as follows:

Plan 9 + non-structural → **Alternative A**
Plan 10 + non-structural → **Alternative B**
Plan 11+ non-structural → **Alternative C**
Plan 12 → **Alternative D**

These alternatives were further evaluated considering alignments with respect to the I-10 corridor. Alternative B would not provide greater risk reduction for the evacuation routes than any of the other plans. Alternative B would reduce risk to the same number of structures as Alternative C but would enclose approximately 4,000 more acres of wetlands. Based on this, Alternative B was eliminated.

3.5 Final Array of Alternatives (*NEPA required)

The final array of alternatives carried forward for consideration included **the No Action Alternative**, **Alternative A**, **Alternative C**, and **Alternative D** (Figure 3-4). Engineering details on each can be found in Appendix B. Comparative details are shown in Table 3-2. The team assumed that Alternatives A, C, and D would provide equal levels of risk reduction. The least costly plan would have the highest net benefits. Analysis is based on a 1% AEP storm event.

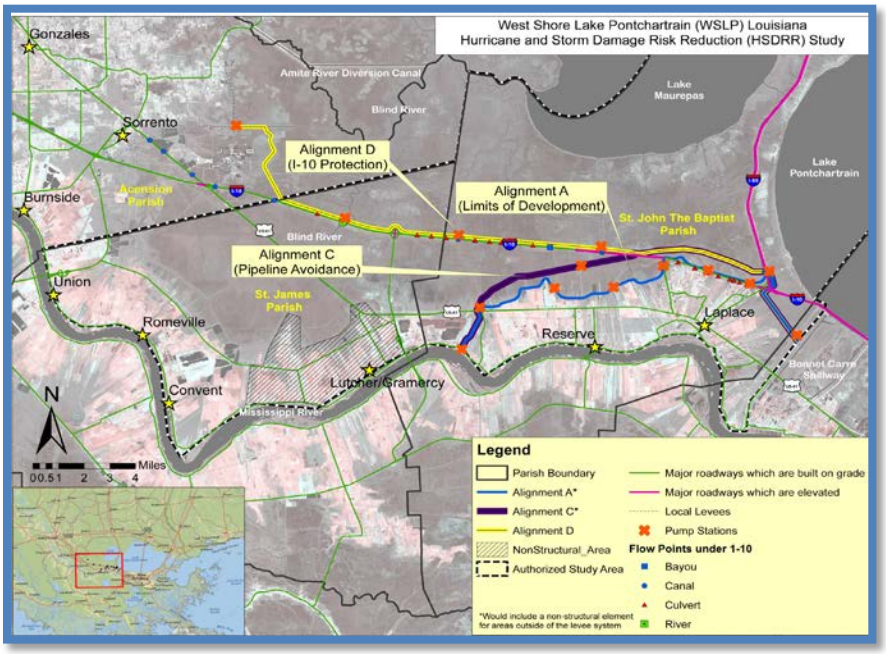


Figure 3-4: Final array of alternative plans.

No Action Alternative (Future without-project condition)

Under the No Action Alternative no risk reduction would occur. The area would continue to experience storm surge damage. This would be exacerbated by RSLR and increased impacts to wetlands due to salinity. As wetlands erode and subside, they would provide less risk reduction.

Table 3-2: Comparative details for final array of alternative plans.

Alternative	Length of Alternative	Size of Study Area Behind Alternative	Number of Structures Behind Alternative	Communities Behind Alternative	Miles of I-10 Behind Alternative	Wetlands Behind Alternative	Number of Pipeline Crossings
A	20 miles	38 sq miles	16,919	Montz, Laplace, Reserve, Garyville	4 miles	~5 sq miles	70
C	18 miles	47 sq miles	16,919	Montz, Laplace, Reserve, Garyville	4 miles	~16 sq miles	36
D	28 miles	160 sq miles	21,840	Montz, Laplace, Reserve, Garyville, Lutcher, Gramercy, Grandpoint	15 miles	~79 sq miles	14

Alternative A: Bonnet Carré Spillway to the Hope Canal to Mississippi River

Alternative A (Figure 3-5) would provide risk reduction to St. Charles, St. John the Baptist and St. James Parishes. The approximately 20.41-mile levee and floodwall alignment begins at the West Guide levee of the Bonnet Carré Spillway, north of transmission line and pipeline corridors and extends west around the interstate interchange and along the wetland/non-wetland interface. The alignment turns south near Hope Canal, until it reaches the Mississippi River Levee (MRL). Elevation and/or acquisition of structures outside of the alignment would reduce risk of storm surge-related damage in areas west of the Hope Canal.

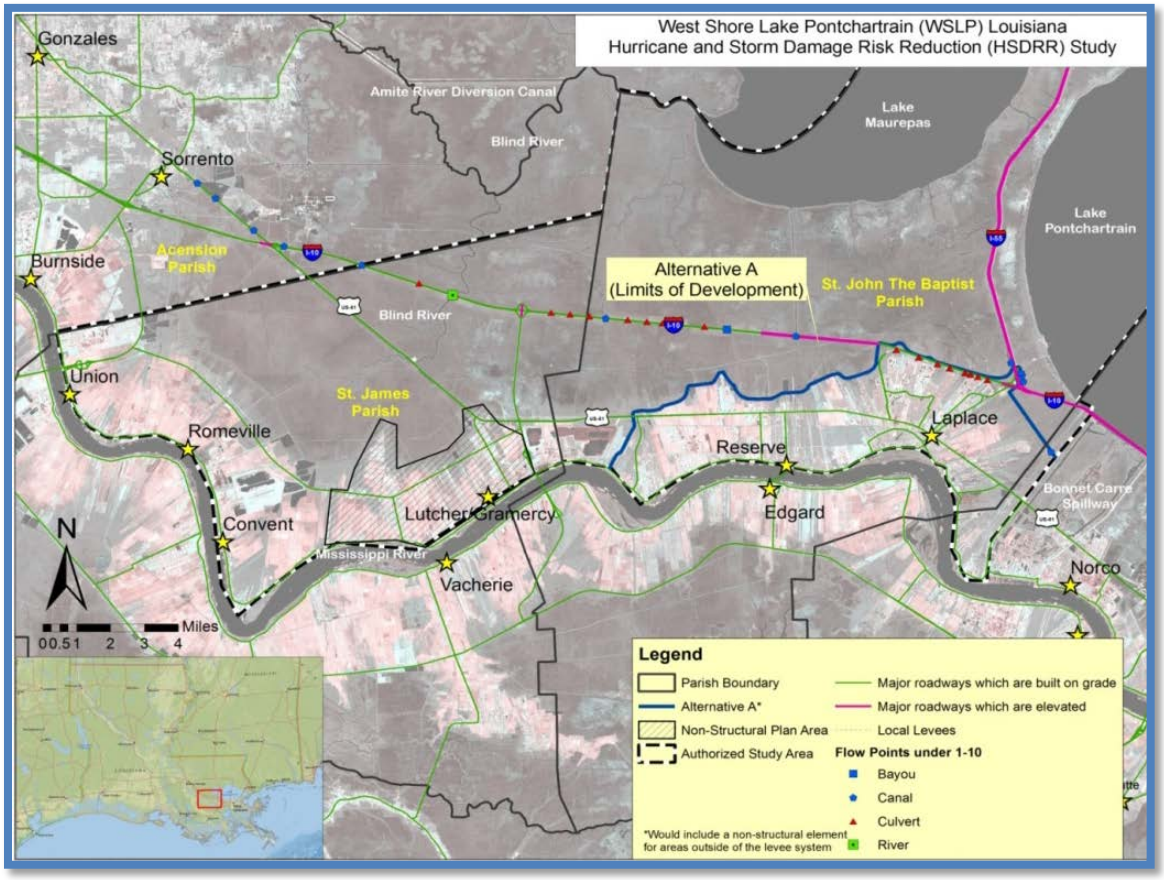


Figure 3-5: Alignment and features of Alternative A.

Construction would require roughly 3,100,000 cubic yards of earthen borrow material; 3,700,000 yards of geotextile fabric; 30,000 cubic yards of aggregate limestone road; nearly 5,000 linear feet of T-walls to cross under the interstate, or as frontal risk reduction for pump stations; 1,200 linear feet of flood gates; 240 linear feet of drainage gates; and 2 railroad gates. Eight pump stations on the alignment would require 25,000 cubic yards of concrete, 230,000 square feet of sheet pile, nearly 7,000 tons of riprap, and 151,000 linear feet of concrete piles. Multiple culverts with flap gates would be constructed. Because the alternative hugs the wetland/non-wetland interface, Alternative A has the least adverse wetland impacts. However, the plan has the greatest residual risk (the risks left after all construction and safety measures have been assessed) because overtopping of the levee by surge would cause immediate inundation of populated areas. It also has the most pump stations which results in more maintenance and greater risk of system failure. It is the least adaptable because expansion of the levee would require the purchase and/or relocation of existing structures. The plan does not reduce risk to infrastructure in St. James Parish.

Alternative C: Bonnet Carré Spillway to the Hope Canal to Mississippi River

Alternative C (Figure 3-6) evaluates the feasibility of avoiding multiple pipeline and utility crossings. It follows the Alternative A alignment between the West Guide levee of the Bonnet Carré Spillway to the US-51 interchange, where it then tracks north across US-51 and along a pipeline transmission corridor. The approximately 18.27-mile alignment crosses I-10 and follows the pipeline corridor through wetlands near the Belle Terre exit until it reaches Hope Canal. The alignment then turns south and extends to the MRL. Elevation and/or acquisition of structures outside the alignment would reduce risk of storm surge-related damage to structures in areas west of the Hope Canal.

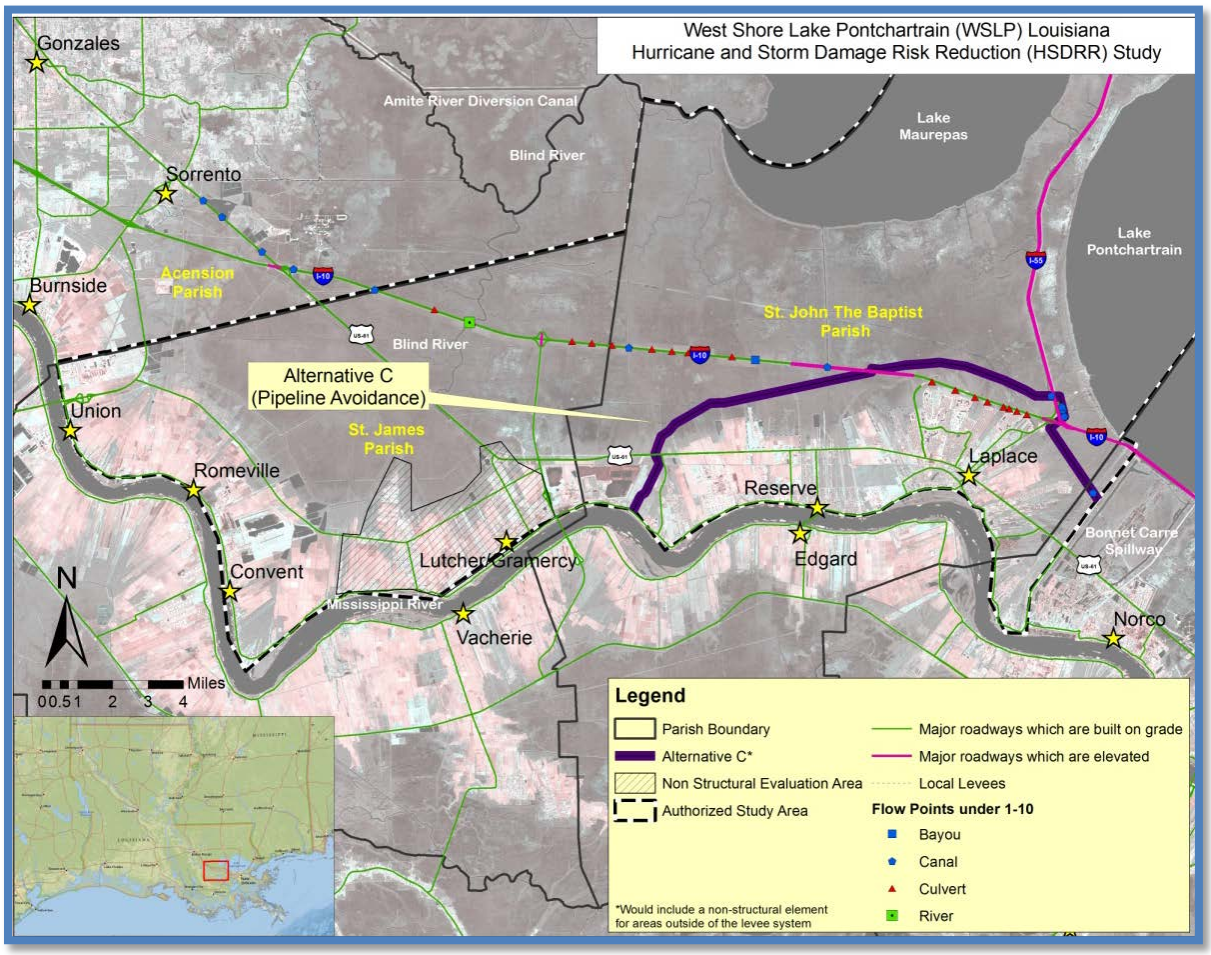


Figure 3-6: Alignment and features of Alternative C.

Construction of the alternative would require roughly the same amount of borrow material as Alternative A. It would require 3,365,000 cubic yards of geotextile fabric; nearly 26,000 cubic yards aggregate limestone road; 5,300 linear feet of T-walls; 300 linear feet of flood gates; 200 linear feet of drainage gates; 4 pump stations; and 2 railroad gates. Environmental structures similar to those identified for Alternative A would be built. This alternative encloses more wetlands than Alternative A, and would require more environmental structures, but has less residual risk because levee overtopping would not immediately inundate populated areas. It is more adaptable should changing conditions require modifications to the structures because the alignment does not abut existing structures. However, the plan does not reduce risk to infrastructure in St. James Parish.

Alternative D: Bonnet Carré Spillway to Ascension Parish

Alternative D (Figure 3-7) is a westward extension of the Alternative C alignment along the I-10 corridor into Ascension Parish. It continues west at the St. James Parish line slightly north of I-10 until it reaches the Old New River, where it proceeds north to the non-Federal Laurel Ridge levee in Ascension Parish. Measures to maintain water flow and to reduce impacts to enclosed wetlands would be built. Alternative D reduces risk to communities in St. Charles, St. John and St. James Parishes and provides a level of risk reduction to a segment of the I-10 hurricane evacuation route.

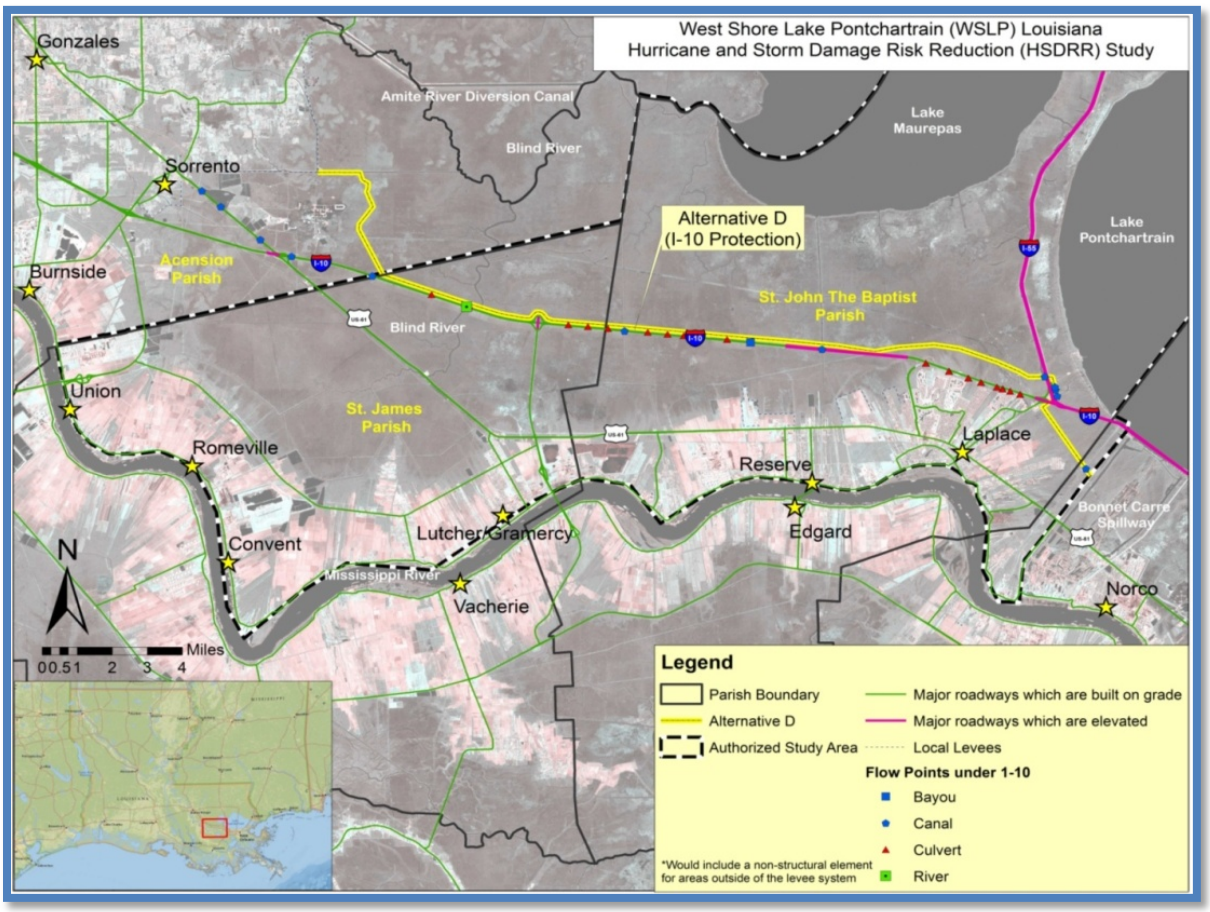


Figure 3-7: Alignment and features of Alternative D.

Construction of the approximately 28-mile alternative would require 3,700,000 cubic yards of borrow material, 3,037,000 square yards of geotextile fabric; approximately 37,000 cubic yards of aggregate limestone road; just over 4,000 linear feet of T-walls; 300 feet of flood gates; 400 feet of drainage gates; approximately 6 pump stations; nearly 24,000 cubic yards of concrete; almost 200,000 square feet of sheet pile; approximately 5,900 tons of rip rap; 154,000 linear feet of concrete piles; and environmental structures, most notably at Blind River, a Louisiana Scenic River. It encloses the most acres of wetlands requiring more environmental structures than any of the other alternatives. Each of these structures would require maintenance because failure of the environmental structures could increase adverse environmental impacts. The greater number of structures results in more maintenance and a greater risk of failure. There is concern about potential impounding of large areas of wetlands under this alternative, especially if the river diversion projects are constructed. Alternative D provides the greatest structural risk reduction and would reduce risks to roads and other infrastructure in St. James Parish.

3.6 Cost Estimates

Estimated costs for levees, floodwalls, and pump stations; real estate costs; operation and maintenance, repair, rehabilitation and replacement (OMRR&R); environmental mitigation; and non-structural features were totaled for each alternative and compared to each other to help identify a TSP. Costs for the non-structural features of Alternative A and Alternative C, and costs associated with mitigation for indirect impacts are uncertain. For this reason, a range of costs was developed for each feature.

Non-structural Cost: Non-structural costs were based on a 100% structure survey of area improvements. The cost of raising and/or acquiring structures located in the 2020 and 2070 100-year floodplains was evaluated by comparing the cost of elevating the structure to the cost of acquiring the structure. The lesser cost was used to determine the cost of the non-structural feature. RSLR greatly impacts the number of structures to be raised, resulting in uncertainty as to how many structures would have to be raised by any given date. A minimum cost of the non-structural feature of $53,143,789 was developed based on the cost of reducing risk to structures in the 2020 100-year floodplain. A maximum cost of $305,256,794 was developed based on the cost of reducing risk to structures in the 2070 100-year floodplain. The maximum cost was used for comparison.

Indirect Impact Cost: At this stage, mitigation costs for indirect impacts remain uncertain due to limited hydrologic information and lack of a full wetland value assessment (WVA). To reduce the uncertainty of costs associated with mitigating for indirect impacts, a maximum cost based on Morganza to the Gulf and Lake Pontchartrain and Vicinity project estimates, and a minimum cost based on local mitigation bank costs were developed. These costs were averaged. In place of WVA analysis, habitat reduction values from 5 - 75 percent were calculated. Using these values, the average estimated mitigation cost associated with indirect impacts ranged from $871,000,000 to $980,000,000 for Alternative A, $844,000,000 to $1,000,000,000 for Alternative C, and $672,000,000 to $2,200,000,000 for Alternative D.

Based on available information, the habitat reduction value impacts are estimated to be approximately 15 percent of the total enclosed wetlands, as shown in Table 3-3. The risk reduction features will be designed to maintain existing hydrologic flows to the extent practicable. If this can be achieved, indirect impacts would be limited to those that occur during closure of structures for storm surge events – an estimated 8.5 days per year. A WVA analysis based on hydrologic modeling will be conducted on the TSP during feasibility design.

Table 3-3: Estimated first costs for final array of alternative plans.

	Alternative A	Alternative C	Alternative D
Levees & Floodwalls	$335,898,670	$334,156,997	$339,508,346
Pump Stations	$132,162,500	$112,687,500	$166,437,500
Pipeline Relocations	$70,300,000	$35,100,000	$11,693,750
Real Estate	$3,849,000	$3,283,000	$2,434,000
Direct Habitat Impacts	$17,000,791	$35,710,811	$43,323,364
Indirect Mitigation Cost (15%)	$23,123,679	$54,655,968	$327,687,626
Non-Structural 2070*	$305,256,794	$305,256,794	$0
Total Cost	**$887,591,434**	**$880,851,070**	**$891,084,586**

***Some non-structural costs will be LERRD costs that are the responsibility of the NFS. The non-structural costs will be spread over the entire period of analysis and will be heavily discounted and result in less than 17% of the total average annual costs.**

OMRR&R Cost: Table 3-4 provides preliminary OMRR&R cost estimates for each alternative. Annual costs will be refined during feasibility level design and analysis. Upon notice of

completion of construction of the project, or a functional portion of the project, the CPRAB shall commence OMRR&R responsibilities for the project (Chapter 8).

Table 3-4: Comparison of annual OMRR&R cost for final array of alternative plans.

Alternative	Levee Grass Cutting		Structure OMRR&R ($)	Total OMRR&R ($)
	(acres)	($)		
Alternative A	390	$234,000	$7,277,050	$7,511,050
Alternative C	868	$520,800	$3,607,275	$4,128,075
Alternative D	1269	$761,400	$5,421,538	$6,182,938

NOTE: Based on levee right-of-way acreage, 2012 dollars, and includes a 25% contingency. OMRR&R costs for mitigation are not included. Cost include grass cutting; pump station and flood gate replacement; and other planned OMRR&R activities.

3.7 Summary of Accounts and Comparison of Alternatives

Plans in the final array are assumed to provide equal levels of risk reduction. To facilitate evaluation and comparison of the alternatives, four Federal Accounts were used to assess the effects of alternatives. The accounts are National Economic Development (NED), Environmental Quality (EQ), Other Social Effects (OSE), and Regional Economic Development (RED).

No Action Alternative: No NED benefits would be associated with the No Action Alternative. There would continue to be adverse impacts to the EQ as salinity levels increase in the area, affecting wetlands and eventually causing impacts to residents (OSE) in the immediate vicinity of the study by reducing the natural swamp buffer. Reducing the natural buffer could also cause uncertainty to RED by impacting major oil refineries in the region and the overall economy.

Alternative A: Alternative A provides NED benefits, but provides less net benefits than Alternative C. It encloses the fewest acres of wetlands, resulting in the least adverse impacts to EQ. However, it risks immediate inundation of developed areas in an overtopping event; thus reducing safety to residents (OSE) in the area. It limits future modification or reinforcement of the system due to its proximity to existing structures. It would also risk disruptions to the local drainage patterns northward if design parameters are exceeded. (Figure 3-8). While Alternatives C and D would disrupt existing drainage if design parameters are exceeded, the damage resulting would be greatest for Alternative A due to

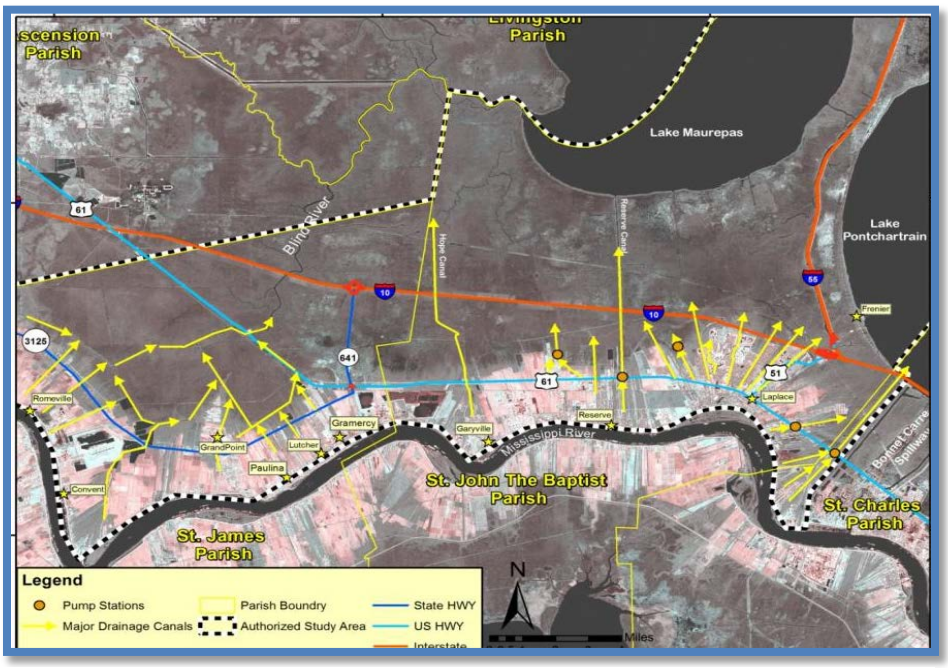


Figure 3-8: Study area drainage patterns.

the close proximity of the levee to existing structures. There is no risk reduction to roads in St. James Parish which could flood, preventing employees from accessing vital industries.

Alternative C: Alternative C maximizes benefits. It has more adverse impacts on EQ than Alternative A but reduces impacts to wetlands compared to Alternative D. In case of a major storm surge event that exceeds the federally authorized project design, Alternative C could reduce the risk to OSE because storm surge would, over time, first fill in the wetlands before potentially inundating developed areas. Because this alternative addresses an uncertain yet reasonably foreseeable need to modify the system, it could provide stability to RED in developed areas. The alignment can be enlarged should RSLR be greater than anticipated without displacing area residents. There is no risk reduction to roads in St. James Parish.

Alternative D: Alternative D provides NED benefits, but does not maximize those benefits. It provides risk reduction to a larger area thus reducing risk to more area residents. Structural risk reduction is provided to roads in St. James Parish, reducing the risk that employees would be unable to access critical infrastructure and places of employment. Additionally, because the levee is not located in close proximity to existing structures, the threat of flooding due to exceedence of design parameters is lessened. Alternative D poses potential uncertainties concerning the impoundment of large areas of wetlands, especially if the river diversion projects are constructed. While it would prevent saltwater intrusion, it would risk impacting hydrology by enclosing approximately 54,800 acres of swamp and would impact the EQ of the Maurepas WMA as well as Blind River, a Louisiana Scenic River. Per the Wild and Scenic River Act, construction within 100 feet of a scenic stream requires a permit.

Economic Costs Comparison: The parametric implementation costs were annualized using the current interest rate (3.75%) and a 50 year period of analysis (2020-2070) as shown in Table 3-5. In 2020, only 5% of the benefits are derived from St. James Parish and only 219 structures are located within the 100-year floodplain. The cost of the non-structural feature for Alternatives A and C increases from approximately $53,000,000 (in year 1) to over $305,000,000 (in year 50) due to RSLR. Most of the structures would not reside in the 100-year floodplain until the later years of the period of analysis. Because of this, the non-structural costs were spread evenly over a 53-year period beginning in 2017 and ending in 2069; and then compounded or discounted to the 2020 base year. The annual benefits were compared to the cost assuming a 100-year level of risk reduction. The total annual benefits were then compared to the total annual costs.

Table 3-5: Economic comparison of final array of alternative plans.

Alternative	Implementation Costs ($ millions)	Annual OMRR&R ($ millions)	Equivalent Annual Benefits ($ millions)	Annual Costs ($ millions)	Benefit-to-Cost Ratio	Annualized Net Benefits ($ millions)
A	887.6	7.5	59.9	40.5	1.48	19.4
C	881.0	4.1	59.9	36.8	1.63	23.0
D	891.1	6.2	59.9	46.7	1.28	13.2

Alternative C has the lowest cost and the highest net benefits followed by Alternative A and Alternative D. The preliminary benefit to cost ratio (BCR) for Alternative C is equal to 1.63 to 1 with annualized net benefits of approximately $23,000,000. For Alternative A the BCR is 1.48 and for Alternative D it is 1.28 with net benefits of $19,400,000 and $13,200,000, respectively.

Hydrologic information is limited, so estimates were not developed to evaluate the number of environmental structures that would be required for the alternatives. The inclusion of environmental structures could greatly increase the cost of Alternative D, which encloses 79 square miles of wetlands, in comparison to Alternative A (5 square miles) and Alternative C (15 square miles). Benefits such as reductions in emergency costs and damage to roadways have not been calculated and would expect to be greatest for Alternative D and the least for Alternative A. These benefits are usually minimal and would not impact the selection of the TSP.

Alternative A tracks the wetland-non-wetland interface in Laplace to its termination at the Hope Canal in western St. John the Baptist Parish. It requires the largest number of pump stations (8 pump stations) compared to Alternative C (4 pump stations) and would require approximately $7,500,000 in OMRR&R cost to maintain the fully constructed alternative compared to $4,100,000 in OMRR&R for Alternative C. If overtopped, Alternative A would allow immediate inundation at developed areas and I-10, resulting in the greatest residual risk.

3.8 Identifying the Tentatively Selected Plan

Alternative C is the tentatively selected plan (TSP) and the NED plan as determined by the evaluation criteria. It fulfills the planning objectives stated in Section 1.5. It reasonably maximizes net benefits, consistent with protecting the Nation's environment in accordance with national environmental statutes, applicable Executive Orders, and other Federal planning requirements.

APPENDIX D

Project Functions and Current Issues

The following list of ***project functions*** were identified and considered as a basis for possible improvement to the current project plan:

Protect Life/Property	Sustain Commerce
Block Surge	Remove Water
Drain Rainfall	Maintain Drainage
Convey Flow	Place Barrier
Lift Water	Prevent Backflow
Reduce Overtopping	Prevent Breaching
Dissipate Energy	Prevent Erosion
Maintain Pipeline Commerce	Elevate Structure
Protect Structures	Relocate Structures

Current project issues as reported by the project managers are:

- Design and decision data is limited by new Smart Planning guidance
- Non-structural measures difficult to quantify and incrementally justify
- Project is politically sensitive; public perception and desire for maximum structural alternative
- Controversy with determination of environmental impacts versus potential benefits when addressing wetlands and swamp that would be on the protected side of the levee.