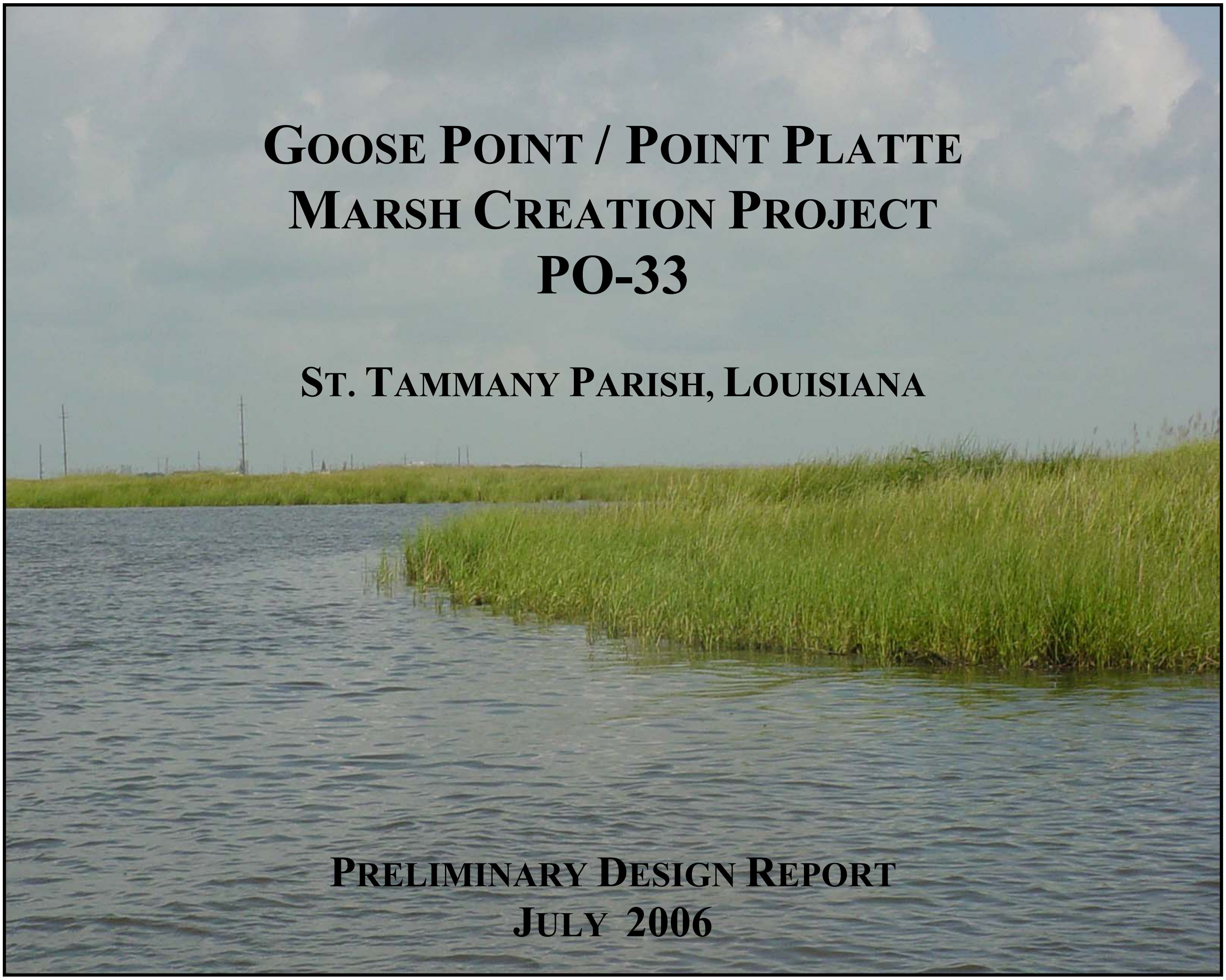

GOOSE POINT / POINT PLATTE MARSH CREATION PROJECT PO-33

ST. TAMMANY PARISH, LOUISIANA

PRELIMINARY DESIGN REPORT
JULY 2006

COASTAL WETLANDS PLANNING, PROTECTION, AND RESTORATION ACT

LOUISIANA DEPARTMENT OF NATURAL RESOURCES
COASTAL ENGINEERING DIVISION

UNITED STATES FISH AND WILDLIFE SERVICE

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1.0 INTRODUCTION

The Goose Point/Point Platte Marsh Creation Project (herein referred to as PO-33) is located in the Lake Pontchartrain Basin along the northern shore of Lake Pontchartrain as shown in Figure 1. The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Task Force designated PO-33 as part of the 13th Priority Project List. The United States Fish and Wildlife Service (USFWS) was designated as the lead federal sponsor with funding approved through the Coastal Planning, Protection and Restoration Act of 1990 by the United States Congress and the Wetlands Conservation Trust Fund by the State of Louisiana. The Louisiana Department of Natural Resources-Coastal Engineering Division (LDNR-CED) is serving as the local sponsor and will also be performing engineering and design.

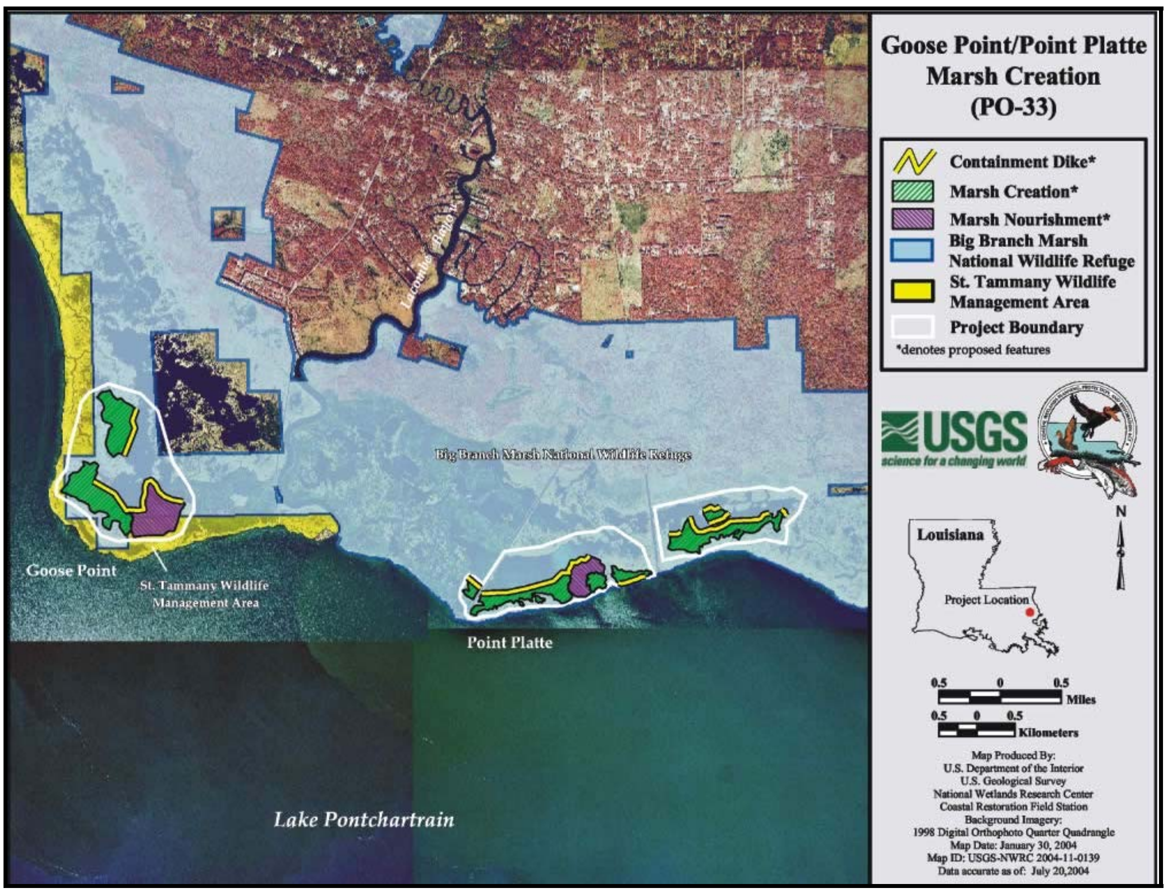

Figure 1 – Project Features

The primary goal of PO-33 is to re-create marsh habitat in the open water areas immediately behind the shoreline in the vicinity of Goose Point and Point Platte along the northern shore of Lake Pontchartrain. This will maintain the lake-rim function along this section of shoreline, especially east of Point Platte where very little land is left between the lake and the open ponds.

Interior ponding and, to a lesser extent shoreline erosion, are the major causes of wetland loss in the project area. Although the shoreline erosion rates are relatively low, only a narrow strip of land currently exists between Lake Pontchartrain and the interior ponds. Several breaches are known to exist along the shoreline. Should shoreline breaching and enlargement of tidal channels allow high tidal energy to intrude into the interior ponds of the project area, the interior marshes would certainly experience accelerated loss rates.

Restoration strategies to be used for this project include marsh creation and marsh nourishment as shown in Figure 1. The proposed marsh creation/nourishment will be achieved by mining sediment from northern Lake Pontchartrain to fill open water and broken marsh areas along the northern lake rim.

Topographic, bathymetric, magnetometer, and geophysical surveys, and a geotechnical investigation have been completed. Additionally, a tidal datum analysis has been performed by LDNR-CED to determine the mean water elevations. These efforts have been carried out in order to determine the quantity of fill material and to select material types to be used for construction.

The project team, consisting of members of USFWS, LDNR, the Lake Pontchartrain Basin Foundation, and Big Branch Marsh National Wildlife Refuge performed an on-site kick-off meeting on July 8, 2004. Based on that meeting, a plan was developed to identify and address all of the project requirements. The engineering and design, environmental compliance, real estate negotiations, operation/maintenance planning, and cultural resources investigations have been carried through to the 30% level of completion as required by the CWPPRA standard operating procedures.

2.0 SURVEYS

In order to facilitate the design of the marsh creation cells and the associated borrow areas, topographic, bathymetric, magnetometer, and geophysical surveys were performed within the project area. Additionally, two (2) secondary monuments were set in the project area as part of LDNR's South Louisiana Coastal Wetlands (SLCW) Secondary GPS Network for horizontal and vertical control. Contracting a single survey effort for the entire project area presented several contractual issues. Therefore the PO-33 survey was separated into two (2) contracted survey efforts:

1. <u>Fill Area Surveys</u>: Topographic, magnetometer, and average marsh elevation surveys associated with the interior marsh ponds (contract also included setting two (2) secondary monuments).
2. <u>Borrow Area Surveys</u>: Bathymetric, magnetometer, and geophysical surveys associated with the offshore portions of the project area (in Lake Pontchartrain).

2.1 Secondary Monument

Prior to performing either of the survey efforts listed above, two (2) permanent secondary monuments were installed at Goose Point and Point Platte. In order to obtain horizontal and vertical positions of theses newly installed monuments, C&C Technologies, Inc. performed a Static GPS survey utilizing Trimble 4000 SE/4000 SI GPS receivers on the newly installed monuments and several existing known control monuments in the general area per SLCW Secondary GPS Network standards. This work was accomplished during the time period of March 29, 2005 to April 2, 2005. "PO33-SM-01" was installed in the vicinity of Goose Point, near the Lake Road Boat Launch, at coordinates 30°16'06.93"N, 89°57'20.77"W. "PO33-SM-02" was installed in the vicinity of Point Platte, near the intersection of Transmitter Road and an unnamed gravel road, at coordinates 30°16'33.50"N, 89°54'42.20"W. These two (2) secondary monuments were used as horizontal and vertical control for the fill area survey and the borrow area survey. The data sheets for these monuments are located in Appendix A.

2.2 Fill Area Surveys

Topographic, magnetometer, and average marsh elevation surveys were performed within the proposed marsh creation cells by C&C Technologies, Inc. This work was accomplished during the time period of April 25, 2005 to May 10th, 2005.

The survey baseline for Goose Point portion of the project was established east of the proposed marsh creation/nourishment cells in a north-south orientation. The survey baseline for Point Platte portion of the project was established north of the proposed marsh creation/nourishment cells in a west-east orientation. The survey transects for the topographic surveys intersect the baselines at 250 ft. intervals and extend into the interior ponds. Elevations were recorded at 50 ft. intervals utilizing a Leica RTK system with Pacific Crest model 4535 positioning data link radios and Carlson palmtop data collectors. Side shots were taken to locate and identify any protruding structures within the fill areas, and any other visible topographic features that may have an influence on the project. Details of these surveys are shown on the C&C Technologies, Inc. survey drawings located in Appendix B.

Survey profiles were taken along each proposed containment levee location. These profiles were performed intermittingly during the fill area surveys utilizing the same equipment used to acquire elevations in the marsh creation/nourishment cells. Positions and elevations were taken at 25 ft. increments or less when topographic features that may have an influence on the project were discovered. Details on these surveys are shown on the C&C Technologies, Inc. survey drawings located in Appendix B.

Seventeen (17) magnetometer lines were surveyed within the PO-33 project area using an EG&G Geometrics Model 822 Portable Cesium Magnetometer. Magnetometer data was collected through a notebook PC utilizing C & C Technologies Maglog software version 1.81 with positioning from a WAAS GPS unit mounted on an airboat. The magnetometer recorded a total of thirty-five (35) magnetic deflections that did not correlate to known features. However, none of the recorded magnetic deflections indicated the presence of an abandoned pipeline.

Average Marsh Elevation Surveys were conducted at six (6) predetermined locations. These surveys consisted of a minimum of twenty spot elevations at each location utilizing the same equipment used to acquire the elevations in the marsh creation/nourishment cells. Average marsh elevations for each location were derived by using the following procedure: (sum of elevations at location # divided by total number of elevations at same location # = Average Elevation). Table 1 shows the data acquired from the six (6) average marsh elevation surveys. The points where the average marsh elevation surveys were performed are shown on the C&C Technologies, Inc. survey drawings located in Appendix B.

SPOT ELEVATION NUMBER	GOOSE POINT			POINT PLATTE		
	POINT NO. 1 30° 16' 40.5"N 89° 58' 38.3"W	POINT NO. 2 30° 16' 07.7"N 89° 58' 46.0"W	POINT NO. 3 30° 15' 38.0"N 89° 58' 32.6"W	POINT NO. 4 30° 15' 28.2"N 89° 55' 18.4"W	POINT NO. 5 30° 15' 21.5"N 89° 54' 34.7"W	POINT NO. 6 30° 15' 44.3"N 89° 53' 44.5"W
1	0.75	1.05	1.22	1.80	1.22	0.88
2	0.96	0.81	0.76	0.36	1.07	0.93
3	1.30	1.08	1.00	0.15	0.97	0.97
4	1.11	0.99	0.67	0.63	0.96	1.14
5	1.04	1.17	1.11	0.72	1.16	0.84
6	1.06	1.03	0.66	0.62	0.83	0.94
7	0.88	0.77	1.10	0.72	1.22	0.86
8	1.04	1.00	0.85	0.65	0.95	0.85
9	0.64	0.94	0.93	0.98	1.20	0.91
10	1.01	1.18	1.02	1.67	0.63	0.34
11	0.88	0.62	0.88	0.71	1.14	1.10
12	0.78	0.88	1.11	0.95	0.90	0.72
13	0.98	0.92	1.02	0.99	1.20	0.85
14	1.05	0.95	1.06	0.73	1.12	0.98
15	1.01	1.15	1.16	0.85	0.82	0.86
16	0.96	1.20	0.96	1.02	0.92	0.90
17	1.07	0.98	1.03	0.98	1.22	0.90
18	0.94	1.28	1.09	0.92	1.06	1.09
19	0.97	1.16	0.95	1.03	1.10	0.89
20	1.03	1.18	1.15	1.10	1.29	0.93
TOTAL	19.46	20.34	19.73	17.58	20.98	17.88
AVERAGE	**0.97**	**1.02**	**0.99**	**0.88**	**1.05**	**0.89**
CUMULATIVE AVERAGE = 0.97						

Table 1-Average Marsh Elevation Survey Results

2.3 Borrow Area Surveys

Bathymetric, magnetometer, side-scan sonar, and sub-bottom profile surveys were performed in Lake Pontchartrain in and around the proposed borrow areas by PBS&J. This work was accomplished during the time period of January 4th, 2006 to January 12th, 2006. All surveys were performed simultaneously using a 20 ft. aluminum workboat called the PeeWee McKinney. A schematic of this vessel with the survey sensor offsets is shown in Figure 2. Details on these surveys are shown on the PBS&J survey drawing located in Appendix C.

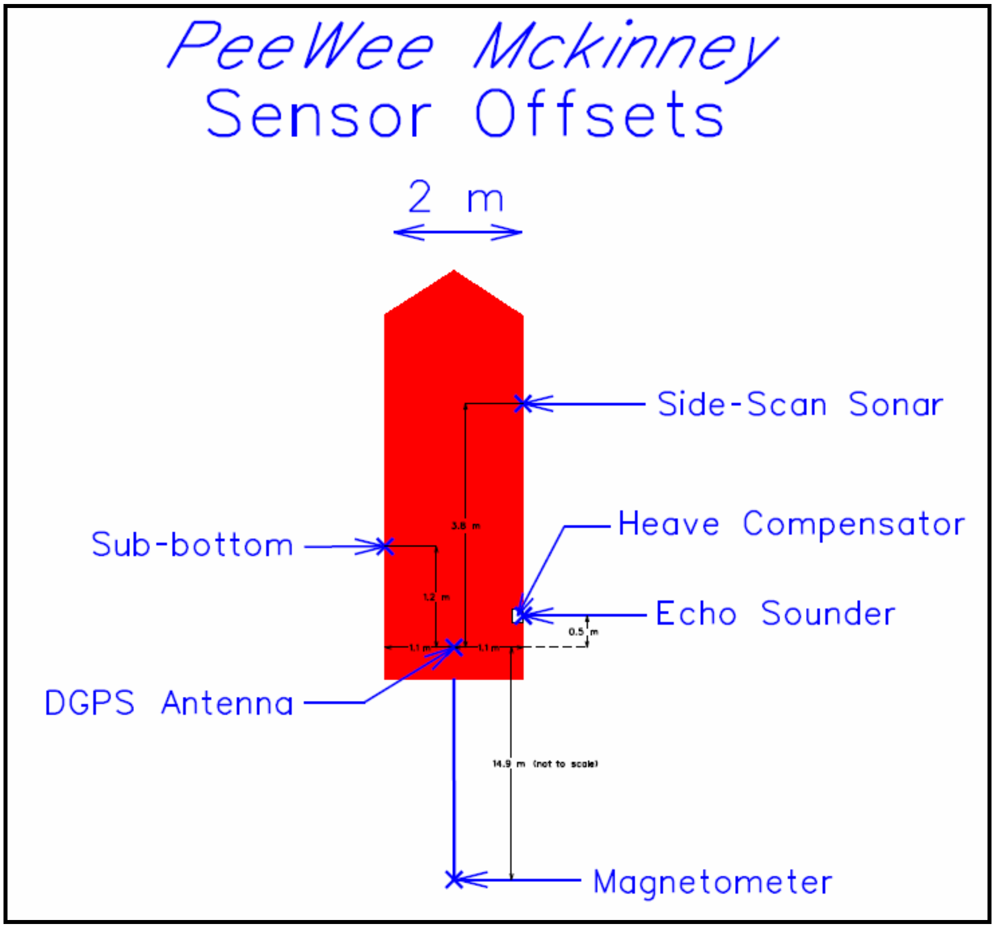

Figure 2-Survey Vessel Pee Wee Mckinney (courtesy of PBS&J)

Bathymetric surveys were performed in Lake Pontchartrain to produce cross-sectional data of the borrow areas. This data was acquired using an Odom Hydrotrac echo sounder with a 200-kHz 9-degree beam transducer. The echo sounder transducer was located 1.3 ft beneath the surface, 3.6 ft. to the starboard side of and 1.6 ft. forward of the GPS antenna. The navigation software calculated and recorded position estimates for the echo sounder transducer in real-time. Water depths were compensated for vertical wave motion (heave) of the transducer in real-time using a TSS DMS-05 Motion Sensor. The motion sensor was mounted on the floor of the survey vessel immediately inboard of the echo sounder transducer. The water bottom elevation data obtained from these surveys were used for determining borrow/dredge operation volumes.

A magnetometer survey was performed in borrow areas to verify existing pipelines and detect any unknown and/or abandoned pipelines. This survey was performed using a Geometrics G-882 cesium vapor towfish. This sensor was towed at the surface 48.9 ft directly aft of the GPS antenna. All magnetic anomalies were boxed in by subsequent survey to rule out their association with pipelines. The magnetometer survey data confirmed the presence and orientation of the previously documented pipelines in the borrow areas. A number of anomalies were detected along profiles that were of very limited lateral extent and exhibited a wide range of field strength values. These anomalies were evaluated by collecting additional data to confirm that these features were of limited lateral extent, and did not represent laterally continuous features that could indicate the presence of a pipeline.

In order to detect certain lake-bottom features such as oyster beds, sand pockets, Pleistocene channels, and geologic faults, sub-bottom profile and side-scan sonar surveys were performed in the borrow areas. The sub-bottom profile survey was conducted using an Edgetech SB-424 CHIRP towfish operating with a bandwidth of 4-24 kHz and a pulse repetition rate of 250 milliseconds (ms). The sub-bottom profile survey was used to detect sub-surface features such as buried oyster beds, sand pockets, and faults. An Edgetech DF1000 was towed for the side-scan sonar survey. This data was obtained to compliment the data recorded by the sub-bottom profiler by providing information concerning surface sediments.

3.0 GEOTECHNICAL ANALYSIS

In order to determine the suitability of the soils in the PO-33 project area for the various proposed marsh creation/nourishment features, a geotechnical investigation and analysis was performed by Soil Testing Engineers, Inc. (STE) and completed on April 20, 2006. STE was tasked to collect soil borings, perform laboratory tests to determine soil characteristics, perform stability analyses on the containment levees and borrow areas, calculate settlements of the containment dikes and marsh fill areas for different fill elevations, and determine an adequate cut to fill ratio for dredge and fill operations. A detail summary of the geotechnical investigation and analysis is presented in the Geotechnical Investigation report prepared by STE.

3.1 Soils Investigation

A total of eleven (11) subsurface borings were drilled in the project area during the period of February 3, 2006 through February 19, 2006 by STE at locations shown in Figure 3. Six (6) borings were drilled in Lake Pontchartrain to a depth of twenty (20) ft., three (3) borings were drilled in the interior ponds to a depth of forty (40) ft., and two (2) borings were drilled in the interior ponds to a depth of sixty (60) ft. The soil samples were tested in the laboratory for classification, strength, and compressibility. Boring logs for PO-33 can be found in Appendix D.

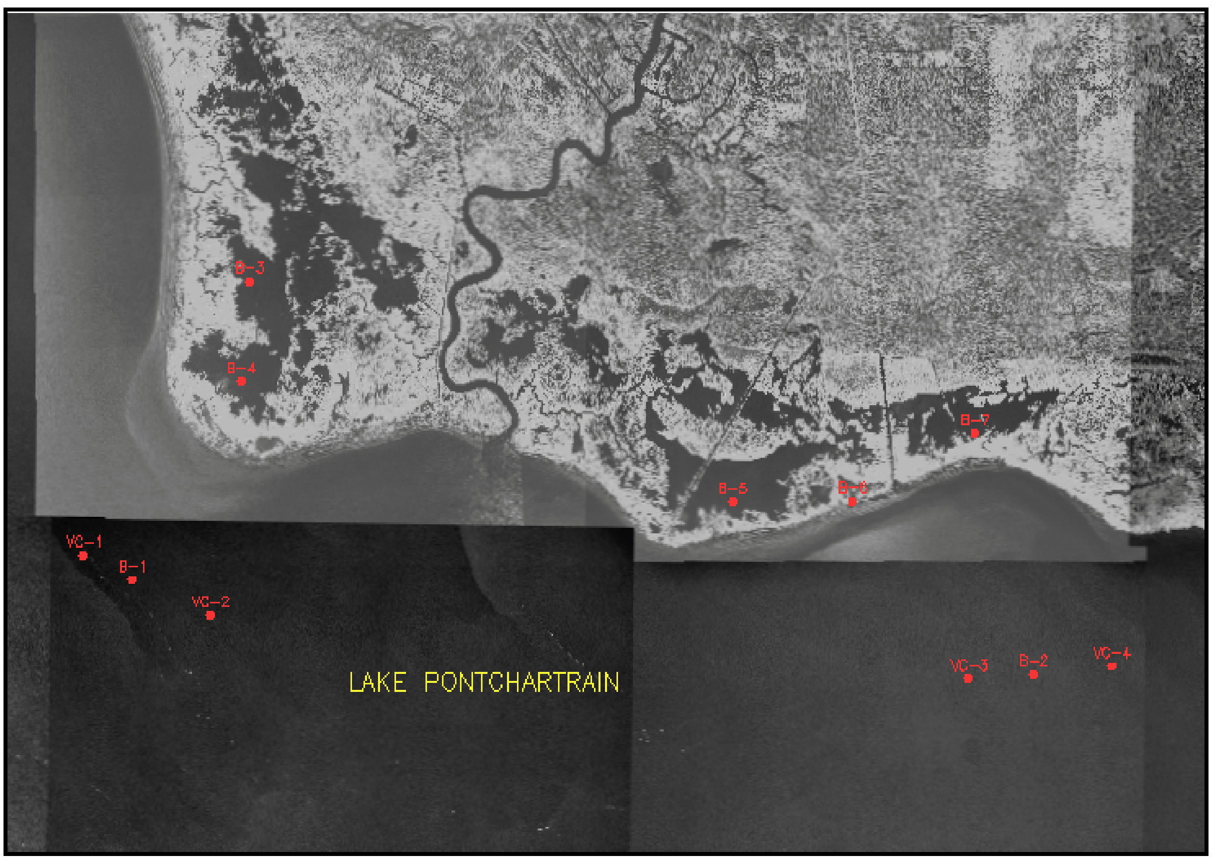

Figure 3 – Soil Borings Locations

3.2 General Geologic Evaluation

The project area is generally underlain by Holocene age soil deposits consisting of the Delta Plain, Saline Marsh sub unit. This layer is predominantly made up of highly organic black to gray clays with some peat and areas of active and abandoned delta lobes of the Mississippi River. Below these deposits are underlying Pleistocene age soil deposits consisting of the Prairie Terrace sub unit. This layer is predominantly made up of light gray and light brown clays, sandy clay, silt, and sand.

3.3 Slope Stability Analysis

Slope stability analyses were performed for the earthen containment dikes and the dredge borrow areas using a software package marketed by Interactive Software Designs, Inc. called XSTABL. Per the STE Geotechnical Report, a slope has two (2) types of driving forces: (1) the forces induced by the soil weight, and (2) any seepage forces which tend to cause the soil to slide. In response to these driving forces, the subsurface soils have a resistant force in the form of shear strength, which tries to keep the slope from sliding. Both the driving forces and the resisting forces are dependant on the geometry of the situation: the "Failure Surface". XSTABL uses the Bishop Method, which isolates a block of soil and computes the ratio of resisting forces to driving forces. This ratio is known as the global slope stability safety factor.

STE performed this analysis for the containment dikes using Borings B-3, B-4, B-6, and B-7. Boring B-5 was not used because near surface soil conditions at this site consist of medium, dense sands and would not be expected to have an effect on the analysis. Containment dike crown elevations of +2.0 ft., +2.5 ft., and +3.0 ft. NAVD 88 with 5.0 ft. crown widths were analyzed. Additionally, the analysis was performed with side slopes of 1(V):4(H) and 1(V):3(H). A side slope of 1(V):3(H) at each elevation listed above at all boring locations produced acceptable safety factors ranging from 1.3 to 2.7. Therefore, STE recommended that all containment dikes be built according to the following geometry:

- Side Slope: 1(V):3(H)
- Crown Width: 5 ft.
- Crown Elevation: 3.0 ft. NAVD 88

The slope stability analysis was performed on the borrow area using the Boring VC-3, which revealed the weakest soils. The purpose of this analysis was to find a safe side slope against failure for the perimeter of the borrow sites. STE concluded that borrow site side slopes 1(V):6(H) to a maximum depth of ten (10) ft. will produced a minimum safety factor of 1.6.

3.4 Settlement Analysis

Settlement analyses for PO-33 were performed using a computer software package developed by the Corps of Engineers called VSTRESS, which calculates onedimensional settlement based on Boussinesq stress distributions. Actual consolidation curves were used in the calculations for the soil types that required consolidation tests. Published correlations for pre-consolidation pressure, coefficient of consolidation, and compression/re-compression indices were used for other soil types to obtain consolidation indices using shear strength, Atterberg Limits, and moisture content values. Settlement analyses were performed for marsh creation fill sites and the earthen containment dikes.

Settlement calculations for the earthen containment dikes were based on the soil conditions at Borings B-3, B-4, B-5, B-6, and B-7 (see Appendix D for boring logs). Containment dike settlement is composed of two (2) parts: (1) the settlement in the foundation soils due the weight of the dikes, and (2) the settlement within the levee itself due to self-weight consolidation. A crown width of 5.0 ft. and a 1(V):3(H) side slope was used based on the results of the slope stability analysis (Section 3.3). An assumed water depth of 1.0 ft. was used throughout the project area and dike crown elevations of +2.0 ft., +2.5 ft., and +3.0 ft. NAVD 88 were evaluated. In general, the settlement values of the containment dikes in the project area were relatively low with an average ultimate settlement of 0.5 ft. The time rate of settlement curves showed that all containment dike settlement would occur within the first year after construction. With average marsh elevation for the project area being approximately +1.0 ft. NAVD 88, it was concluded by STE that any containment dike built in the project area to an elevation of +2.0 ft., +2.5 ft., or 3.0 ft. NAVD 88 would not settle to marsh elevation.

Settlement calculations for the marsh fill were also based on Borings B-3, B-4, B-5, B-6, and B-7 (see Appendix D for boring logs). The marsh fill settlement is composed of three (3) parts: (1) the settlement that will occur within deposition area, (2) the additional settlement at the perimeter containment dikes induced by the fill area, and (3) the settlement within the marsh itself due to self-weight consolidation. Because the subsidence rates of the project area are relatively low, LDNR requested that STE not include subsidence in the settlement calculations. Target marsh fill elevations of +2.0 ft. and +3.0 ft. NAVD 88 were used for this analysis. As with the containment dikes, settlement values for the marsh fill were found to be relatively low. The time rate of settlement curves showed that most of the settlement in the foundation soils of the marsh fill would occur within the first year after construction. These settlement curves are shown on the STE drawings in Appendix E. Figure 4 shows the ultimate settlement of the foundation soils in marsh fill areas based on the soil data at Borings B-3, B-4, B-5, B-6, and B-7.

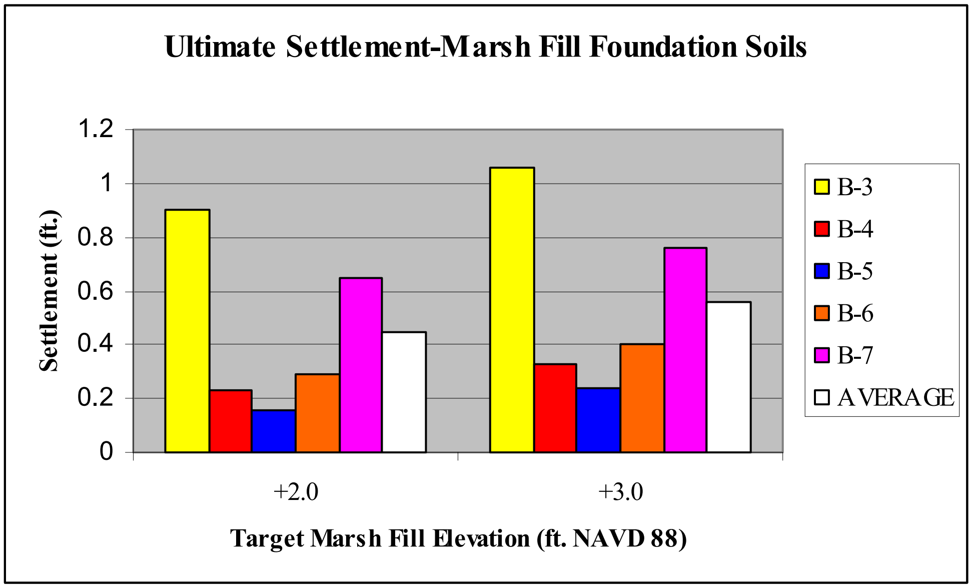

Figure 4 – Ultimate Settlement of Marsh Fill Foundation Soils

The weight of the fill material adjacent to the containment dikes will induce additional settlements on these dikes. These movements will occur at a rate similar to that of the foundation soils. STE recommended that an additional 0.2 ft. be added to the settlement of the containment dikes.

LDNR tasked STE to run additional settlement tests on the borrow area material to estimate how much settlement occurs within the mass of marsh fill itself due to self-weight consolidation. A composite sample from Borings B-1, B-2, VC-1, VC-2, VC-3, and VC-4 for was used for this test. The time-rate of settlement for this test was calculated for +2.0 ft. and +3.0 ft. fill elevations. The results showed that the self-weight consolidation of the borrow material would be approximately 3 inches for a +2.0 ft. fill elevation and approximately 5 inches for a +3.0 ft. fill elevation. The time-rate curves for this test are shown on the STE drawings located in Appendix E.

3.5 Cut:Fill Ratio Recommendations

LDNR tasked STE to determine an estimated cut:fill ratio for PO-33. Two (2) cases were considered in this analysis: (1) the quantity of in-situ borrow material necessary to construct the containment dikes using mechanical dredging techniques, and (2) the quantity of material that will be dredged hydraulically and placed in the fill cells. The cut:fill ratio for mechanical dredging was primarily based on the expected transport losses during construction and water loss shrinkage of the clayey material in the project area. With these factors in mind, STE recommended that the cut:fill ratio for mechanical dredging range from 1.5 to 2.0.

The cut:fill ratio for the hydraulically dredged material was estimated by comparing the density of an in-situ sample from the borrow areas to the density of a sample taken at the end of Type III settling (post-construction). Based a settling column test performed by

Louisiana State University for STE, the density at the end of Type III settling was slightly less that the density of the in-situ sample. The comparison of the borrow volume and the fill volume can be directly related to the comparison of the in-situ density and the post-settling density. Therefore, STE estimated that the cut:fill ratio for the hydraulically dredged material range from 0.75 to 1.0. STE did note that this analysis does not include any losses that may occur during construction such as losses in the dredged pipe itself, losses due to breaches or failures in the fill site containment, and losses that may occur during dewatering. These factors could contributed to a 30% to 40 % loss in borrow material during construction. Therefore, it was decided that a cut:fill ratio of 1.4 be used for hydraulic dredging.

4.0 HYDRAULIC ANALYSIS

Hydraulic calculations performed during the design of PO-33 included the determination of a tidal datum, or the mean high/mean low water (MHW/MLW) elevations (NAVD 88).

4.1 Tidal Datum

LDNR monitoring gage PO06-06 was selected to determine historical water levels due to its close proximity to the project area and database availability. It is located in Salt Bayou at 30°11'42.52"N, 89°45'11.99"W, approximately twelve (12) miles east of the project area. Approximately 3 years of hourly water level data was recorded from October 18, 2000 to December 31, 2003.

A normal tidal epoch lasts approximately nineteen (19) years. In order to accurately estimate MHW and MLW, a data set which has less than nineteen (19) years of data should be correlated to a gage which has data from a full tidal epoch using a technique known as the Range-Ratio method. NOAA station #8761724 located at Grand Isle, Louisiana near Barataria Pass at 29°15'48"N, 89°57'24"W was used as the control station for making this correlation. The period of record used for the nineteen (19) year tidal epoch was from January 1, 1985 to December 31, 2003. The results of the tidal datum determination for PO-33 are shown in Table 2. A more detailed summary of how this tidal datum was calculated is shown in Section I of the Design Calculation Packet located in Appendix F.

KNOWN VARIABLES	**ELEV. FT NAVD 88**
MHWc = 19 YEAR MEAN HIGH WATER AT CONTROL STATION	1.37
MTLc= 19 YEAR MEAN TIDE LEVEL AT CONTROL STATION	0.85
MLWc = 19 YEAR MEAN LOW WATER AT CONTROL STATION	0.32
MRc = 19 YEAR MEAN TIDE RANGE AT CONTROL STATION	1.05
TLc = MEAN TIDE LEVEL FOR THE OBSERVATION PERIOD AT CONTROL STATION	1.00
Rc = MEAN TIDE RANGE FOR THE OBSERVATION PERIOD AT CONTROL STATION	1.06
TLs = MEAN TIDE LEVEL FOR THE OBSERVATION PERIOD AT SUBORDINATE STATION	0.93
Rs = MEAN TIDE RANGE FOR THE OBSERVATION PERIOD AT SUBORDINATE STATION	0.61
CALCULATED VARIABLES	**ELEV. FT NAVD 88**
MHWs = 19 YEAR MEAN HIGH WATER AT SUBORDINATE STATION (MHWs=MTLs+MRs/2)	1.08
MTLs= 19 YEAR MEAN TIDE LEVEL AT SUBORDINATE STATION (MTLs=TLs+MTLc-TLc)	0.78
MLWs = 19 YEAR MEAN LOW WATER AT SUBORDINATE STATION (MLWs=MTLs-MRs/2)	0.48
MRs = 19 YEAR MEAN TIDE RANGE AT SUBORDINATE STATION (MRs=(MRc*Rs)/Rc)	0.60

REFERENCE: Cole, George M. Water Boundaries. New York, NY: John Wiley & Sons, Inc., 1997. pp. 24-27.

Table 2 – Summary of Tidal Datum Determination

5.0 MARSH CREATION DESIGN

This project proposes to create marsh by pumping sediment from Lake Pontchartrain into the designated areas shown in Figure 1. The marsh creation design was broken into three (3) components: the marsh creation fill sites, the dredge borrow sites, and the containment dikes. The design and analysis of each component is discussed in the sections below.

5.1 Fill Site Design

The main design component of PO-33 involves the calculation of the fill area volumes. Before this could be accomplished, a fill elevation had to be determined. This elevation was governed by several factors including average marsh elevation, the tidal datum, the physical properties of the borrow material, and the bearing capacity of the foundation soils in each fill area.

The first step of the fill elevation design involved an examination of the existing marsh conditions. Data collected from a pre-design field trip (July 2004) showed that the existing marshes at Goose Point and Point Platte were relatively low lying with the roots being near the water surface. The average marsh elevation survey performed during the Fill Area Survey revealed that the average marsh elevation throughout the entire project area was approximately +1.0 ft. NAVD 88 (see Section 2.2 for additional details). The calculated tidal datum (MHW=1.08 ft., MLW=0.48 ft.) shown in Section 4.1 verified that the existing marsh predominantly fell in the upper portion of the project inter-tidal zone, the range of elevations that lie in between the upper and lower extents of the tidal datum.
In order to evaluate the performance of the created marsh over the 20 year life of the project (standard for CWPPRA), the project team decided that the criteria would be marsh elevation. Ideally, scientists from both USFWS and LDNR would like the created marsh to be as close as possible to the existing marsh conditions and within the inter-tidal zone. This means that the final marsh elevation (after initial consolidation and long term settlement) would fall between MHW and MLW. To achieve this, the marsh platform will initially have to be pumped to an elevation higher than MHW during construction and settle into the inter-tidal zone over time.

In order to determine the construction fill elevation, LDNR tasked STE to run consolidation settlement calculations for boring locations B-3, B-4 B-5, B-6, and B-7, which are located in marsh fill areas. Additionally, self-weight consolidation tests were run using a composite sample from Borings B-1, B-2, VC-1, VC-2, VC-3, and VC-4, which are located in the borrow areas. The calculations were performed for potential fill elevations of 2.0 ft. and 3.0 ft. NAVD 88. The purpose of these analyses was to assist in the determination of a construction fill elevation that would be as close as possible to the existing marsh elevation after 20 years, and that would fall within the inter-tidal zone for the longest period of time possible. After reviewing the data, the project team concluded that most of the settlement would be complete two (2) years after construction. It was also concluded that a target fill elevation of +2.0 ft. NAVD 88 would ultimately settle to an elevation of +0.80 ft. NAVD 88 and that a target fill elevation of +3.0 ft. NAVD 88 would ultimately settle to an elevation of 1.41 ft. NAVD 88 (conservatively estimated using the worst case settlement results from Boring B-3). These settlement values are composed of foundation settlement and self-weight consolidation settlement. By interpolating between the settlement values for the +2.0 ft. NAVD 88 fill and the +3.0 ft. NAVD 88 fill, it was estimated that a fill elevation +2.5 ft. NAVD 88 would ultimately settle to an elevation of approximately +1.08 ft. NAVD 88 (also composed of foundation and self-weight consolidation settlement). Because this value is extremely close to the existing marsh elevation, and still falls within the upper portion of the inter-tidal zone (similar to existing marsh), a target fill elevation of +2.5 ft. NAVD 88 was chosen for PO-33.

Subsequently, a target fill elevation of +1.5 ft. NAVD 88 was chosen for the marsh nourishment sites. These sites generally include some broken-up marsh and are relatively well contained by surrounding marsh. Theoretically, the dredged slurry will fill in the degraded areas of these sites. These sites need not be filled more than 0.5 ft. above the average marsh elevation and are mainly intended as outfall for the marsh creation sites.

Once the target fill elevation was the determined, the marsh fill volumes were calculated. To simplify this process, the project was broken up into eight (8) fill sites (five (5) marsh creation sites and three (3) marsh nourishment sites), each analyzed separately. Cross-sectional areas of the transects in each fill site were calculated using the data produced by the Fill Area Survey described in Section 2.2. Fill site volumes were then computed using these areas. Table 3 shows the results of the volume calculations for each fill site. A more detailed summary of the fill site design is shown in Section II the Design Calculation Packet located in Appendix F.

FILL SITE	AREA (acres)	VOLUME OF FILL (yd^3)
MC-1	64	328,545
MC-2	125	640,192
MC-3	120	655,198
MC-4	13	60,366
MC-5	95	393,979
MN-1	23	13,150
MN-2	77	111,570
MN-3	49	89,827
Totals	566	2,292,826

Table 3 – Summary of Marsh Creation Volumes

5.2 Borrow Site Design

The controlling factors of this design component include the borrow site location and the size of the borrow site (acreage and depth). The initial location of the borrow site was the portion of Lake Pontchartrain that lies in between Goose Point and Point Platte, near its confluence with Lacombe Bayou. It was discovered by USFWS personnel that this area is a critical feeding area for the Gulf Sturgeon, a bottom feeding fish that is listed as an endangered species by USFWS and the National Marine Fisheries Service (NMFS). Therefore, the project team decided that the borrow site be split into two portions, one on either side of the Gulf Sturgeon feeding area near Bayou Lacombe. Under this plan, the initial single borrow site was divided into two (2) smaller borrow sites, one for the fill sites at each marsh creation location (Goose Point and Point Platte).

Another governing factor in the determination of the borrow site location was the presence of the submerged aquatic vegetation (SAV), or "grass beds", found on the north shore of Lake Pontchartrain. It was estimated that these grass beds could extend as far as 500 ft. from the lakeshore rim in some places. Due to the uncertainty in the location of these grass beds, the project team decided to place each borrow site in deeper waters, at least 4000 ft. from the lakeshore rim. This distance would insure the safety of the grass beds during dredging operations, and would still be close enough to the fill sites to operate without booster pumps. The Goose Point borrow site was simply placed directly southwest of the fill site, avoiding potential oyster/shell beds that were detected by the geophysical survey. The Point Platte borrow site was placed south of the fill sites and lies in between two (2) sets of oil and gas pipelines, with at least a 500 ft. buffer on either side. Traces of a subsurface Pleistocene channel were detected near Point Platte during the geophysical survey. The silty/sandy material in this channel appeared to be more suitable for marsh creation than the medium to stiff clays found in the areas surrounding the channel. Therefore, the Point Platte borrow site was placed within this subsurface feature. Figure 5 shows the two (2) designated borrow areas with respect to the shoreline and the fill sites.

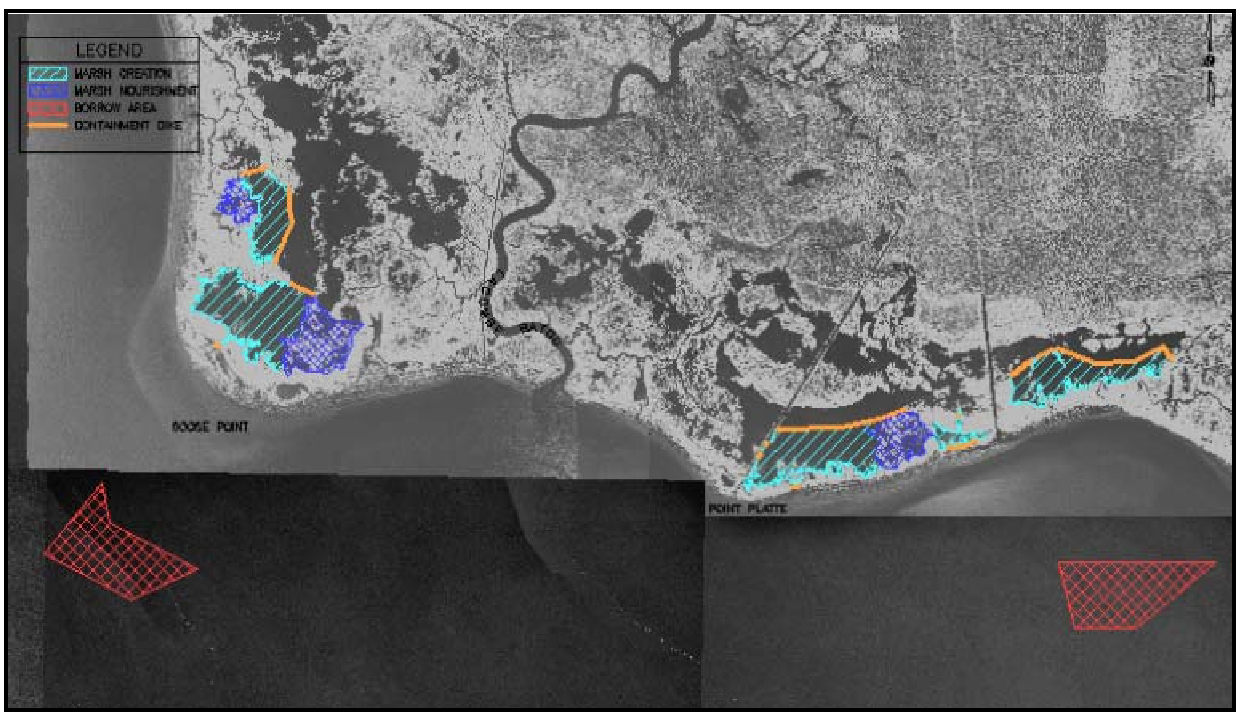

Figure 5 – Designated Borrow Sites

The size of the each borrow area is governed by the volume of material calculated to fill the marsh creation cells as discussed in Section 5.1. The borrow volume is computed by simply multiply the fill volume by the cut:fill ratio if 1.4 for hydraulically dredged material mentioned in Section 3.5. The borrow site acreage can be calculated by dividing the borrow volume by the maximum dredge depth of cut discussed in Section 3.3. A safety factor of 1.5 was applied to each borrow site area to account for any permit issues that may arise. Table 4 shows a summary of the borrow site volumes and areas. Details on the borrow site design are shown in Section IV of the Design Calculations Packet located in Appendix F.

BORROW SITE	DESIGNATED FILL SITES	REQUIRED VOLUME (yd^3)	AVAILABLE VOLUME (yd^3)	AREA (acre)
Goose Point Borrow Site	MC-1,MC-2,MN-1,MN-2	1,530,838	2,297,482	142
Point Platte Borrow Site	MC-3,MC-4,MC-5, MN-3	1,679,119	2,516,034	156

Table 4 – Borrow Site Summary

Another design technique from USACE EM 1110-2-5027 was utilized for comparison. This technique assumes that a dredge quantity is already known, and conservatively produces a fill quantity based on the physical properties of the dredged material by calculating a "bulking factor". Applying this "bulking factor", or fill:cut ratio, to the known dredge volume produces a fill volume that is significantly smaller. The primary concept of this design technique is to adequately design the containment dikes of a predetermined disposal site (with a given acreage) so that the dredged material being pumped will be 100% contained with no losses whatsoever. This differs from the design concept of PO-33 in that the goal of marsh creation design is to build a mass of land that will, over the 20 year life of the project, be as close to the existing marsh conditions as possible. LDNR recommends that the fill sites of PO-33 be pumped to a target elevation of +2.5 ft. NAVD 88 to accomplish this goal. From previous marsh creation project experience, losses may occur during dredging from containment dike failure and, to a lesser extent, leaks in the dredge pipeline. Therefore, rather than utilizing the "bulking factor" technique described in EM 1110-2-5027, a cut:fill ratio is applied to the calculated fill volumes to account for these losses and to insure that enough material is made available to accomplish the target fill elevation. The calculations for the USACE method described in EM 1110-2-5027 can be found in Section V of the Design Calculations Packet located in Appendix F. An alternative method from the textbook Handbook of Dredging Engineering is also featured in Section VI of the Design Calculations Packet.

5.3 Containment Dike Design

The primary design parameters associated with the containment dike design include crown elevation, crown width, and side slopes. LDNR tasked STE to determine these parameters for slope stability and settlement analyses. STE recommended that the containment dikes built to a +3.0 ft. NAVD 88 crown elevation, with a 5 ft. crown width and 1(V):3(H) side slopes would not incur in slope failures. A crown elevation of +3.0 ft. NAVD 88 would only allow 0.5 ft. of freeboard between the top of the target fill (+2.5 ft.

NAVD 88) the crown of the dike. The containment dikes shall be constructed using in-situ material from within each fill site. For stability purposes, STE recommended that the dike borrow pits be located at least 25 ft. from the toe of the dike. To help eliminate any losses of dredged material during construction, the project team suggested a freeboard of 1.0 ft. (2.0 ft. at the marsh nourishment sites) be used instead. This would require a dike crown elevation of +3.5 ft. NAVD 88. After performing an additional analysis, STE recommended that a crown elevation of +3.5 NAVD 88 would suffice and that the new crown elevation would not have any effect on the previous slope stability and settlement analyses. Once these parameters were determined, cross-sectional areas and containment volumes were calculated using the methods described in Section III of the Design Calculations Packet located in Appendix F. Table 5 summarizes the containment dike volume calculations.

DIKE	DIKE LENGTH (ft)	AVERAGE XS AREA (ft^2)	CALCULATED VOLUME (yd^3)
CD-1	821	78.59	2,359.23
CD-2	2,186	78.52	6,357.01
CD-3	798	73.82	2,105.16
CD-4	58	254.79	547.32
CD-5	65	95.16	229.09
CD-6	71	208.25	547.63
CD-7	74	82.29	225.54
CD-8	58	145.48	312.51
CD-9	4,206	71.23	11,095.47
CD-10	228	104.24	880.28
CD-11	984	79.45	2,895.63
CD-12	55	281.55	573.52
CD-13	658	76.36	1,860.80
CD-14	521	72.42	1,397.39
CD-15	4,015	86.81	12,908.42

Table 5 – Containment Dike Volume Summary

6.0 2-DIMENSIONAL WAVE MODELING

As part of the borrow area impact analysis, an STWAVE two-dimensional wave model will be run to assess the impact of the borrow areas on local wave energies. In order to do this, the bathymetry of Lake Pontchartrain will be represented by a grid system, with a refined grid, known as a nested grid, placed over the borrow areas. Since no wave data is available for Lake Pontchartrain, the nearest available wind data will be used as boundary input into the model. In addition to wind data, initial assumptions must be made for incident wave spectra at the boundary in order to give the model a computational starting point. Once the boundary conditions are input, the model will be run for a 90th percentile wind condition at various angles to the shore with and without the borrow area. After the runs are completed, they will be visually analyzed using SMS software to determine if any focusing of energy has occurred on the shore. The results of this modeling effort will be presented with the 95% Design Documents.

7.0 CONSTRUCTION COST ESTIMATE

PRELIMINARY CONSTRUCTION COST ESTIMATE

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization/Demobilization	1	LS	$1,233,500	$1,233,500
2	Marsh Creation	2,909,592	CY	$3.75	$10,911,000
3	Marsh Nourishment	300,365	CY	$3.75	$1,126,400
4	Containment Dikes	14,853	LF	$20	$297,100

Subtotal = $13,568,000
Contingency (25% x Subtotal) = $3,392,000

TOTAL ESTIMATED CONSTRUCTION COST = $16,960,000

8.0 MODIFICATIONS TO APPROVED PHASE 0 PROJECT

As a result of Phase 1 activities, the approved Phase 0 project has undergone very minor modifications. The Phase 0 project included 437 acres of marsh creation and 114 acres of marsh nourishment for a total of 551 acres. Marsh creation and marsh nourishment boundaries were slightly modified during Phase 1 resulting in 417 acres of marsh creation and 149 acres of marsh nourishment for a total of 566 acres.

9.0 REFERENCES

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