PRELIMINARY DESIGN REPORT
LABRANCHE CENTRAL MARSH CREATION PROJECT
(PO-133)

ST. CHARLES PARISH, LOUISIANA
August 2020

CPRA
Coastal Protection and Restoration Authority of Louisiana

USDA United States Department of Agriculture
Natural Resources Conservation Service

Preliminary Design Document
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License Number 26385

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

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1.0 INTRODUCTION

The LaBranche Central Marsh Creation Project PO-133 is located in the Pontchartrain Basin south of the Canadian National Illinois Central Railroad running parallel to Interstate 10 as shown in Figure 1. The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Task Force approved PO-133 LaBranche East Marsh Creation for engineering and design as part of the 21st Priority Project List in January 2012. The United States Department of Agriculture – Natural Resources Conservation Service (NRCS) was designated as the lead federal sponsor for this project with funding approved through CWPPRA by the United States Congress, and the Wetlands Conservation Trust Fund by the State of Louisiana. The State of Louisiana's Coastal Protection and Restoration Authority (CPRA) is serving as the non-federal sponsor. NRCS is the lead agency on engineering and design of the project. NRCS's standards and procedures for design will be used.

Figure 1. Phase 0 Project Area

The goal of the project is to restore marsh that converted to shallow open water. Project implementation would result in an increase of fisheries and wildlife habitat acreage and diversity, and improvement of water quality. The proposed project will provide a protective wetland buffer to the railroad and Interstate 10 (I-10), the region's primary westward hurricane evacuation route, and complement hurricane protection measures in the area.

Dredging of access and flotation canals for the construction of I-10 increased salinity and altered hydrology by converting wetland vegetation into shallow open water bodies. Without action, these effects will continue to worsen, deepening the area. Creating and

nourishing the marsh will aid in prevention of land loss by reducing tidal exchange through the area and providing a platform for growth of emergent vegetation. The project would also provide synergistic benefits with several other protection and restoration projects in the immediate vicinity. Directly to the northwest of the proposed project is the PO-17 Bayou LaBranche Marsh Creation project, the first CWPPRA project to successfully build marsh using dredged material. North of the project is the approved PO-75 LaBranche East Marsh Creation Project and the completed PO-3b LaBranche Shoreline Protection Project. In addition, the U.S. Army Corps of Engineers has several hurricane protection efforts in the area. All of these projects will help to protect the vulnerable I-10 corridor and Canadian National Illinois Central Railroad just south of I-10.

The restoration strategy for this project is hydraulic dredging for marsh creation and marsh nourishment. The proposed marsh creation/nourishment will be achieved by mining sediment from Lake Pontchartrain to fill open water and mud flat areas. Based on a 2011 USGS aerial photography analysis, approximately 670 acres of marsh will be affected, with 591 acres of open water filled as marsh creation, and 79 acres of existing fragmented marsh nourished as a result of the project.

The project team, consisting of members of NRCS and CPRA, held a kick-off meeting in 2012. At that meeting, the approved project plan was discussed, and a schedule was developed to identify and address all of the project requirements and milestones. The engineering and design, environmental compliance, real estate negotiations, operation/maintenance planning, and cultural resources investigations have been completed to the 30% level as required by the CWPPRA Standard Operating Procedures.

Topographic and magnetometer surveys and a geotechnical investigation have been completed for the marsh fill area and for the borrow areas. All elevation data was converted or surveyed using Geoid 03. This information was used to calculate volumes of material required and to evaluate the immediate and long-term properties of the marsh fill material. Additionally, an analysis has been performed to determine mean high water, mean low water, and mean water elevations in the fill area.

2.0 ENVIRONMENTAL CONSIDERATIONS

One of the main purposes of LaBranche Central Marsh Creation Project (PO-133) is to restore the intermediate marsh that has been converted to shallow open water. Project implementation would result in an increase of fisheries and wildlife habitat acreage and diversity and improvement of water quality. The proposed project would increase storm buffer protection to I-10, the region's primary westward hurricane evacuation route, and the Canadian National Illinois Central Railroad line.

The project area is primarily shallow open water classified as intermediate salinity. Submerged aquatic vegetation is prevalent throughout. The dominant species is *Ruppia maritima* (widgeongrass) with *Myriophyllum spicatum* (watermilfoil) dispersed throughout.

Salinity in the project area is based on the CRMS 2830 monitoring site located northwest of the project area on the north side of the railroad track and interstate. The site is characterized as intermediate marsh with dominant taxa listed as *Spartina patens* (marshhay cordgrass).

These environmental parameters were taken into consideration to determine the benefits of creating and nourishing the marsh. Past projects around the area were analyzed to determine if a marsh creation project would be successful. For more information on the environmental considerations of PO-133 LaBranche Central Marsh Creation Project see Appendix G (WVA Document).

3.0 CULTURAL RESOURCES / LANDOWNERSHIP CONSULTATION

Consultation was undertaken pursuant to Section 106 of the National Historic Preservation Act (NHPA) (54 U.S.C. 300000) and it's implementing regulation *Protection of Historic Properties* (36 CFR 800). The NRCS made a reasonable and good faith effort to determine if historic properties would be affected by this undertaking (36 CFR 800.4(b)(1). Background research consisted of review of the GIS database, archaeological site files, and cultural resources survey files maintained by the Louisiana Division of Archaeology. This review determined that no previously identified archaeological sites were in the project's Area of Potential Effect (APE). This review also determined that two cultural resource surveys had been conducted in the eastern one-third of the APE (Louisiana Report Numbers 22-0047 and 22-2955).

The NRCS initiated Section 106 consultation with the Louisiana State Historic Preservation Officer (SHPO) and the Tribal Historic Preservation Officers (THPOs) of federally recognized Indian tribes that have declared an Area of Interest (AOI) in the State Of Louisiana that encompasses the project's APE on June 8, 2018 [54 U.S.C. 302706; 36 CFR 800.2(c)(1), 800.2(c)2(ii), 800.3(a)]. Federally recognized Indian tribes with an AOI that encompassed the APE include the Alabama-Coushatta Tribe of Texas, Chitimacha Tribe of Louisiana, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Jena Band of Choctaw Indians, and the Tunica-Biloxi Tribe of Louisiana. Documentation sent to the Louisiana SHPO and THPOs included a two-page letter that described all aspects of the planned project, a general project map, and a project plan map that illustrated all planned construction items (36 CFR 800.11). The NRCS also submitted a preliminary determination for review and comment that the planned project would not adversely affect any historic properties and requested that the project be allowed to proceed without any additional cultural resources investigation.

The Louisiana SHPO acknowledged receipt of the Section 106 documentation on June 8, 2018 and concurred with the preliminary determination that no historic properties would be adversely affected by this undertaking and the project could proceed as planned on June 29, 2018. Choctaw Nation of Oklahoma also concurred with the preliminary determination that no historic properties would be adversely affected by this undertaking and the project could proceed as planned on July 9, 2018. Choctaw Nation of Oklahoma

requested that all work on the project be stopped if Native American artifacts and/or human remains were discovered during construction. The NRCS did not receive any correspondence from the remaining federally recognized Indian tribes consulted within the 30-calendar day review period.

NRCS and CPRA have also conducted landownership investigation of the project area. The major landowner identified for the project is Monteleone, Willian A et al. CPRA is acquiring land rights for the project and will assign these rights to NRCS prior to construction, if the project is approved for Phase II funding.

4.0 PIPELINE, RAILROAD, AND SCENIC STREAM COORDINATION

NRCS has contacted all owners/operators of pipelines within the borrow area and the marsh creation area and will continue to update companies as the design progresses toward construction. A Royal Dutch Shell, P.L.C. pipeline crosses through the marsh placement area. NRCS has coordinated with Shell personnel during the design to ensure that the pipeline located within the marsh creation area isn't damaged or unearthed during construction.

NRCS has also contacted the representative of the Canadian National Illinois Central railroad company to coordinate dredge pipeline placement and routes. Agreements such as a railroad representative on site during placement and removal of dredge pipeline will be included in the construction specifications.

Bayou LaBranche is classified as a Louisiana Natural and Scenic Stream. Consultation with the Scenic Rivers Coordinator was held to determine what restrictions and requirements were needed during construction. As a result of this coordination the access route through Bayou LaBranche will not be used due to concerns over potential damage to the water bottoms and banklines of the scenic stream. A route through the PO-75 project area will be used instead. The project will still coordinate with the Scenic Streams Coordinator to determine if the stream can be crossed with equipment for access to the project area. At this time, a verbal agreement has been reached with the request to limit damage to the smallest degree possible. Further clarification and written agreements will be finalized before the Phase II request.

All restrictions or agreements made with pipeline and railroad companies, and with the Scenic Stream Coordinator will be detailed in the special provisions of the specifications.

5.0 TIDES AND WATER LEVELS

Calculations performed during the design of PO-133 LaBranche Central Marsh Creation include the determination of the mean high, mean low water, and mean water elevations (NAVD 88) for CRMS 2830 using data from 2008 to 2017. All elevations used in the calculations are referenced to Geoid 2003. The water levels from CRMS 2830 were also used to calculate the inundation at 90% and 10%, which is recommended by CPRA's

Marsh Inundation Methodology and Guidance for the Design of Marsh Creation Projects for a marsh that is determined to be of intermediate salinity. The eustatic sea level rise (RSLR) was calculated using CPRA's RSLR spreadsheet. The inundation of the marsh is critical to ensure that the project is designed and built to sustain a healthy marsh and allow appropriate tidal exchange. The calculations for the eustatic sea level rise for PO-133 are shown in Table 1. The 1.0-meter scenario was used based on the 2017 Coastal Master Plan. An accretion rate (0.48 in/year) determined from CRMS 2830 for the area, is greater than the estimated subsidence from CPRA's RSLR spreadsheet (0.20 in/yr). Because the accretion rate is greater than the subsidence rate, subsidence will be offset by accretion and only eustatic sea level rise rate will be applied to the water data when determining fill height. Table 2 is the calculated water level and inundation after construction using CRMS 2830 site for PO-133 project. A more detailed summary of these calculations is located in Appendix D under the spreadsheet labeled Design Calculation and Quantities.

Table 1: Eustatic Sea Level Rise using CPRA's RSLR Spreadsheet

Eustatic Seal Level Rise	**Eustatic Sea Level (from 1992)**			**Project Estimated ESLR**	
	Year 0 (feet)	Year 20 (feet)	Year 50 (feet)	20-yr RSLR (feet)	50-yr RSLR (feet)
Historical Linear Rate by 2100	0.2480	04252	0.6909	0.1772	0.4429
0.5 meters by 2100	0.2940	0.5603	1.0476	0.2663	0.7536
1.0 meters by 2100	0.4042	0.8843	1.9032	**0.4800**	1.4990
1.5 meters by 2100	0.5145	1.2083	2.7589	0.6938	2.2444
1.98 meters by 2100	0.6204	1.5194	3.5803	0.8990	2.9599

Table 2. Water Level and Inundation with Eustatic Sea Level Rise

Calculated Values	**ELEV. FT NAVD 88, Geoid 03**
Mean High Water from CRMS 2830 (Construction Start Year 2020)	1.20
Mean Low Water from CRMS 2830 (Construction Start Year 2020)	0.21
Mean Water Level from CRMS 2830 (Construction Start Year 2020)	0.75
Mean Range from CRMS 2830 (Construction Start Year 2020)	1.00
10% Inundation of marsh (Construction Start Year 2020)	1.57
90% Inundation of marsh (Construction Start Year 2020)	-0.01
10% Inundation of marsh at year 20	2.05
90% Inundation of marsh at year 20	0.47

6.0 SURVEYS

Topographic, bathymetric, and magnetometer surveys were completed within the marsh fill area to facilitate the design of the project. Both PO-75 and PO-133 will utilize the same borrow area. The bathymetric and magnetometer surveys of the borrow area were previously performed for PO-75 in Lake Pontchartrain.

6.1 Secondary Monument

An existing secondary monument was located near the PO-133 project site and was used for vertical and horizontal control for the surveys (Table 3). The monument data sheets can be found in Appendix A.

Table 3. Existing Secondary Monument

Station Name	876 2372 F TIDAL
Northing	565201.15
Easting	3586265.26
Latitude	30° 03’02.36539” N
Longitude	090° 22’04.43653” W
NAVD 88 Elevation	1.71 feet (0.520 meters)
Geoid	2003

6.2 New Secondary Monument

A new monument PO-75-SM-01 was installed in June 2017. This monument will serve as another control for PO-133 LaBranche Central Marsh Creation for both the marsh creation area and the borrow area during construction. The monument details are shown in Table 4. The monument data sheet can be found in Appendix A.

Table 4. New Secondary Monument

Station Name	PO-75-SM-01
Northing	5673471.754
Easting	3585346.929
Latitude	30° 03’23.63147” N
Longitude	090° 22’14.68128” W
NAVD 88 Elevation	4.376 feet (1.33 meters)
Geoid	2003

6.3 Fill Area Surveys

NRCS contracted T. Baker Smith in 2013 to perform all magnetometer surveys for the proposed project. The purpose of the magnetometer survey is to locate any unknown

pipelines not identified through permits and any other metallic objects that could cause harm or delay the project during construction. The magnetometer surveys were completed in June 2013 and NRCS will have the construction contractor perform magnetometer surveys prior to construction to verify original surveys and/or identify any new pipelines or metallic objects. The magnetometer surveys in the marsh creation area showed a Shell Pipeline along the railroad and then turning south in the project area and a Gulf South Pipeline running north-south on the west side of the project as shown by Figure 2. Magnetometer recordings showed a low magnetism and through probing in the field various objects were located i.e., tin, duck blinds and in some cases, nothing was located. A Klein Model 3000 side scan sonar and a Marine Magnetics SeaSPY marine magnetometer with a Trimble Model DSM 232 global positioning receiver was used to perform the magnetometer survey. Control for all surveys used for design was monument 876 2372 F TIDAL. All of the information found during the magnetometer survey can be found in Appendix B.

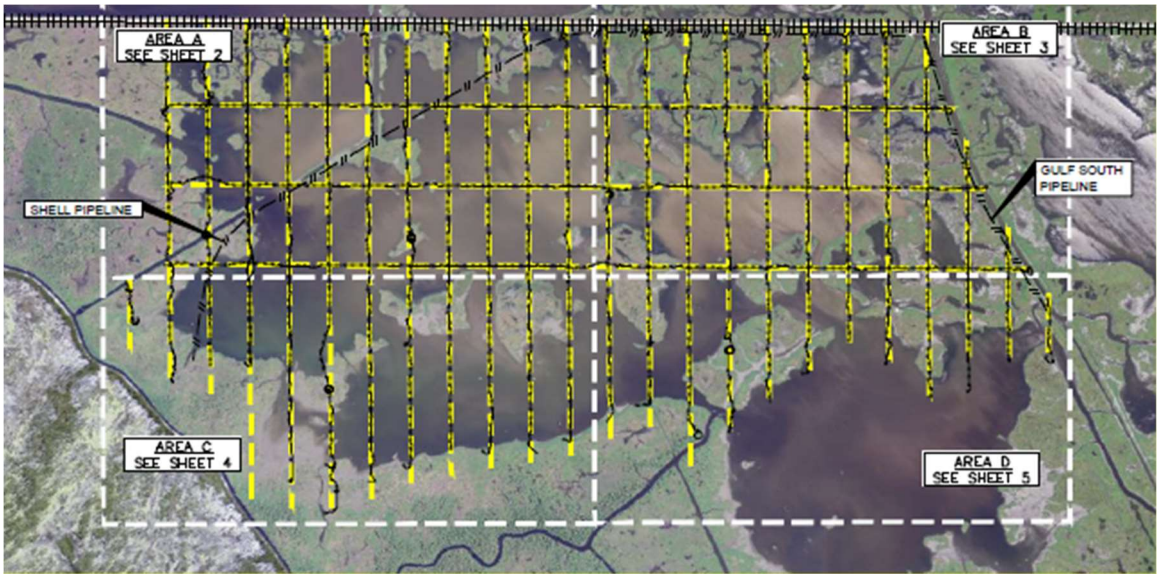

Figure 2. Magnetometer Survey of Pipeline in Project Area

NRCS performed in-house topographic surveys in 2013 of the marsh creation area to coincide with the T. Baker Smith magnetometer data. The surveys were conducted in the same time frame as PO-75 surveys and in 2017 NRCS conducted verification surveys for PO-75 and PO-133 to confirm that the data is still valid for the project. The topographic surveys allow the project team to determine the best location for the containment dike while either avoiding or limiting areas that could cause issues during construction of the containment area. The equipment used to collect the topographic data was a Trimble RTK system with Trimble Data collector. The equipment used was selected to ensure compatibility with the T. Baker Smith magnetometer surveys. The survey baseline was established through the proposed marsh creation area in a southwest - northeast orientation. The survey transects for the topographic surveys intersect the baseline at 500-foot intervals.

Elevations were recorded at 25 foot intervals or less when topographic features that may have an influence on the project were discovered. Thirty one additional surveys were taken at various bayous, cuts, and tidal openings connected to the marsh creation area. The survey team took surveys of the marsh bottom, marsh edge and any tidal creeks that could impact the design. The survey team also surveyed the scenic stream in case the stream would be used as a pipeline corridor or equipment access route.

The containment dike was aligned on the marsh edge to help stabilize the dike. An area of concern from a design and construction stand point is the channel that separates the two marsh creation cells; this portion of the two containment dikes will be aligned with the remnant spoil banks. To reduce the chance of failure where the containment dike crosses smaller channels, the containment dike was aligned to the channel's narrowest point possible. The average marsh elevation across the project area was calculated to be 0.64 feet elevation. The survey reports are located in Appendix B.

6.4 Borrow Area Surveys

A bathymetric survey was performed in 2013 within the proposed Lake Pontchartrain borrow area for PO-75. The PO-133 project will use the same borrow area. The bathymetric surveys were completed using a 24-foot survey vessel and data was collected using Hydrotrac digital echo sounder with HYPACK MAX survey navigation software in conjunction with the Trimble RTK GPS unit. The water bottom elevation ranges between -5 ft to -12 ft.

Magnetometer surveys were performed in an east west configuration at 250 ft intervals within the borrow area. A total of 284 magnetic anomalies were reported in the survey area, with the majority of these anomalies determined to be crab traps placed by local fishermen. The survey confirmed the location of the Shell Pipeline Company pipeline that was reported in the LDNR pipeline data base. The survey located two pipelines not reported in the LDNR data base (Air Products and Chemicals, Inc. and an unknown owner pipeline). The survey did not locate the Wilprise Pipeline Company pipeline that was reported in the LDNR data base. Additionally, there is a Tri-States NGL LLC pipeline running east-west approximately 1,000 feet north of the borrow area. The construction drawings will identify 100-foot buffer zones on both sides of all referenced pipelines to buffer the dredge from the pipelines. Details of these surveys are located in Appendix B.

7.0 GEOTECHNICAL EVALUATION

In order to determine the suitability of the soils in the PO-133 LaBranche Central Marsh Creation Project area for the proposed marsh creation feature, geotechnical subsurface investigations and analyses were completed in April 2014. Soil borings were gathered for the marsh creation area, using the information from Geotechnical report for PO-75 LaBranche East Marsh Creation Project for the borrow area and performed laboratory tests to determine soil characteristics on those samples. In addition to standard laboratory testing, column settling tests and self-weight consolidation tests were completed to further

analyze material behavior. Following all testing, analyses were completed to determine consolidation of the marsh fill material, stability of the containment dikes, settlement of the containment dikes, and borrow to fill ratios for dredge and fill operations.

A pilot study was conducted during the geotechnical investigation of PO-75. The pilot study is a small-scale marsh creation testing settlement of the fill material. The pilot study monitoring results were used to adjust the time rate of the subgrade soil settlement. This adjustment showed that the subgrade soil settled over a longer time period than initially calculated without the pilot study. The results from the study were used to better estimate the settlement of PO-75 and PO-133. The geotechnical investigation report and pilot study report for the project can be found in Appendix C and H, respectively.

7.1 General Geologic Evaluation

The northern part of the Louisiana coastal zone consists of older, elevated sedimentary units to the north that slope seaward further to the south underneath the newer Holocene sediments. Throughout the delta plain of south Louisiana, Pleistocene muds and stiff clays underlie Quaternary (Holocene) deposits and are typically denser than the overlying sediments due to compaction. The LaBranche wetlands are located within an area of Delta Plain and Saline Marsh deposits of the Holocene Age. Areas such as this have some variability but are typically weak and compressible. Shallow sediments are usually made up of peat deposits, soft organic clays, soft clays and loose silts that grade better with depth.

7.2 Soils Investigation

A total of eight (8) subsurface borings were taken in the borrow area. The borings showed a significant amount of clay with some silt mixed for borings BHBA 1-3; while BHBA 4-8 showed interbedded layers of silt, sand, silty sand, sandy silt, and clay. Shells were present in many of the borings at both the mudline and deeper. BHBA-8, where PO-17 borrow area was located, showed more organic clay than was present in the other borings.

A total of fourteen (14) subsurface borings were taken in the marsh creation area. BHMC-11 boring was terminated at 80 ft below the existing bottom elevation. and the other 13 borings were terminated at 30 ft in depth. All borings encountered peat layer 10 to 15 feet thick followed by organic clay and clay intermixed with silt and sand seams or layers sometimes several feet thick. The peat and organic clay will be the controlling factor moving forward during design. Figure 3 shows all boring locations taken for the marsh creation area.

The soil samples were tested in the laboratory for classification, strength, and compressibility. Testing included: field or miniature vane, unconfined compression, unconsolidated undrained triaxial compression, Atterberg limits, grain size distribution, consolidation, settling column, and self-weight consolidation. The marsh creation area boring logs, geotechnical report and borrow area boring logs for PO-133 LaBranche Central Marsh Creation Project can be found in Appendix C.

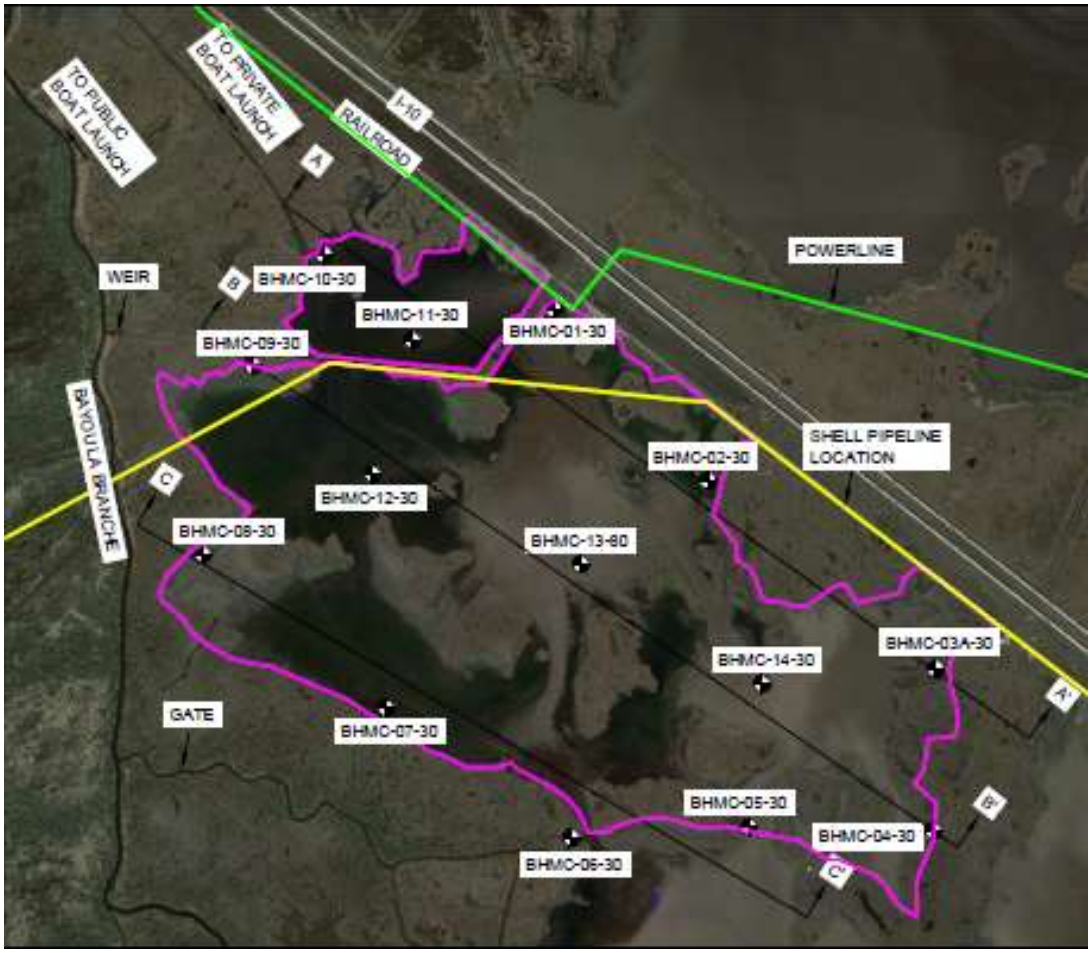

Figure 3. Soil Boring Locations

7.3 Slope Stability Analysis for Containment Dikes

Slope stability analysis were performed to give NRCS the failure point of the containment dike parameters. The analysis was conducted using a displaced mudline, where the organic soils are displaced when the containment dikes are constructed, with a bottom elevation of -2 ft and a factor of safety of 1.2. GeoEngineers determined that, at a minimum, the earthen containment dikes should have a slope of 3H: 1V, and a 5-ft crown with a maximum crown elevation of +5 ft (Figure 4). To prevent losses of dredged material, one foot of freeboard above the anticipated marsh fill elevation will be added to the containment dike; therefore, crown height will be determined once a fill elevation is selected. The lower limit of excavation for the borrow area for the containment dike was determined by stability analysis to be an elevation of -15 ft. Slope stability analysis were done for both unreinforced containment dike and containment dikes reinforced with geotextile. The reinforced sections will be used where the containment dikes will cross open water. Factors of safety were determined to be 1.2 for slope stability, 1.5 for global bearing, and 1.3 for lateral squeeze. Lateral squeeze is typically applied to geotextile reinforcement conditions only. The results of the slope stability analysis for the

containment dike are shown in Table 5. The table shows the borings using just earthen containment failed to meet the FOS of 1.2. The slope stability analysis was then ran using geotextile fabric and the resulting FOS is shown in Table 5. The geotextile reinforcement used was a woven fabric with a tensile strength of 400 pounds per linear inch. Two stability scenarios (titled "Condition 1" and "Condition 2") were used. The first (Condition 1) was potential for the constructed dike to fail into the borrow channel immediately after dike construction. The second (Condition 2) was potential for dike failure at the maximum hydraulic fill level.

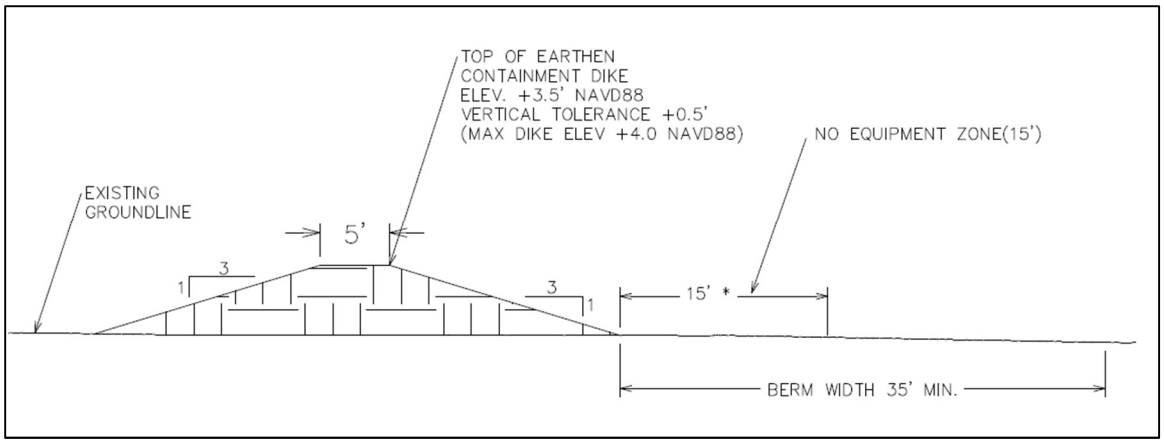

Figure 4. Typical Section of Containment Dike

Table 5: Containment Dike Stability Summary

Boring Id.	FOS without Reinforcement			FOS with Reinforcement			
	Condition 1	Condition 2	Global Bearing FOS	Condition 1	Condition 2	Global Bearing FOS	Lateral Squeeze FOS
BHMC-7	2.24	1.17	1.89	2.81	1.25	3.75	3.38
BHMC-8	2.56	1.15	2.28	2.81	1.24	4.40	3.01
BHMC-9	1.97	0.99	1.68	2.21	1.25	3.26	2.49
BHMC-10	2.66	1.15	1.89	3.00	1.25	3.65	2.59

The boring that fails to meet factor of safety reflects a condition where the elevation is at or below -2 ft elevation.

The North MCA has no areas that are at or below a -2 ft elevation.

The South MCA has 2 areas that are at or below a -2 ft elevation.

- STA 80+83.48 to STA 80+86.50 (approx. 3')
    - Due to the short distance the design will not be modified for this section.

- STA 127+92.29 to STA 128+35.53 (approx. 43 LF)
    - The deepest location is at Sta 128+14.37 Elev -2.923)
    - The design will be modified for this section by placing geotextile on the water bottom

- The geotextile would have to be 50 ft wide to cover the deepest area, therefore the entire geotextile panel will have to be that wide
- The geotextile will extend around 25 ft at the start/stop stations to ensure good tie in, starting at STA 127+50 and ending at 128+75 to make even stationing – total length = 125'
- Total square yards = 125' x 50' / 9 = 694.4 SY

7.4 Marsh Fill Settlement Analysis

A marsh fill settlement analysis was used to determine the construction fill height required to achieve the project goals. Settlement and self-weight consolidation tests were performed using samples collected in the marsh fill and borrow area along with the results from the pilot study. In order to accurately quantify cumulative settlement, the Army Corps of Engineers (USACE) program, primary consolidation, secondary compression, and desiccation of dredged fill (PSDDF) was used. The program considers settlement of the underlying soils from placement of the fill material above it and the self-weight consolidation that occurs within the fill material itself. Properties of the underlying soils were obtained from the laboratory tests conducted on the borings taken by GeoEngineers. Properties of the fill material were obtained from self-weight consolidation testing and index testing on the borings taken. In addition, climatic data was considered and added into PSDDF. Time rate of settlement was analyzed for fill heights of +1.5', +2.0', +2.5', +3.0', +3.5, and +4.0' NAVD88. The summary of 20-year marsh fill settlement is shown below in Table 6. Figure 5 shows the 90% inundation, 10% inundation, and the average settlement curve for each fill height elevation. The average settlement curve was taken from the 14 boring in the MCA for a particular slurry height and averaged to generate one curve. Water and inundation levels are adjusted for eustatic sea level rise over the 20-year project life. Settlement curves are located in Appendix (D).

Table 6. Summary of 20 Year Marsh Fill Settlement

Initial Fill Elevation (feet) (Year 0)	Final Fill Elevation (feet) (Year 20)
4.0	1.1
3.5	0.9
3.0	0.7
2.5	0.6
2.0	0.4
1.5	0.3

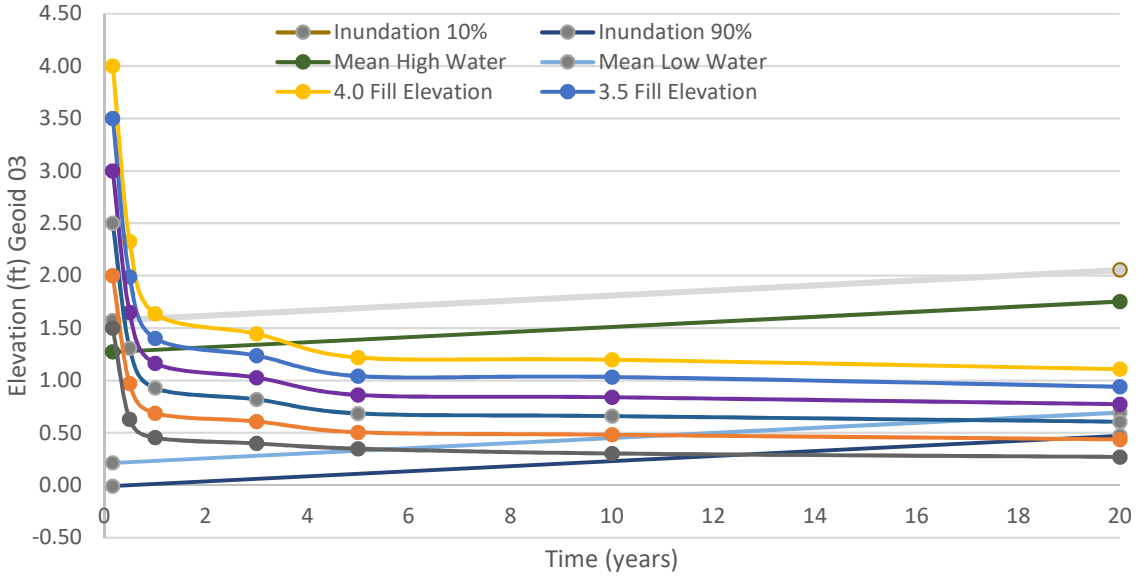

Figure 5. Marsh Fill Settlement Curves

8.0 MARSH CREATION DESIGN

A critical component of the design for PO-133 LaBranche Central Marsh Creation Project is the calculation of the fill area volume. This volume is governed by several factors including desired marsh elevation, the physical properties of the borrow materials, and the bearing capacity of the foundation soils in the marsh creation area. The elevation of the marsh dictates the type and amount of vegetation that is supported, and ultimately the health of the marsh. To aid in selecting the construction fill elevation, the settlement of marsh creation fill was determined. The elevation by percentage of the marsh creation area is shown in Table 7. Table 8 shows the range of the elevation in the MCA with Figure 6 showing the elevation map. The majority of the project is at elevation -1.5 feet to +1.5 ft. Approximately 5 acres in marsh creation area 2 is between elevation -2 ft to -1.5 ft

Table 7: Elevation Percentage of the MCA

MCA 1 (76 Acres)				MCA 2 (716 Acres)			
Min Elev.	AREA Ft^2	Acres	% Total Acres	Min Elev.	AREA Ft^2	Acres	% Total Acres
-2.5	0	0	0%	-2.5	0	0	0%
-2	0	0	0%	-2	215635	5.0	1%
-1.5	1568086	36.0	48%	-1.5	10318260	236.9	33%
-1	882427	20.3	27%	-1	6547885	150.3	21%
-0.5	465098	10.7	14%	-0.5	5396166	123.9	17%
0	325368	7.5	10%	0	2527691	58.0	8%
0.5	0	0	0%	0.5	3829159	87.9	12%
1	0	0	0%	1	1918895	44.1	6%
1.5	0	0	0%	1.5	146113	5	1%

2	0	0	0%	2	0	0	0%
2.5	0	0	0%	2.5	0	0	0%
Sum of Acres		**74**	100%	**Sum of Acres**		**711**	100%

Table 8: Elevation Range with Color Code

Elevation Table			
Number	Min. Elevation	Max. Elevation	Color
1	-2.5	-2.0	
2	-2.0	-1.5	
3	-1.5	-1.0	
4	-1.0	-0.5	
5	-0.5	0.0	
6	0.0	0.5	
7	0.5	1.0	
8	1.0	1.5	
9	1.5	2.0	
10	2.0	2.5	
11	2.5	3.0	

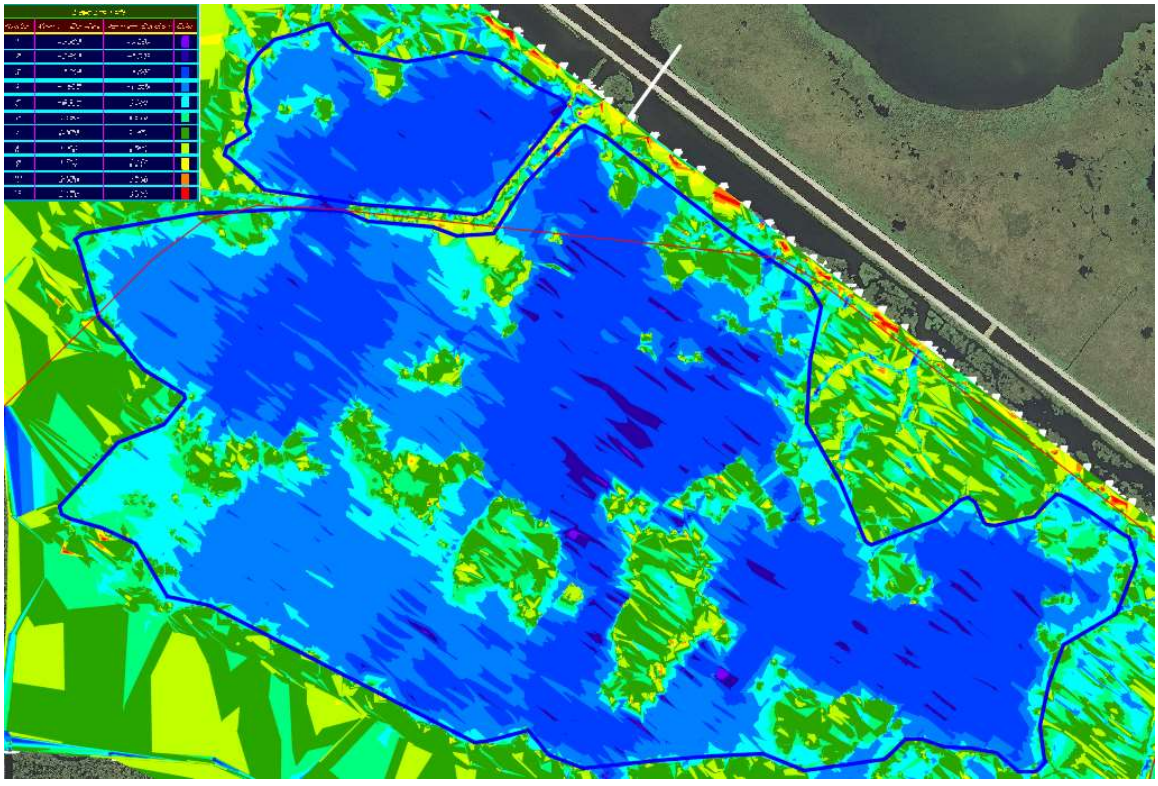

Figure 6: Elevation Map of the Project site

8.1 Borrow Site Design

The borrow site was broken down into 4 areas: Cells 1, 2, 3, & 4 (Figure 7) because of the wide range of depths (-5 ft to -12 ft) and to accurately calculate the available material. The cells will be excavated to a depth of -22 ft; thus, the total volume for all 4 cells is calculated at 16 million cubic yards. The calculations are provided in the Design Calculation Packet located in Appendix D.

Since the borrow area is planned to be used by both PO-133 and PO-75, sediment management was considered; i.e. having enough material to complete both projects and to avoid creating an expansive borrow area. PO-75 is currently planned to take material from Cell 1 and PO-133 project is proposing to excavate in the following order: Cell 4 followed by Cell 3. This will leave Cell 2 untouched thus breaking up the depressions created by dredging and providing cover for pipeline in the borrow area and reduce the risk of uncovering those pipelines due to sloughing or spillway scour.

A Cut-to-Fill ratio was applied to determine the quantity needed to be dredged from the borrow area to create a marsh platform at a determined elevation. Dredging inefficiencies, material losses through weirs and other factors will affect dredge quantities and should be factored into volume calculations when estimating project costs. A review of the construction of previous projects cut-to-fill ratios have been reported between 1.1 to 1.5. A cut-to-fill ratio of 1.3 will be used to estimate fill volume quantities for PO-133 based on the following: assuming a cut-to-fill ratio 1.1 for large fill area, the construction settlement which is 16% of the fill height, 9 to 12 inches for a fill height between +3.0 to +3.5 feet. By multiplying 1.1 cut-to-fill by 1.16 construction settlement the calculated cut-to-fill ratio of 1.3 is obtained.

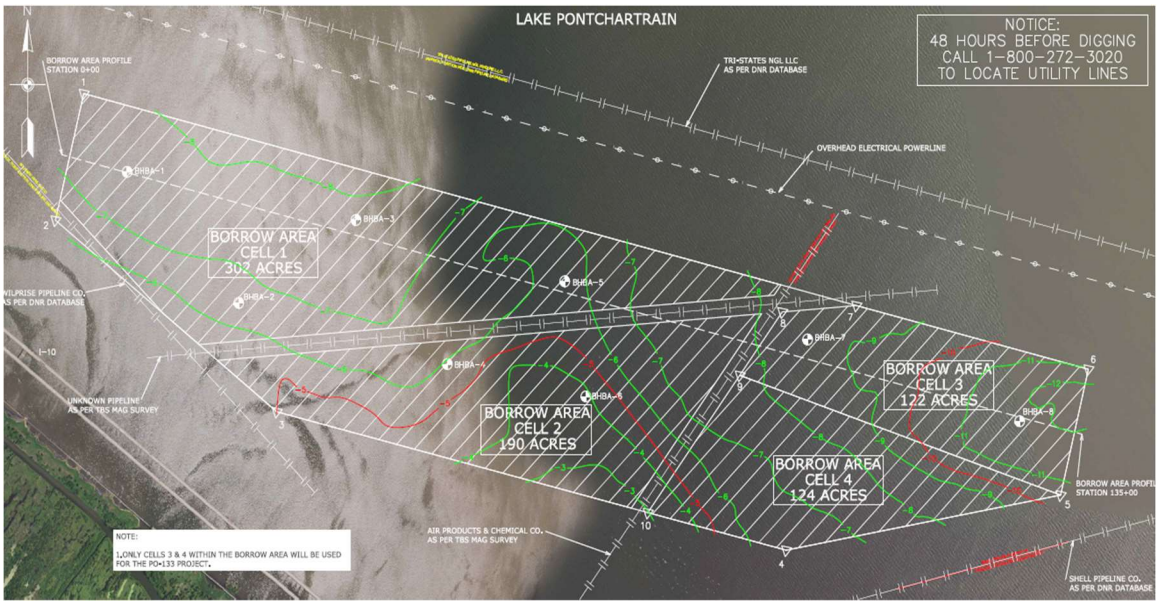

Figure 7. Borrow Area

8.2 Constructed Fill Elevation

To achieve the optimal constructed fill elevation, the goal is to provide a marsh platform that stays within the inundation range (between 10% and 90% inundation levels) for the majority of the project life. In order to achieve this, the marsh platform must be constructed above the optimal inundation range and be allowed to settle or consolidate into that range in the years following construction. For this project, additional information considered includes the following:

- The PO-75 pilot study fully-contained and partially contained cells were constructed to an elevation of +2.5 ft NAVD88. Predicted settled elevation at year 3 for those cells was +0.8 ft NAVD 88. Surveyed elevation for the fully contained cell was +1.2 ft NAVD at Year 3 and Year 4. Surveyed elevation for the partially contained cell was +1.06 ft NAVD at Year 3 and Year 4. This data indicates that the marsh platform has not settled as much as predicted and that the elevation seems to have stabilized in the Year 3 – Year 4 timeframe. The As-built plans, design report, and draft completion report for the pilot study can be found in Appendix H.

Using the settlement curves from Figure 5, the design team initially chose three fill elevations that met the goal of having a marsh platform that stays within the optimal inundation range (between 10% and 90% inundation levels) for the majority of the project life. The three slurry elevations are as follows, +3.5, 3.0, & 2.5 ft NAVD88. The final slurry fill elevation of the marsh creation area will be determined in Sections 6.2.1 through 6.3.

For the fill volume estimates, both AutoCAD Civil 3D 2014 and project site transects were used to determine the average mudline within the project area. Volume calculations were determined near the final dewatered slurry fill to allow for primary consolidation settlement of the fill to occur. This process accounts for the decrease in voids, primarily water, as the material dewaters and begins to consolidate. The fill elevation decreases at a much quicker rate within the first few years after construction as compared to the mid to later years due to the draining of excess pore water. Near the completion of primary consolidation settlement, the material has dewatered giving a more accurate estimate of the actual volume of dredged material needed to achieve a stable marsh platform. For each of these alternative constructed fill heights, the following sections present and discuss settlement curves for each bore hole for each fill height, provide fill volume estimates, and identify other considerations.

8.3 Constructed Fill Elevation of +3.5 ft (NAVD88)

Figure 8 provides a settlement curve for each borehole. With the slurry height, the marsh platform is predicted to remain between the 90% and 10% inundation levels throughout the life of the project (20 years). For a constructed slurry elevation of +3.5 ft NAVD88, the volume of dewatered material needed (including backfill of containment borrow) would be 4,734,448 cubic yards and the containment dike elevation would have to be +4.5 ft NAVD88. Dewatered volume calculations are located in the Design Calculation Packet located in Appendix (D) and the spreadsheet is labeled Design Calculation and Quantities. The height of the slurry that would need to be pumped into the marsh creation area could

increase settlement resulting in more material to be dredged to meet the dewatered elevation. The containment dike could be susceptible to significant shrinkage due to surface area being exposed to air causing the material to lose moisture. Based on the pilot study, more than two lifts would be needed to construct the containment dike and a geotechnical fabric could be needed to stabilize the containment dike for segments constructed in water. Reach for the equipment could be an issue depending on the geometry of the containment.

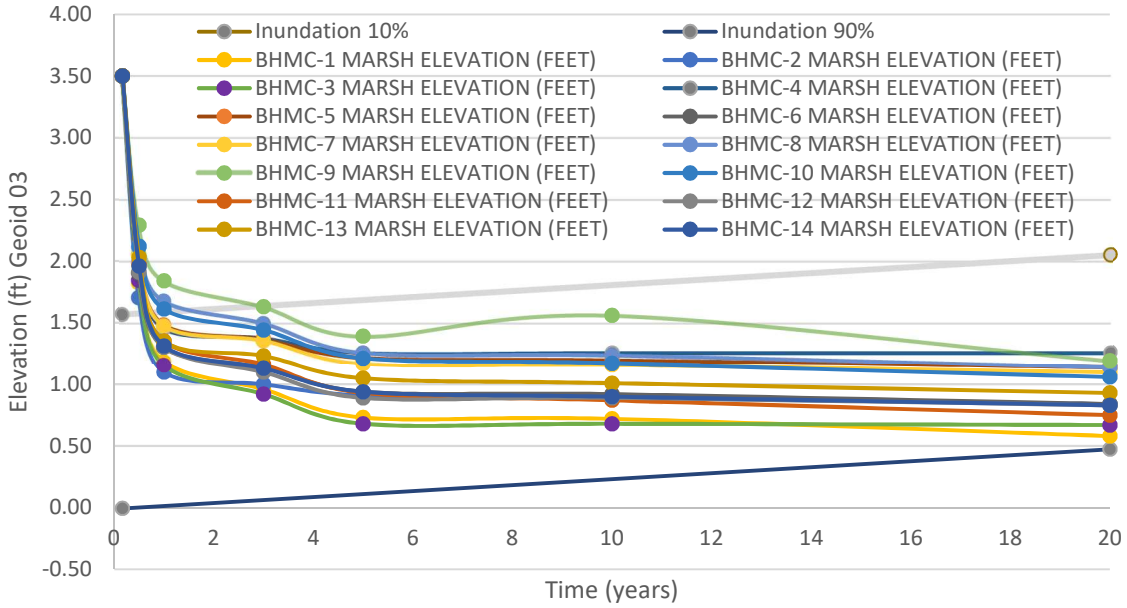

Figure 8. Settlement Curves for 3.5 Foot Fill Height

8.4 Constructed Fill Elevation of +3.0 ft (NAVD88)

Figure 9 provides a settlement curve for each borehole. With the slurry height, the marsh platform is predicted to remain between the 90% and 10% inundation levels throughout the life of the project (20 years). For a constructed slurry elevation of +3.0 ft NAVD88, the volume of dewatered material needed (including backfill of containment borrow) would be 4,171,067 cubic yards and the containment dike elevation would have to be +4.0 ft NAVD88. Dewatered volume calculations are in the Design Calculation Packet located in Appendix (D) and the spreadsheet is labeled Design Calculation and Quantities. The containment dike could be susceptible to moderate shrinkage due to surface area being exposed to air causing the material to lose moisture. Based on the pilot study more than two lifts would be needed to construct the containment dike and a geotechnical fabric would be needed to stabilize the containment dike for segments constructed in water instead of relying on alternative containment options.

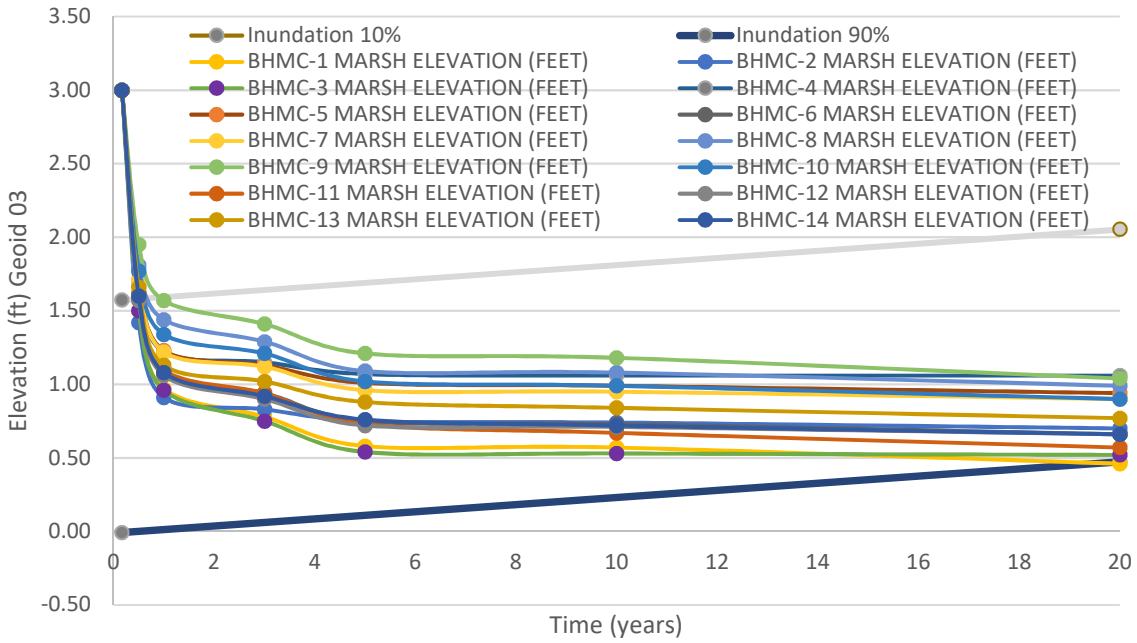

Figure 9. Settlement Curves for +3.0 ft Fill Height

8.5 Constructed Fill Elevation of +2.5 ft (NAVD88)

Figure 10 provides a settlement curve for each borehole. With the slurry height, the marsh platform is predicted to remain between the 90% and 10% inundation levels throughout the life of the project (20 years). For a constructed slurry elevation of +2.5 ft NAVD88, the volume of dewatered material needed (including backfill of containment borrow) would be 3,607,685 cubic yards and the containment dike elevation would have to be +3.5 ft NAVD88. Dewatered volume calculations are located in the Design Calculation Packet located in Appendix (D) and the spreadsheet is labeled Design Calculation and Quantities. The containment dike shrinkage would be less than for higher fill heights due to a smaller surface area being exposed to air. Based on the pilot study two lifts would be needed to construct the containment dike. A geotechnical fabric may sufficiently stabilize the containment dike for segments constructed in the water instead of relying on alternative containment options. Reach for equipment would not be an issue except in deeper water (bottom elevation less than -2 ft NAVD88).

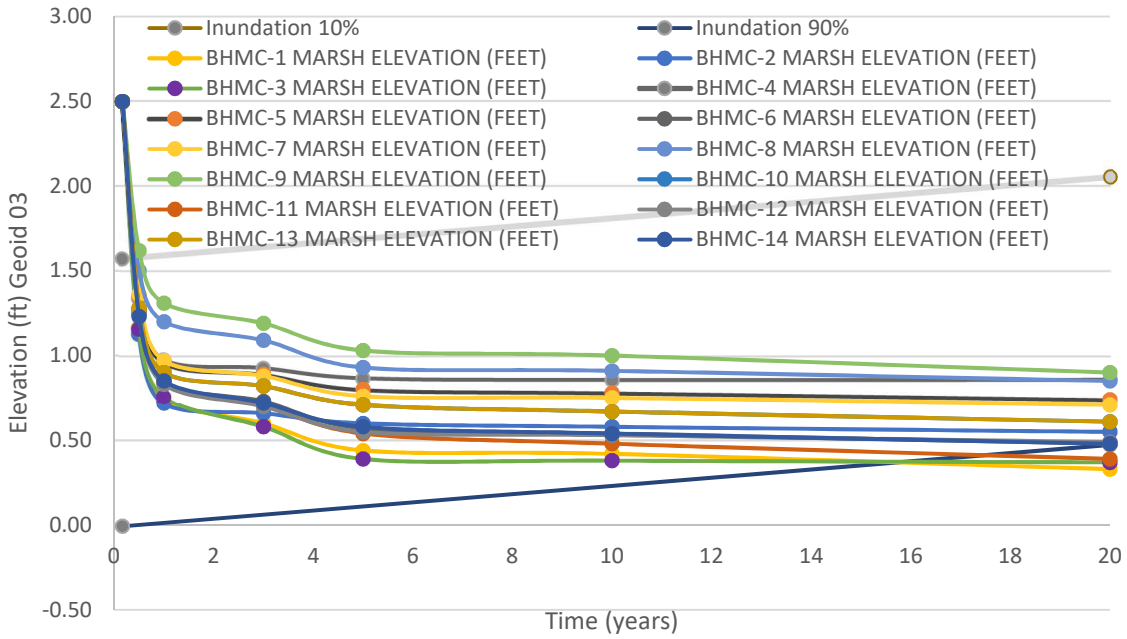

Figure 10. Settlement Curves for +2.5 ft Fill Height

8.6 Best Constructed Fill Elevation

Figure 11 shows the settlement curve, averaged across the boreholes, for the constructed slurry elevations of +3.5, 3.0, and 2.5 ft NAVD. All three slurry elevations would both achieve the goal of having a marsh platform that remains within the inundation range over the project life. Given the results of the pilot study where the observed year 3 elevation was considerably higher than the predicted elevation, the constructed slurry elevation of +2.5 ft NAVD can be expected to yield a marsh platform that would support emergent vegetation throughout the project life. Additionally, containment dikes for a constructed slurry elevation of +2.5 ft NAVD would be easier to construct and maintain compared to those needed for a constructed slurry elevation of +3.5 ft NAVD. Selecting a +2.5 ft slurry height would also minimize the amount of scour of material and potential of exposing the pipelines that run through the borrow area. The difference in the quantity of dewatered material between the slurry height of +3.0 ft and +2.5 ft is 563,382 cubic yards. Using a slurry height of +2.5 ft, along with reducing the construction concerns previously cited, the project would have a lower construction cost and still achieve a lasting and healthy marsh elevation.

For these reasons, the project team selected a constructed fill elevation of +2.5 ft NAVD as the best construction fill elevation, however with the given tolerance of +0.5 ft, the initial marsh platform will range from +2.5 feet to +3.0 feet throughout the project area. The volume of dredged material required was determined from the settlement curve for the +2.5 ft constructed elevation. Current NRCS design procedures use two methods to evaluate the required volume. The first method uses the average of the 20 yr elevation of the minimum and maximum inundation marks for the plant type. For PO-13 this was the 10% and 90% inundation elevations and the resultant elevation was determined to be +1.30 ft elevation. The second method is to determine the elevation on the settlement curve where

the effluent is significantly dewatered. That was determined to be +1.3 ft elevation. Therefore, the volume of dredged material required was taken from a +1.3 ft elevation with a cut to fill ratio applied.

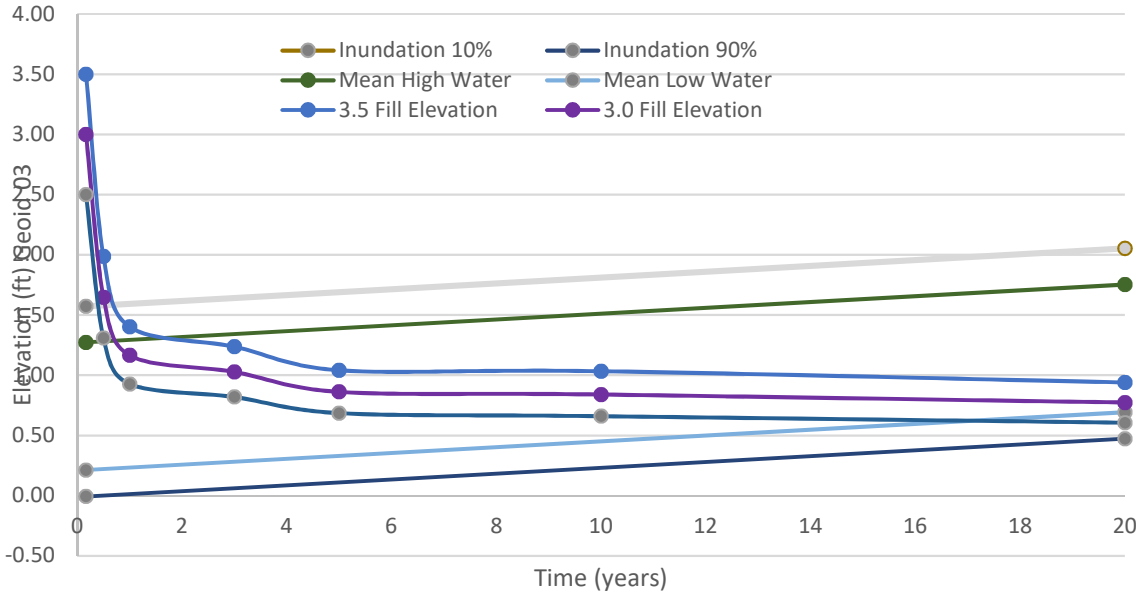

Figure 11. Settlement Curves for +3.5, 3.0, and 2.5 ft Fill Height

9.0 CONTAINMENT DIKE DESIGN

The primary design parameters associated with the containment dike design includes crown elevation, crown width, side slopes, berm width, and depth of borrow area. Slope stability was performed using GeoSlope and hand calculations to verify the program. A stability analysis indicated that the containment dike can be constructed to the following limits, a 5-foot crown width with a maximum elevation of +5.0 ft and a 3H: 1V slope. The borrow area for the containment dike was designed with a 35 ft berm, 3H: 1V side slope and a lower limit of excavation of -15 feet. The layout of the containment dike is shown in Figure 12. The design team determined that a containment dike placed on the marsh as much as a practical would allow for the best constructible containment dike possible. Geotextile will be needed in areas where the containment dike crosses channels/ tidal creeks or areas of open water with mudline elevations below -2 ft. Current surveys indicate this is only required at two existing cuts in the marsh, approximately Station 97+00 and Station 106+00. The containment dike layout for the south marsh creation area was modified to never cross the existing Canadian National Illinois Central pipeline, however, should site conditions or modifications during construction require crossing the pipeline, a 50-foot no access buffer from centerline of the pipeline is required per coordination with the pipeline company.

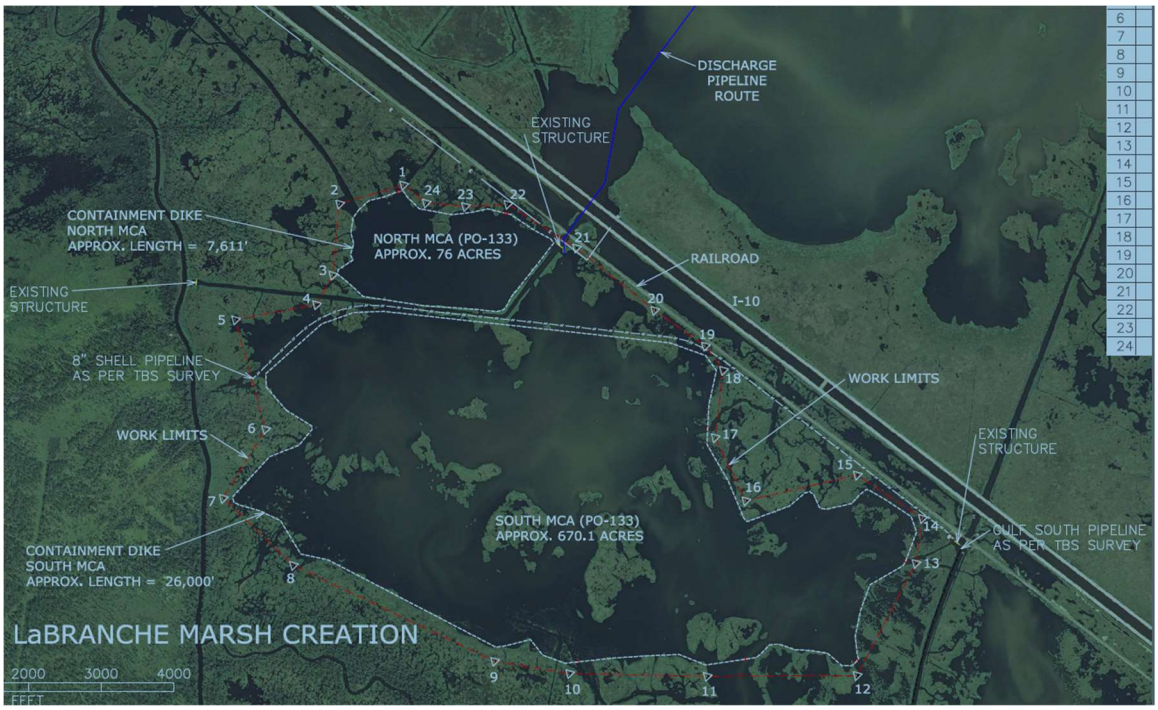

Figure 12. Plan View of Containment Dike

10.0 DREDGE PIPELINE CORRIDOR AND EQUIPMENT ACCESS

The design team looked at two possible access routes for the dredge pipeline from Lake Pontchartrain to the project site as shown in Figure 13. The first route consists of going from Lake Pontchartrain, under I-10 and railroad, through the scenic stream crossing, over the bank of the scenic stream near camps just south of the railroad, and into a canal that enters the smaller MCA cell. The second route will start at Lake Pontchartrain, over the shoreline into PO-75 project, under I-10 and the railroad, around the water control structure then into the MCA cells. Since both routes cross under the railroad, coordination was very important. The requirements of the railroad have been stated in section 4.0. The railroad requires certified personnel on site and steel casing over the dredge pipeline. Some of the concerns for the first route include the requirements of the scenic stream, requirements of the railroad, and depth of the water at the interface of the scenic stream and railroad. The major concern is the scenic stream for the first route. Some coordination has taken place with the LDWF scenic stream personnel to gather the requirements of using the scenic stream. The major concern for the second route is the water control structure. NRCS has coordinated with CPRA to determine that as long as the dredge pipe doesn't interfere with the operation of the structure and NRCS and CPRA have a servitude agreement with the landowner, then the pipe will be able to be placed as close to the structure as possible.

The design team determined that the only reasonable route for equipment access into the MCA's would be from the Bonnie Carrie Spillway levee, through a canal, into the scenic stream, crossing over the bank, and into a canal that leads to the smaller MCA. Once the equipment is in the project area the equipment will need to cross over an 8-inch pipeline owned by Shell. An additional access route using the railroad access road is currently being considered and discussed with both Shell and the railroad company.

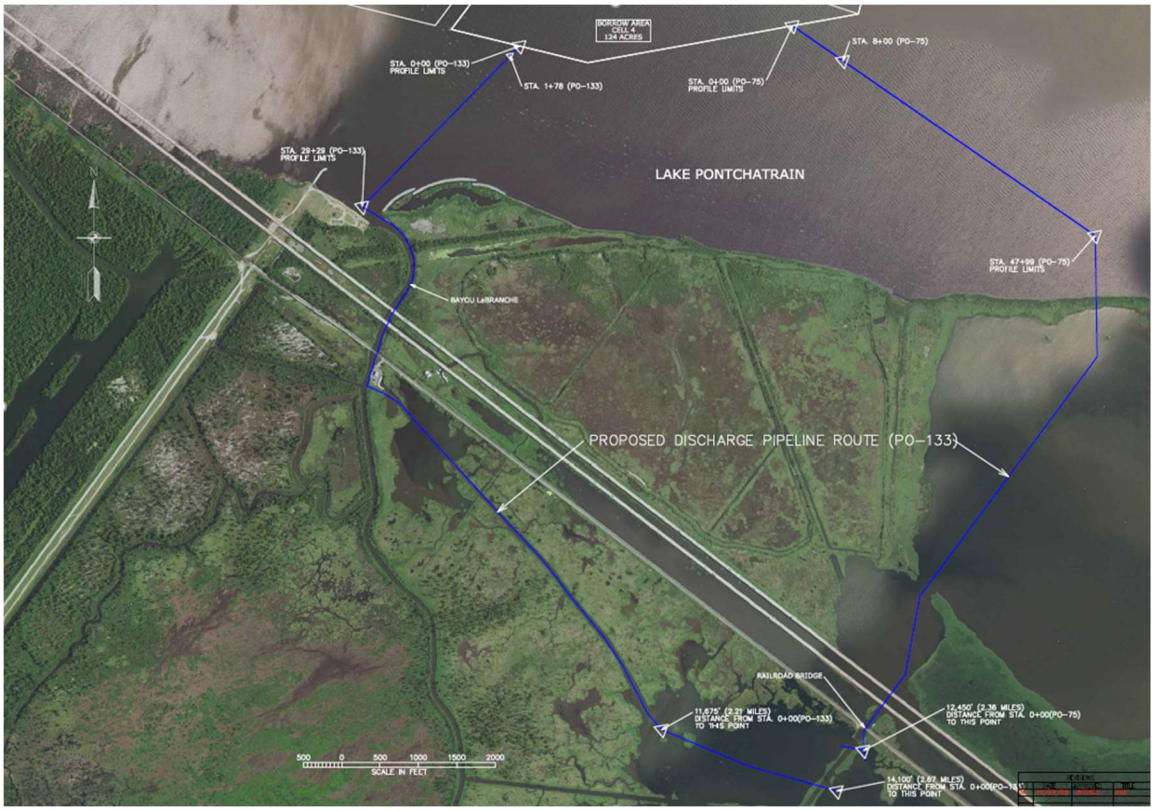

Figure 13. Dredge Pipeline Corridor and Equipment Access

11.0 VEGETATIVE PLANTINGS

Many marsh creation areas will experience natural vegetative colonization and will not require plantings. The PO-133 project area is very large and to prevent any portions from not colonizing naturally, the project cost estimate includes funding to install vegetative plugs over ¼ of the marsh creation area.

12.0 CONSTRUCTION DOCUMENTS

12.1 Construction Sequence

Bid Item No.		Activity	Start Day	Duration (days) (7-day week)	End Day	Duration (months)	Month of end day
	1a	Mag Survey Borrow Area	1	14	15	0.5	0.5
	1b	Hydrographic Survey	1	14	15	0.5	0.5
2		Mobilize to Project site	14	4	18	0.1	0.6
		Contractor Quality Control	1	340	341	11.2	11.2
1		Construction Surveys	14	317	331	10.4	10.9
5		Containment Dike	14	68	82	2.2	2.7
3		Geotextile	20	0.4	20	0.0	0.7
6		Install Staff Gauges	79	3	82	0.1	2.7
	2a	Place Discharge Pipe	60	28	88	0.9	2.9
4		Fill Marsh Creation Area	88	243	331	8.0	10.9
	5a	Structure Removal	331	5	336	0.2	11.0
2		Demobilize from site	336	4	340	0.1	11.2
	1c	As-Built	331	14	345	0.5	11.3

12.2 Construction Drawings

Draft Construction Drawings have been provided as a separate attachment.

12.3 Specifications

Specifications has been provided as a separate attachment.

12.4 Bid Schedule

The bid schedule has been provided as a separate attachment.

12.5 Cost Estimate

The cost estimate has been provided as a separate attachment.

13.0 MODIFICATIONS TO APPROVED PHASE 0 PROJECT

Changes from Phase 0 to 30% design review of the project have occurred and are as follows. 1) The containment dike in the South MCA was shortened by 4,239 feet, on the southeast corner, from the Phase 0 concept.

14.0 COMMENTS ON PRELIMINARY (30%) DESIGN

Comments from Engineer Workgroup from the 30% Design Review meeting are included in Appendix I. NRCS and CPRA has also provided response to the agency's comments. The concurrence letter to move the project to 95% Design meeting is in appendix I as well.

15.0 MODIFICATIONS TO PRELIMINARY (30%) DESIGN

After the 30% Design meeting the following changes were made to the project. 1) Sections in the design report were added to address dredge pipeline and equipment access. 2) Coordination with pipeline, railroad, scenic stream coordinator resulted in changes in access routes, containment dike layout and dredge pipe layout. 3) Consultation with the Corps of Engineers operation of the Bonnet Carre Spillway and access through and over the guide levees altered the project access routes. 4) The NRCS State Engineer made changes to the way NRCS calculated quantities from the settlement curves, how the borrow site excavation would be inspected, and how the marsh creation placement would be inspected and approved for payment. As a result, significant changes were made to the specifications, cost estimate, and design report. All of these changes were previously discussed with CPRA and presented to the CWPPRA workgroups for the previously designed projects PO-75, ME-20, BA-195, and BA-206.

16.0 OPERATION, MAINTENANCE, AND MONITORING

The Operation, Maintenance, and Monitoring (OM&M) plan will be developed prior to Phase II request. CPRA New Orleans Field Office will develop the OM&M plan. There is currently no change to the Phase 0 O&M cost.

17.0 REFERENCES

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