DESIGN REPORT
SOUTH GRAND CHENIER MARSH CREATION PROJECT (ME-20)

CAMERON PARISH, LOUISIANA

FEBRUARY 2016

Prepared for project sponsors:
US Fish and Wildlife Service (USFWS)
Louisiana Coastal Protection and Restoration Authority (CPRA)

Prepared by:
United States Department of Agriculture
Natural Resources Conservation Service (NRCS)

Contact:
Ed Kantz, P.E
edward.kantz@usda.gov

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION & BACKGROUND

1.1 Design Report Scope

This report is one part of the South Grand Chenier Marsh Creation Project (ME-20) final design package. The other parts of the package include the project specifications, plans, bid schedule, cost estimate, and quality assurance plan. This document will provide a narrative summary of the design of the project. This will include a brief discussion of the project background and objectives. Components of the preliminary investigation, project features, and design basis will also be discussed. Data, criteria, assumptions, procedures, and decisions used in the design will be included. Selected dimensions, elevations, and capacities will be used to augment the narrative, but are not intended to serve as a replacement for the project specifications, plans, or other parts of the design package.

1.2 Project Approval and Revision of Scope

The South Grand Chenier project was approved for Phase I funding by the LA Coastal Wetlands Conservation and Restoration Task Force on Priority Project List 11. The Fish and Wildlife Service (FWS) and the Louisiana Coastal Protection and Restoration Authority (CPRA) are the Federal and State sponsors. The original Wetland Value Assessment (WVA) was completed October 18, 2001, and revised on October 30, 2009. The original project was approved for construction funding in January 2010 but funding was returned in January 2012 due to landrights difficulties. 100% of the landrights for the marsh creation features was secured by September 2012.

The original project consisted of two components; 1) marsh creation using material excavated from the Gulf and 2) fresh water introduction from the Mermentau River through the Dr. Miller Canal to brackish marshes south of Hwy 82. The original project was intended to restore approximately 453 acres from dredged material placement and nourish or enhance an additional 4,000 acres of emergent marsh through fresh water introduction.

The project was revised to include the marsh creation component only. The project scope was changed to remove the freshwater introduction component, and the name was changed from “South Grand Chenier Hydrologic Restoration Project” to “South Grand Chenier Marsh Creation Project”, at the December 2012 Technical Committee meeting. The marsh creation component’s goal is to restore marsh material excavated from the Gulf of Mexico in two marsh creation areas; one in the southeastern portion of the Miller-Sweeney tract and the other east and south of Second Lake south of Hog Bayou. Additional unconfined material placement is to occur around the southern end of the Price Lake Unit Levee, to fill some of the levee borrow pits, improve the marsh, and help maintain the integrity of the levee.

Further discussion of the expected benefits of the revised project can be found in the FINAL Revised Wetland Value Assessment, USFWS, November 2012, included as Appendix B.

Further discussion of the design of the project with its original scope can be found in the “South Grand Chenier Hydrologic Restoration Project (ME-20) Final Engineering Design Report”, NRCS, October, 2009.

1.3 Project Location

The project is located in Region 4, Mermentau Basin/Chenier Sub-basin, Grand Chenier, Cameron Parish, in the Hog Bayou Watershed (Watershed) Coast 2050 Mapping Unit. The Watershed mapping unit is bordered by Lower Mud Lake to the west, the Gulf of Mexico to the south, Rockefeller Refuge to the east, and LA Hwy 82 to the north. The original approved project consisted of two areas north of Hog Bayou; an area located south of Hwy 82 and the Dr. Miller Canal between Hwy 82 and Hog Bayou, and an eastern marsh creation area south of Hog Bayou and east of Second Lake.

The revised project includes two confined marsh creation areas from the original project. The West Confined Marsh Creation Area (MCA) is located to the immediate west of Second Lake to the north of Hog Bayou. The East Confined MCA is located to the immediate southeast of Second Lake and immediately south of Hog Bayou. The project will also include an area of unconfined marsh fill around the southern end of the Price Lake Unit Levee. Marsh fill material will be excavated from a borrow area located in the Gulf of Mexico.

1.4 Hog Bayou Watershed Wetland Problems

The major environmental problem in the Hog Bayou Watershed is land loss caused by failed agricultural impoundments and pump-offs. Other problems include saltwater intrusion from the Mermentau Ship Channel construction and a Gulf shoreline erosion rate of 40 feet per year. Over a period of 60 years, 9,230 acres (38% of the original marsh) was lost, with the greatest amount of land loss occurring between 1956 and 1974. The major contributors to land loss in the watershed are subsidence, compaction, and the oxidization of marsh soils in the former pump-offs, and leveed agricultural areas between Hog Bayou and Highway 82**.** Large areas of marsh south of Highway 82 were “forced drained” during the 1960s, 1970s, and 1980s. Many of these same areas now consist of open water with very little wetland vegetation. The largest area of current loss is in a failed impoundment in the southern part of the project area (Louisiana Coastal Wetlands and Restoration Task Force and Wetland Conservation and Restoration Authority 1999).

2. WAVE ANALYSIS

Borrow Area Wave Refraction Analyses have been completed (Appendix C). Three alternative borrow areas were evaluated in the wave analysis report.

Alternative 1 was a 3,000-foot by 3,000-foot area placed seaward of the Dynegy Pipeline and approximately 5 miles south of the marsh creation areas. Based on the wave height and direction the impact on the shoreline would be negligible under average conditions. However, 1 and 20 year storms are expected to have an impact on the sediment transport. Alternative 1 would involve transporting the fill material a greater distance than Alternative 2, which would increase costs.

Alternative 2 is a trapezoidal shaped 6,000-foot by 1,500-foot area located approximately 4 miles south of the marsh creation areas. This borrow area would have a minor impact on the shoreline, but the wave flux would be smaller than Alternative 1. Alternative 2, because it is closer to the marsh creation areas, would have reduced transporting costs compared to the other alternatives.

Alternative 3 is rectangular shaped 3,850-foot by 1,500-foot area placed seaward of the Dynegy Pipeline and approximately 5 miles south of the marsh creation areas. This borrow site would have the least impact on the shoreline. However to get the required volume of in situ borrow material, an additional 5 feet of cut depth would be required. Alternative 3 would also involve transporting the fill material a greater distance than for Alternative 2, which would increase costs.

Alternative 2 was ultimately selected. Further discussion of this decision is included in Section 6.1 of this report.

3. SURVEYS

Topographic, bathymetric, and magnetometer surveys were performed within the marsh fill area to facilitate the design of the project. In addition, bathymetric and magnetometer surveys were performed offshore to help in delineating a suitable borrow area.

3.1 Horizontal and Vertical Control

The existing monument "TEAL" will be used for horizontal and vertical positioning during the project. The coordinates for this benchmark in Lambert Conformal Conic Projection, Louisiana State Plane Coordinate System South Zone 1702, NAD83 for horizontal datum and NAVD88, Geoid99 for vertical datum are as follows:

Northing: 434748.312
Easting: 2800752.529
Elevation: +1.745

This benchmark was set as ME16-SM-08 and was later corrected by NRCS for the ME-20 project.

The benchmark ME18-SM-03 was used for at least one project survey, the perimeter of the east confined MCA, but this benchmark has since been destroyed.

A new benchmark, ME32-SM-01, was set in the Spring of 2015 as part of the design work for the ME-32 project. The coordinates for this benchmark in Lambert Conformal Conic Projection, Louisiana State Plane Coordinate System South Zone 1702, NAD83 for horizontal datum and NAVD88, Geoid99 for vertical datum are as follows:

Northing: 453509.278
Easting: 2797564.120
Elevation: +2.671

It was determined that "TEAL" would be the primary benchmark to be consistent with existing surveys

3.2 Average Marsh Elevation Surveys

The desired marsh-creation target elevation at 3 years post construction was determined to be +1.3 feet NAVD 88 by project team members comprised of NRCS, USFWS, and OCPR (Office of Coastal Protection and Restoration, precursor to CPRA) based on NRCS field surveys. Field surveys established marsh elevations at + 1.2 feet NAVD 88. Fenstermaker and Associates recorded marsh elevations of +1.5 feet NAVD 88 in their hydrologic modeling report completed for the original project scope.

3.3 Borrow Area Surveys

Magnetometer and bathymetric surveys of the borrow area were conducted by T. Baker Smith (TBS) in May of 2008. Physical verification of all anomalies found was completed on July 1, 2008. All magnetic anomalies found were determined to be insignificant marine debris. The final report by TBS is included as Appendix D.

Because of the significant length of time that has passed since this borrow area magnetometer survey, the Contractor will be required to complete another magnetometer survey prior to operating any bottom disturbing equipment in the borrow area.

3.4 Fill Area Topographic Surveys

NRCS performed topographic surveys on both the east and west confined MCAs as well as the unconfined fill area. The confined marsh creation areas were surveyed with N-S transects spaced approximately 600 feet apart. The perimeters of these areas were also surveyed with a profile of shots taken approximately every 20 feet and cross-sections taken approximately every 200 feet.

The unconfined fill area was surveyed with transects spaced approximately 250 feet apart. The borrow pits located in this area were also surveyed.

3.5 Magnetometer Surveys of Fill Areas and Corridors

Magnetometer surveys of the fill areas and pipeline and equipment access corridors were conducted by EMC, Inc. in April and May of 2015. Two pipelines were identified. One pipeline is located to the west of the West Confined MCA and is crossed by the equipment access corridor. This pipeline was determined to be owned by Bridgeline Holdings LP and operated by EnLink Midstream.

The other pipeline is located in the northern part of the unconfined fill area and has been identified as an abandoned 6” flow line formerly belonging to Amoco Production Company. According to the abandonment documentation, the line was flushed with seawater and abandoned in place. The abandoned pipeline is now property of the Louisiana Department of Wildlife and Fisheries.

The locations of both pipelines are indicated in the project plans. The Magnetometer survey report by EMC, Inc. is included as Appendix E and the abandonment letter from Amoco is included as Appendix F.

4. TIDES AND WATER LEVELS

Calculations performed during the design of the ME-20 project included the determination of a tidal datum, or the mean high/mean low water (MHW/MLW) elevations. The tidal datum was calculated on at least two separate occasions. The first time the values were calculated for the Wetland Values Assessment report utilizing water levels recorded at CRMS station CRMS0614 for the period of 12-2009 to 12-2010. The following values were determined from these calculations:

MLW = 0.27 feet NAVD 88
MHW = 1.98 feet
Mean Water Level = 1.1 feet NAVD 88

It is not clear if these mean values were corrected using a control station following NOAA procedures.

The tidal datum was later revised using water levels recorded at CRMS station CRMS0614, this time for the longer period of 7-2007 to 8-2014. The tidal datums were calculated using the methodology provided in the NOAA publication “Computational Techniques for Tidal Datums Handbook - September 2003 (CO-OPS 2)” utilizing NOAA station 8758094, Calcasieu Pass, LA as the control station. The following values were determined from these calculations:

MLW = +0.99 feet NAVD 88 Geoid 99
MHW = +1.08 feet NAVD 88 Geoid 99
Mean Water Level = +1.04 feet NAVD 88 Geoid 99

The revised water level information is provided in the project plans. The following figure shows the location of the CRMS station water level gauge relative to the project location.

Figure 1: Location of Water Level Gauge Relative to Project Site

It should be noted that the CRMS0614 is located in an area that is partially impounded by board roads, Highway 82 and the Grand Chenier ridge, and the Miller-Sweeney levee but is not actively managed. This partial impoundment likely limits tidal effects on the water levels, and the portions of the project area that are less hydraulically isolated from the Gulf may see greater fluctuations between high and low water.

5. GEOTECHNICAL EVALUATION AND ANALYSES

5.1 Summary of Services

In 2008, Eustis Engineering Services (Eustis) was tasked by NRCS to perform a geotechnical investigation on the project site. The investigation included the drilling of soil test borings to determine subsoil conditions and stratification, and to obtain samples. Selected borings were transported to the US Army Corps of Engineers - Engineering Research and Development Center (ERDC) laboratory in Vicksburg, Mississippi, for testing. Soil Mechanics laboratory tests were performed by Eustis on samples of the remaining borings. Eustis performed analyses to evaluate the stability of the containment dike and the retained marsh fill. Analyses were also made to estimate allowable pile load capacities for piles to be used in the structure construction included in the project's original scope. The geotechnical report provided by Eustis is included as Appendix G.

ERDC performed testing and analyses on the samples they received to determine the following:
1) Settling and consolidation behavior of the proposed dredged fill and foundation material to

model elevation change with time after placement.
2) The initial fill height of dredged fill required to achieve project goals based on settling characteristics.
3) The in situ borrow quantity required for filling the marsh creation areas to obtain the project goals.
The geotechnical report provided by ERDC is included as Appendix H.

5.2 Eustis Engineering Services

5.2.1 Field Investigation

Eustis performed three soil test borings in the West confined MCA, one 50-ft deep boring and two 80-ft deep borings. Five borings were performed in the East confined MCA, three 50-ft borings and two 80-ft borings. These borings were made using a rotary type skid rig mounted on a marsh buggy. The 80-ft borings were transported to ERDC. The locations of the marsh-creation area borings are provided in the project plans.

Nineteen 20-ft deep undisturbed soil borings were made within the proposed borrow area. These borings were made using a rig on a jack-up barge. All of the borrow borings were transported to ERDC.

An additional 14 borings were made outside of the current project area in support of the original project scope.

Samples of cohesive and semi-cohesive soils were obtained using a 3-in. diameter thin-wall Shelby tube sampling barrel. Field torvane tests were also performed on survey samples. Samples of cohesionless and semi-cohesive materials were obtained during the performance of in-situ standard penetration tests.

5.2.2 Laboratory Testing

Laboratory tests performed on the samples included natural water content, unit weight, unconfined compression shear (UC), one-point unconsolidated undrained triaxial compression shear (OB), and Atterberg limits tests.

5.2.3 Analyses

Slope stability analyses were performed for the design of proposed containment dikes that will enclose the marsh creation features. Slope stability analyses were conducted by a two-dimensional limit equilibrium stability analysis of selected trial failure surfaces. These analyses were performed using GEO-SLOPE International, Ltd.'s program SLOPE/W 2007, Version 7 .14. A recommended minimum factor of safety of 1.2 based on Spencer’s Method of Slices was used in the analyses.

The analyses assumed that containment dikes would be placed at an existing mudline elevation of 0 NAVD 88 and the dike crowns would be at an elevation of +6 feet. The crest width was assumed to be approximately 5 feet. The dikes were assumed to be constructed from material excavated from within the containment area. The low water level was assumed to be at an elevation of 0 (at the existing ground surface). A composite set of parameters was selected for the evaluation of slope stability. The containment dike fill was assumed to be uncompacted with a wet unit weight of 88 pounds per cubic foot (pcf) and a remolded shear strength of 100 pounds per square foot (psf). The hydraulically dredged and pumped fill material was assumed to have a unit weight of 100 pcf and no strength and was assumed to be placed 1 to 1.5 feet below the levee crown. Differential water surface across the containment was assumed to vary between elevation of +1 on the exterior and elevation of +4.5 on the interior. It was assumed that the dikes will remain in place a minimum of 60 days prior to pumping hydraulic fill to create the marsh area.

The side slopes of the dike borrow channel were assumed to be 1 vertical to 2 horizontal, and the cut was assumed to be no deeper than an elevation of -5.0 NAVD 88.

5.2.4 Construction Recommendations

Based on the analyses and assumptions Eustis made the following recommendations.

a) Side slopes should be 1 vertical to 4 horizontal.
b) The distance between the toe of the containment dike and the beginning of the borrow area excavation should be at least 15 feet plus two times the excavation depth within the borrow canal.
c) Uncompacted fill may be placed directly over any existing vegetation. Trees and shrubs should be cut to grade but the root mass should remain in place.
d) Uncompacted dike fill should be placed in lifts of no more than 3 feet. The Dike construction can be performed in two to three stages.
e) Hydraulic fill slurry should be placed no higher than 1 foot below the crown of the containment dikes.

5.3 Engineer Research and Development Center Services

Eustis delivered samples from several different borings to ERDC for testing and analysis. Samples included four 80-ft borings with 27 – 28 samples per boring. Two borings were taken from the east placement area and two were taken from the west placement area. Eustis also delivered sixteen 20-ft borings, divided into 20 samples each, and 7 buckets of site water from the borrow area.

5.3.1 Laboratory Testing

It was determined that only one boring in each of the marsh creation areas would need to be analyzed because the borings in each area were similar to each other. Samples from each analyzed boring were tested for water content and grain size distribution. Two composite samples were created from each of the analyzed borings and these samples were used for standard oedometer testing as well as specific gravity, salinity, and grain size distribution tests.

Due to the uniformity of the samples collected from the borrow area, 3 samples were homogenized to form one composite sample for consolidation testing (self-weight and oedometer) as well as column settling analyses, atterberg limits, specific gravity, organic content, water content and grain size distribution tests. A second composite sample was created for water column settling analysis. Individual samples throughout the depth of the cores were analyzed for water content and grain size distribution.

Column settling tests were performed in accordance with USACE Engineer Manual 1110-2-5027 using a 6-ft column and monitoring settlement and supernatant quality over 15 days. From the test data, the SETTLE model was used to develop settling curves, both turbidity and total suspended solids were measured to develop a flocculent settling curve.

5.3.2 Analyses

Volume occupied by the dredged material was estimated based on the settling behavior of the dredged material using the SETTLE model developed by the US Army Corps of Engineers. This model utilizes the results of laboratory column settling tests.

After initial settling, long-term consolidation will occur, further reducing the dredged material volume and elevation. Long-term consolidation was modeled using the Primary Consolidation, Secondary Compression and Desiccation of Dredged Fill (PSDDF) model.

It was assumed that the target marsh elevation would be as high as +1.5 ft. NAVD 88 at 5 years after placement. Average elevations of +0.15 ft. in the West are and -0.15 ft. in the East area were used in the analysis. It was assumed that a 30-inch dredge would be used, and allowed to operate 7 days per week, 24 hours per day with 50% of the time spent actually dredging.

SETTLE and PSDDF models were developed to support dredging projects where a known volume will be dredged and one desires to know the elevation of the material at a future time. In this project scenario, the dredged volume is the unknown so the models were run iteratively, estimating a dredged volume, then using SETTLE to determine the as-placed volume thickness and void ratio and using PSDDF to determine the resulting elevation at the target time period, then adjusting the dredging volume for subsequent iterations.

The PSDDF model runs used typical foundation parameters for the incompressible foundation. For the compressible foundation, oedometer test results from the sample that showed the greatest compressibility were used to be conservative. All of the foundation demonstrated very low permeability, which will limit compression due to the inability to drain water. Due to low compressibility of the foundation material, the PSDDF model could not be used to model compression of the foundation material. Therefore, the foundation behavior was modeled manually within a spreadsheet. A depth of compressible foundation of 30 ft. was assumed, with half of the consolidation shown to occur in the upper 4 feet. Consolidation of the fill material was modeled using the PSDDF model. Then, the resulting effective stress from the fill material was used to calculate the maximum settlement of the foundation. Monthly rainfall data was obtained from the Rockefeller Wildlife Refuge, LA Coop ID 167932 weather station. Evaporation pan data was used from the southeast part of Texas (the closest location found). The settlement occurring at the specified times was calculated based on the limitation of the foundation material’s low permeability. The permeability-based foundation settlement was subtracted from the PSDDF model results (which assumed an incompressible foundation) to estimate the surface elevations over time.

5.3.3 Findings

The results of the PSDDF model runs are shown in the following tables.

Table 1: PSDDF Model Runs – East Placement Area

	As Placed									Elevation	
In Situ Volume yd^3	Estimated Time to Complete Dredging days	Predicted Effluent Conc.[1] mg/l	Volume Sand yd^3	Volume Fines yd^3	Volume Total yd^3	Void Ratio Fines	Average[2] Sediment Thickness ft	Fill Elevation ft	Required Dike[3] Elevation ft	At 5 years ft	At 3 years ft
700,000	44.2	25.24	8528	2,063,788	2,072,316	9.8748	4.55	4.40	6.40	1.196	1.272
705,000	44.5	25.24	8589	2,077,051	2,085,640	9.8671	4.58	4.43	6.43	1.205	1.281
707,000	44.6	25.24	8614	2,082,353	2,090,966	9.8640	4.60	4.45	6.45	1.208	1.286
707,200	**44.7**	**25.24**	**8616**	**2,082,883**	**2,091,499**	**9.8637**	**4.60**	**4.45**	**6.45**	**1.2088**	**1.3022**
707,500	44.7	25.24	8620	2,083,678	2,092,298	9.8632	4.60	4.45	6.45	1.209	1.323
708,000	44.7	25.24	8626	2,085,004	2,093,629	9.8624	4.60	4.45	6.45	1.293	1.370
709,000	44.8	25.24	8638	2,087,654	2,096,292	9.8609	4.61	4.46	6.46	1.295	1.372
710,000	44.8	25.24	8650	2,090,304	2,098,954	9.8594	4.61	4.46	6.46	1.297	1.374
725,000	45.8	25.24	8833	2,130,007	2,138,840	9.8367	4.70	4.55	6.55	1.325	1.403
715,000	45.1	25.24	8711	2,103,547	2,112,258	9.8518	4.64	4.49	6.49	1.306	1.384
800,000	50.5	25.24	9747	2,327,329	2,337,076	9.7305	5.14	4.99	6.99	1.464	1.550
820,000	**51.8**	**25.24**	**9990**	**2,379,629**	**2,389,620**	**9.7041**	**5.25**	**5.10**	**7.10**	**1.5001**	**1.5886**
825,000	52.1	25.24	10051	2,392,684	2,402,735	9.6976	5.28	5.13	7.13	1.509	1.598
850,000	53.7	25.24	10356	2,457,842	2,468,197	9.6657	5.43	5.28	7.28	1.611	1.703

Table 2: PSDDF Model Runs – West Placement Area

In Situ Volume	As Placed									Elevation	
	Estimated Time to Complete Dredging	Predicted Effluent Conc.[1]	Volume Sand	Volume Fines	Volume Total	Void Ratio Fines	Sediment Thickness	Fill Elevation	Required Dike Elevation[3]	At 5 Years	At 3 Years
yd^3	days	mg/l	yd^3	yd^3	yd^3		ft	ft	ft	ft	ft
250,000	15.8	42.33	3,046	817,002	820,047	11.0542	2.99	3.14	5.14	0.875	0.920
275,000	17.4	42.33	3,350	890,177	893,527	10.9398	3.26	3.41	5.41	0.905	0.955
290,000	18.3	42.33	3,533	933,760	937,293	10.8766	3.42	3.57	5.57	0.975	1.027
300,000	18.9	42.33	3,655	962,689	966,344	10.8364	3.52	3.67	5.67	1.014	1.068
350,000	22.1	42.33	4,264	1,105,957	1,110,221	10.6553	4.05	4.20	6.20	1.226	1.288
355,000	**22.4**	**42.33**	**4,325**	**1,120,166**	**1,124,491**	**10.6388**	**4.10**	**4.25**	**6.25**	**1.2402**	**1.3038**
360,000	22.7	42.33	4,386	1,134,355	1,138,741	10.6225	4.15	4.30	6.30	1.255	1.319
400,000	25.3	42.33	4,873	1,247,185	1,252,058	10.5007	4.57	4.72	6.72	1.431	1.502
420,000	26.5	42.33	5,117	1,303,170	1,308,287	10.4447	4.77	4.92	6.92	1.490	1.565
423,000	26.7	42.33	5,153	1,311,545	1,316,698	10.4366	4.80	4.95	6.95	1.499	1.575
423,500	**26.7**	**42.33**	**5,160**	**1,312,940**	**1,318,100**	**10.4352**	**4.81**	**4.96**	**6.96**	**1.5003**	**1.5761**
424,000	26.8	42.33	5,166	1,314,335	1,319,501	10.4339	4.81	4.96	6.96	1.502	1.578
425,000	26.8	42.33	5,178	1,317,125	1,322,303	10.4312	4.82	4.97	6.97	1.505	1.581

The predicted effluent concentration assumes a withdrawal depth of 1 ft. where withdrawal depth is essentially the ponded water depth at the weir. The output also assumes a 1 ft. freeboard and 1 ft. ponded water depth.

The bolded rows in the tables highlight the required volume of material to be dredged to achieve an elevation of +1.3 feet at 3 years and +1.5 feet at 5 years. These volumes assume the West placement area is 170 acres and the East area is 282 acres.

ERDC also predicted the result of continued consolidation after the target years; these predictions are illustrated in the following charts.

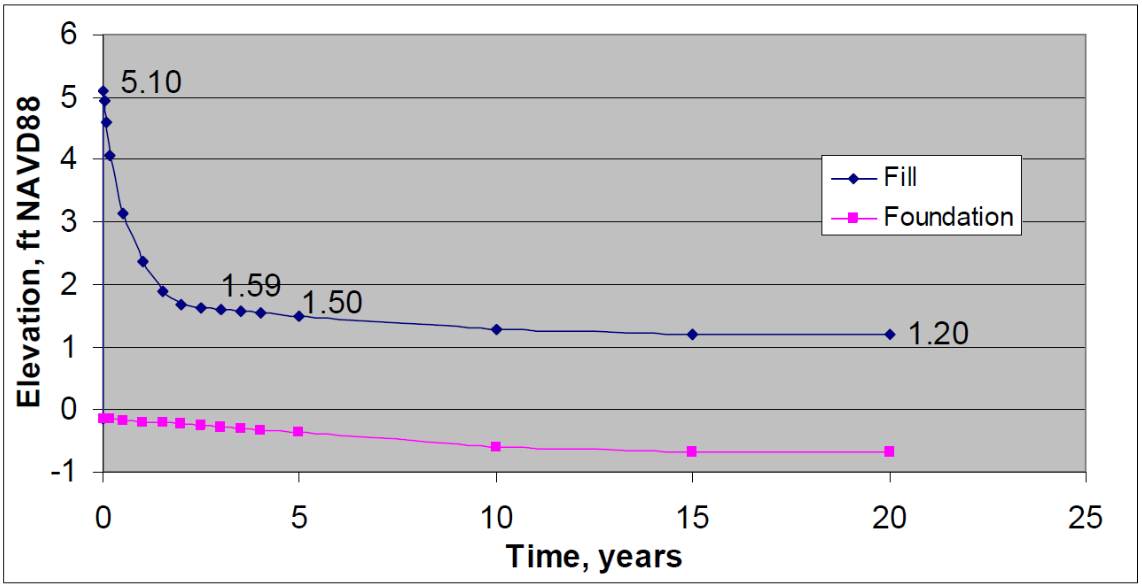

Figure 2: East Area – Elevation vs. Time, 820,000 in situ CY

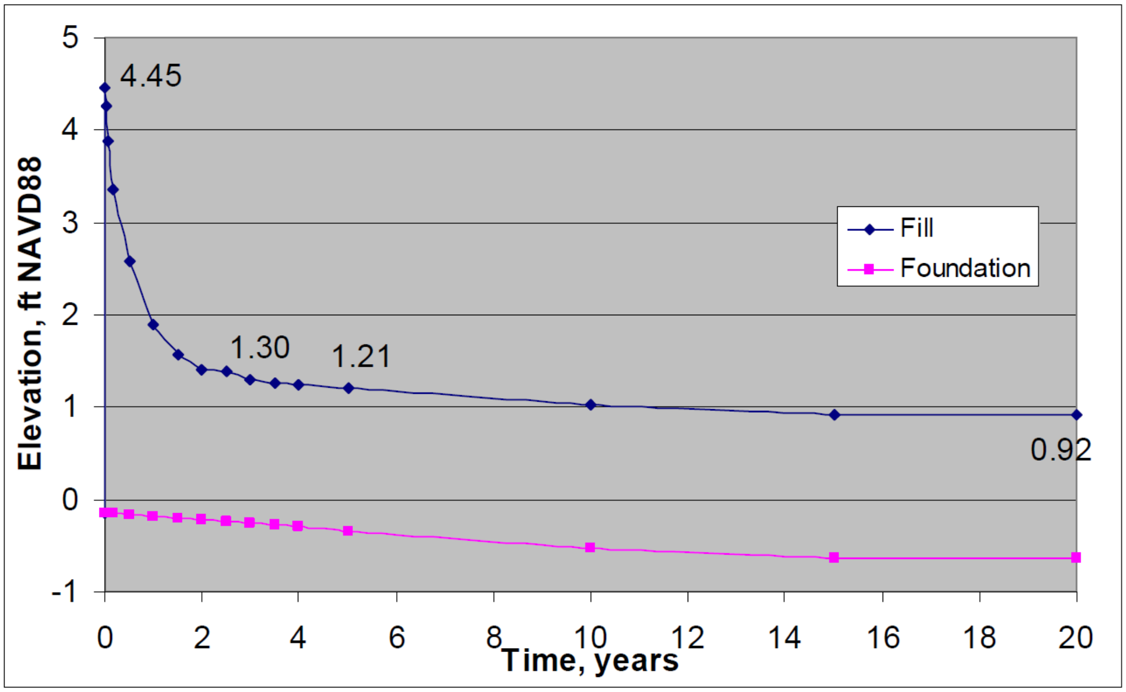

Figure 3: East Area – Elevation vs. Time, 707,200 in situ CY

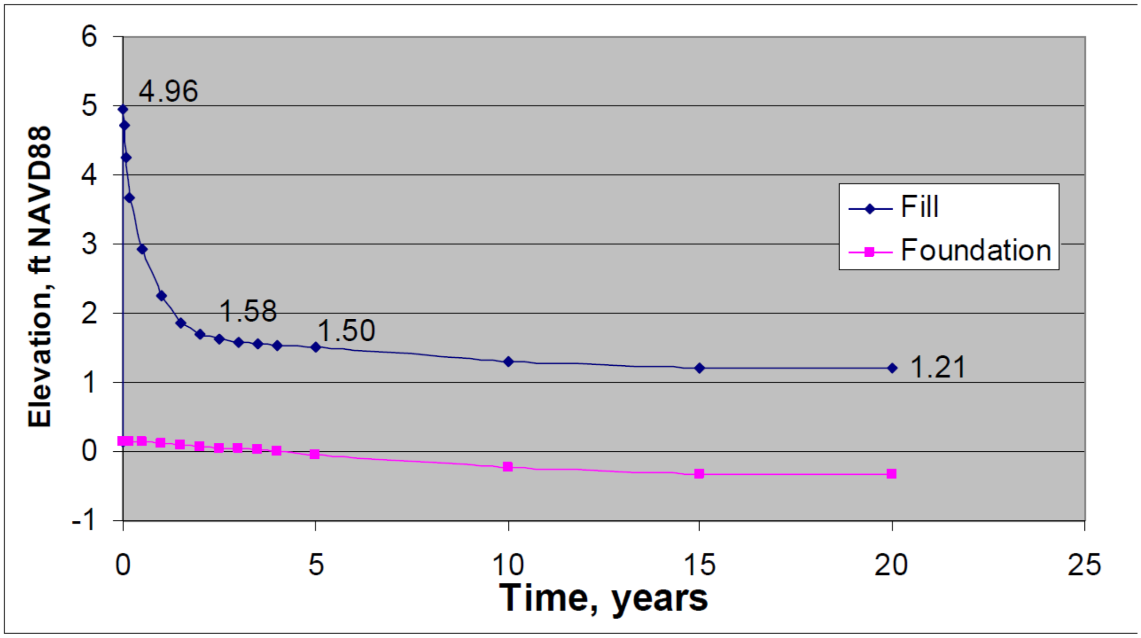

Figure 4: West Area – Elevation vs. Time, 423,500 in situ CY

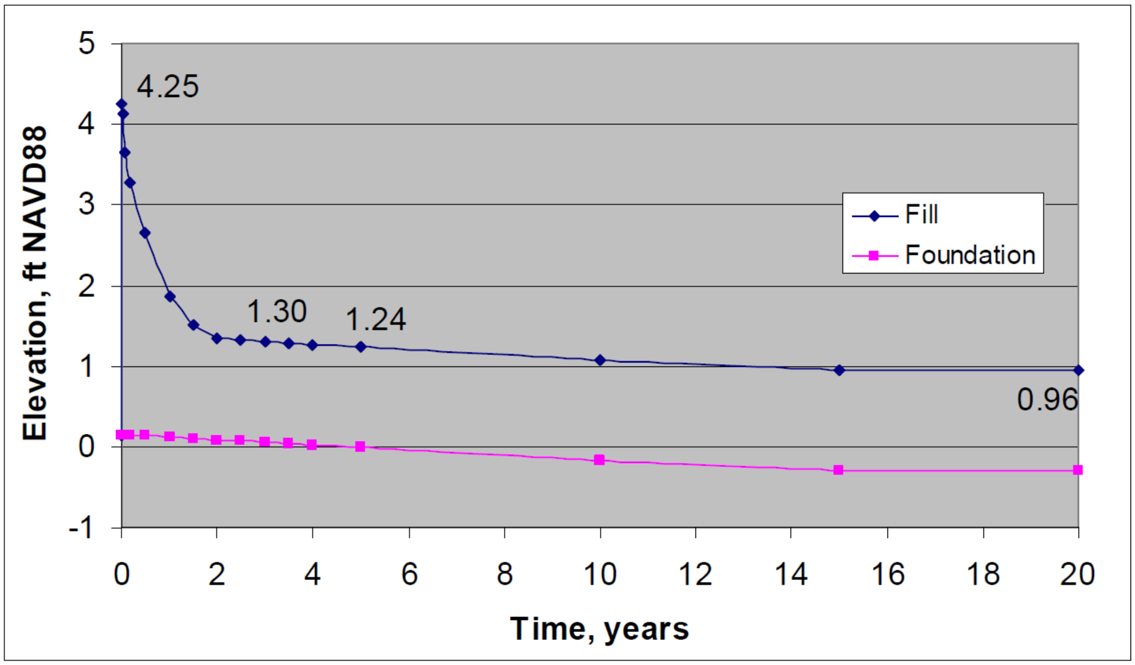

Figure 5: West Area – Elevation vs. Time, 355,000 in situ CY

The report also contains an analysis of variable dredging rates based on SETTLE analyses. These results illustrate that slower dredging rates from smaller dredges provide more time for compression settling resulting in lower dike elevation requirements.

6. MARSH CREATION DESIGN

6.1 Borrow Site Design

As discussed in section **2**, a wave analysis was performed on three separate potential borrow areas

Alternative 2 was chosen for the borrow area because it was the closest alternative to the fill site, and its effects on wave height and direction would have a minor impact on the Gulf shoreline south of Grand Chenier. Because the borrow area is one mile closer to the fill areas than the other alternatives, it would have reduced costs for transporting material. Project benefits would outweigh any borrow site impacts to near shore sediment transport compared to the other sites.

Later, after the selected alternative had been further investigated with magnetometer and bathymetric surveys, the size of borrow area was reduced to more closely match with the size needed to produce the marsh fill soil as calculated based on ERDC analyses. The eastern side of the original borrow area was removed to save it for potential use for the ME-32 project marsh creation area which is located just to the north of the East confined MCA. The final size and shape of the borrow area is shown in the project plans. It was also decided that the Contractor would be required to excavate starting from the west side of the borrow area to the east side so a contiguous borrow area would be left over for any future project if the full borrow area is not needed, and so excavation could continue in the same direction if the borrow area should need to be expanded.

6.2 Design Marsh Fill Elevation Selection

The target marsh elevation was determined to be +1.3 feet NAVD88 at 3 years post construction by project team members comprised of NRCS, USFWS, and CPRA. The team based this decision on NRCS field surveys and the results of the ERDC dredge fill volume analysis.

The initial fill height is established at +4.5 feet NAVD 88 for the East confined MCA, and +4.3 feet NAVD 88 for the West confined MCA to achieve the desired 3 year marsh elevation as determined in the ERDC marsh creation report (Tables 1 and 2).

The maximum fill elevation for the unconfined marsh creation areas was set at +3.0 feet to ensure that the fill material does not flow over the levee road or the beach ridge.

6.3 Containment Dike Design

The containment dike alignment was developed for full containment of the fill material in the planned marsh creation areas. The alignment was modified during the design process to ensure that Hog Bayou would be maintained as a continuous open water channel, and acute angles in the alignment would not create unnecessary construction difficulties.

The crown of the containment dike was set at an elevation of +6.0 NAVD 88 for both the East and West confined MCAs. The +6.0 crown elevation was selected by assuming 0.5 feet of ponding/fill tolerance and 1.0 foot of freeboard over the initial fill elevation in the East confined MCA. The same crown elevation was used for the West confined MCA to reduce potential confusion during construction, given the minor difference in required initial fill height elevation.

The top width of the containment dikes was set at 5 feet and the minimum side slopes are required to be 4 horizontal to 1 vertical based on the recommendations in the Eustis geotechnical report.

A minimum berm of 35 feet is required allowing a minimum width of 20 feet for equipment operation with a 15-foot buffer required between any construction equipment and the toe of the dike. This buffer is intended to prevent construction equipment trafficking along the side of the dike from undercutting the toe and compromising the structural integrity of the dike. This berm width also ensures compliance with the Eustis geotechnical report recommendation of a berm width of 15 feet plus two times the maximum depth of borrow excavation, as the maximum borrow excavation depth is set at 5 feet and as such the berm width need only be 25 feet or greater to meet the Eustis recommendation.

Because the combination of the dike slope lengths, top width, and equipment buffer is greater than the typical reach of a typical long reach excavator, it was determined that the outside slope of the containment dike would not need to be dressed.

The locations along the dike alignments where dewatering structures would be allowed were selected to prevent sediment in the outflowing water building up in areas where it would be problematic. The locations selected do not discharge into stream channels where the sediment buildup might interrupt flow, nor do they discharge into areas owned by entities not involved in the project. Dewatering into Second Lake was also avoided as the project seeks to rebuild a portion of the Second Lake lake rim and not alter second lake with additional sediment.

6.4 Dredge Volume Determination

The dredge “cut” volume for the contract was determined using the volumes developed in the ERDC report. Because the area of each confined MCA was reduced somewhat from the original areas provided to ERDC, the new fill volumes were calculated by multiplying the ERDC average fill depth by the new containment area. The volume of borrow material for constructing the dikes was added to this volume. The borrow volume for the dikes was estimated to be the constructed dike volume based on neat lines and grades multiplied by a factor of two to account for shrinkage, settlement, and material loss. This fill volume was then divided by the bulking factor derived from the ERDC report to determine the required dredge cut volume. This dredge cut volume was then increased by 30% to account for material loss in the dredging process. This material loss would occur pre-discharge (e.g. material disturbed by the dredge cutter head is not sucked into the dredge pipe).

The project also includes an unconfined marsh creation area, the purpose of which is to fill borrow pits at the southern end of the Price Lake Unit Levee while nourishing the surrounding marsh. The volume required for this was based on the characteristics of unconfined fill in the PO-75 LaBranche East Marsh Creation project. The before-construction surveys and after-construction surveys were analyzed to determine a typical slope of the unconfined flow as well as an approximate volume of fill (post settling). The dredge tracking spreadsheets and site observations were used to determine an estimate for the cut volume, which was then used to create an approximate cut to fill ratio. The target fill height for the ME-20 unconfined areas was determined based on the elevation of the beach ridge and the levee top. The PO-75 slope was then applied to the fill height, and a digital surface developed from surveys of the ME-20 marsh, to determine an approximate fill area and volume of unconfined fill (post settling). The PO-75 cut to fill ratio was then used determine a cut volume for the ME-20 unconfined fill.

The final cut volume was the sum of the cut volumes for the confined and unconfined areas, and was determined to be 1,506,440 cubic yards.

Dredge volume calculations are attached as Appendix I.

7. DEVELOPMENT OF OTHER DESIGN DOCUMENTS

Additional design documents created for this project include plans, specifications, a bid schedule, a construction cost estimate, and a construction schedule. These documents are included as part of the design package and supplemental information on each is included in the following subsections.

7.1 Project Plans

The project plans were developed using Microstation CAD software. The plans were developed using the plans developed for the original project scope. The plan sheets that did not apply to the revised scope were removed, and the remaining sheets were revised and additional sheets were added based on input provided by the project team through multiple reviews.

7.2 Project Specifications

The following specifications were used in this project.

(CS3) Structure Removal
(CS5) Pollution Control
(CS7) Construction Surveys
(CS8) Mobilization and Demobilization
(CS21) Excavation
(CS23) Earthfill
(CS93) Identification Markers or Plaques
(CS94) Contractor Quality Control

The project utilizes only NRCS national standard construction specifications with items of work and construction details that include project specific information. Because the Standard Excavation (CS21) and Earthfill (CS23) specifications were developed for earthwork operations that are more typical of NRCS' national workload (i.e. upland earthen structures where long term strength is required), and do not fit well with the requirements of the marsh earthwork in this project, the use of state interim specifications for containment dike construction, and marsh infill dredging were considered. New specifications were developed for this purpose, but it was ultimately determined that the NRCS national standards would be used as the new specifications were introduced too late in the design process and there was concern that there would not be adequate opportunity for input from all interested parties.

7.3 Bid Schedule

The project bid schedule is shown in the following table.

Table 3: ME-20 Bid Schedule

Item No.	Work	Spec No.	Quantity	Unit	Unit Price	Amount
1	Contractor Quality Control	94	1	Lump Sum	XXXX	$
2	Construction Surveys	7	1	Lump Sum	XXXX	$
3	Mobilization and Demobilization	8	1	Lump Sum	XXXX	$
4	Earthfill, Containment Dikes	23	33,560	LF	$	$
5	Staff Gauges	93	73	Each	$	$
6	Lighted Buoys	93	69	Each	$	$
7	Excavation for Marsh Creation Fill	21	1,506,440	CY	$	$
					Total Bid	$
8	Structure Removal (Additive Item)	3	5	Each	XXXX	$
			Total Bid including Optional Item 8			$

Each specification warranted its own bid item or items with the exception of pollution control, which was made subsidiary to Contractor Quality Control, and Clearing, which was made subsidiary to Earthfill, Containment Dikes. Pollution Control was made subsidiary to Contractor Quality Control because these two items often utilize the same personnel and it may be difficult for the contractor to separate the cost accurately. Clearing was made subsidiary to Earthfill, Containment Dikes because the clearing work is specifically for the containment dike construction, with a minimal cost.

Contractor Quality Control, Construction Surveys, and Mobilization and Demobilization were all set as lump sum items because the expenses are project wide and do not correlate with a measurable work quantity.

7.4 Construction Cost Estimate

The construction cost estimate is shown in the following table.

Table 4: ME-20 Cost Estimate

Item No.	Work	Spec No.	Quantity	Unit	Unit Price	Amount
1	Contractor Quality Control	94	1	Lump Sum	XXXX	$ 267,600.00
2	Construction Surveys	7	1	Lump Sum	XXXX	$ 510,900.00
3	Mobilization and Demobilization	8	1	Lump Sum	XXXX	$ 2,381,500.00
4	Earthfill, Containment Dikes	23	33,560	LF	$ 56.98	$ 1,912,300.00
5	Staff Gauges	93	73	Each	$ 769.86	$ 56,200.00
6	Lighted Buoys	93	69	Each	$ 2,097.10	$ 144,700.00
7	Excavation for Marsh Creation Fill	21	1,506,440	CY	$ 8.48	$ 12,781,400.00
					Total Bid	$ 18,054,600.00
8	Structure Removal (Additive Item)	3	5	Each	$ 4,860.00	$ 24,300.00
			Total Bid including Additive Item 8			$ 18,078,900.00

Costs may be affected by adjustment of quantities, change in project features, or changes in industry prices prior to the bid opening. Details on methodology and assumptions used in developing this estimate are included with the cost estimate calculations details.

7.5 Construction Schedule

The estimated construction schedule is shown in the following table and bar chart.

Table 5: ME-20 Estimated Construction Schedule

Activity	Start Day	Duration (days) (7-day week)	End Day	Duration (months)	Month of end day
Mobilize containment dike crew and equipment	1	2	3	0.1	0.1
Mobilize dredge	67	9	76	0.3	2.5
Mobilize pipeline	27	9	36	0.3	1.2
Install buoys	29	7	36	0.2	1.2
Prepare pipeline at jobsite	36	40	76	1.3	2.5
Construction of West containment dike	3	70	73	2.3	2.4
Install Gauges in West MCA	73	3	76	0.1	2.5
Pumping material into West confined MCA	76	31	107	1.0	3.5
Switch pumping from W to E MCA	107	2	109	0.1	3.6
Construction of East containment dike	3	81	84	2.7	2.8
Install Gauges in East MCA	84	4	88	0.1	2.9
Pumping material into East confined MCA	109	58	167	1.9	5.5
Removal of pipeline from northern part of project site	167	12	179	0.4	5.9
Pumping material into unconfined areas	179	5	184	0.2	6.0
Removal of dredge pipeline & load on barges	184	2	186	0.1	6.1
Prepare dredge for demobilization	184	2	186	0.1	6.1
Site cleanup and prep onshore equipment for demob	184	2	186	0.1	6.1

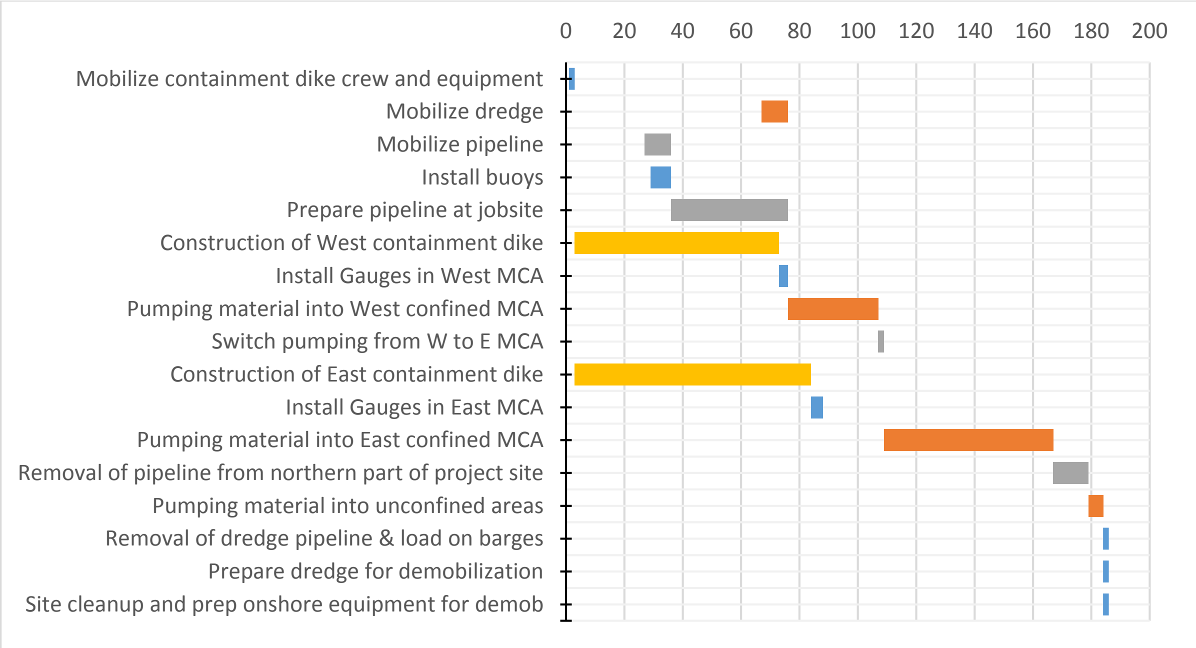

Figure 6: ME-20 Construction Schedule Bar Chart

Note that the containment dike for at least one confined MCA must be completely constructed and the pipeline to that area must be assembled before any fill material can be placed. In this estimate, it was assumed that the West confined MCA was going to be fully completed prior to the initiation of pumping material into the East confined MCA. It was also assumed that the pumping into the unconfined areas would occur after the pipeline has been removed from the northern part of the site after both confined MCAs have been completed. It should be noted that the contractor will have other options, such as completing the East confined MCA first or pumping into both areas simultaneously. A slower average fill rate was used for the unconfined areas, as more frequent stopping will likely be required due to their small size.

The estimated schedule shown here does not account for weather delays or other potential delays associated with other construction approaches or unexpected circumstances. The contract performance time will need to be longer than the construction time shown to account for these issues.

8. CONSTRUCTION REVIEW

A preconstruction conference should be held to help ensure that the contractor understands the design and construction requirements. If conditions encountered during construction appear to differ significantly from design assumptions, the design engineer should be notified in a timely manner and allowed to perform an engineering review.

9. REFERENCES

Clark, Darryl. 2012. *FINAL Revised Wetland Value Assessment Project Information Sheet.* U. S. Fish and Wildlife Service.

Coastal Engineering Consultants, Inc. 2008. "South Grand Chenier Hydrologic Restoration Project Borrow Area Wave Refraction Analysis."

EMC, Inc. 2015. "Magnetometer Survey - ME-20 Cameron Parish, LA." Grenada, MS.

Eustis Engineering Services. 2009. "Geotechnical Investigation ME-20 South Grand Chenier Cameron Parish, Louisiana." 16 pages + appendices.

Morris, J. C. 1983. "Right-of-Way Forfeiture." Lafayette, Louisiana, July 22.

National Oceanic and Atmospheric Administration. 2003. "COMPUTATIONAL TECHNIQUES FOR TIDAL DATUMS HANDBOOK." NOAA Special Publication, Silver Spring, Maryland.

T. Baker Smith, Inc. 2008. "South Grand Chenier Magnetometer/Sonar Scan Survey Cameron Parish, Louisiana." 15.

U. S. Army Corps of Engineers. 1987. "Engineering Manual 1110-2-5027 Confined Disposal of Dredged Material." Washington, D. C.

U. S. Army Corps of Engineers. 2009. "Grand Chenier, LA, Marsh Creation - Analysis of Dredge Fill Volume Requirements." Engineer Research and Development Center, Vicksburg, MS.

USDA NRCS. 2009. "South Grand Chenier Hydrologic Restoration Project (ME-20) Final Engineering Design Report."

AUTHORITY

Designed by:

.______________________________________.
Edward Kantz, P.E.
Civil Engineer

Approved by:

.______________________________________.
John Jurgensen, P.E.
State Conservation Engineer

Appendix A
U.S. Fish and Wildlife Service
FINAL Environmental Assessment

Appendix B
U.S. Fish and Wildlife Service
FINAL Revised Wetland Value Assessment

Appendix C
Borrow Area Wave Refraction Analysis

Appendix D
T. Baker Smith Inc.
Borrow Area Survey Report

Appendix E
EMC, Inc.
Magnetometer Survey Report

Appendix F
Amoco
Pipeline Abandonment Letter

Appendix G
Eustis Engineering Services
Geotechnical Investigation Report

Appendix H
USACE ERDC
Analysis of Dredge Fill Volume Requirements

Appendix I
Volume Calculations