95% DESIGN REPORT

BA-195 Barataria Bay Rim Marsh Creation Project
Jefferson & Plaquemines Parishes, Louisiana

January 2020

Prepared for:

Natural Resources Conservation Service
3737 Government Street
Alexandria, La 71302

Attention: Mr. Curt Clark, Contracting Officer

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CIVIL ENGINEERING AND LAND SURVEYING CONSULTANTS

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Scope of Work and Work Performed to Date

Lonnie G. Harper & Associates, Inc. (LHA) has been tasked by the Natural Resource Conservation Service (NRCS) to provide professional services for the design of the BA-195 Barataria Bay Rim Marsh Creation Project, which originally comprised of approximately 500 acres of marsh creation/marsh nourishment along the northern rim of Barataria Bay in Jefferson and Plaquemines Parishes. As part of the initial design phase, LHA, with the assistance of its geotechnical engineering subcontractor, GeoEngineers, Inc. (GEO), was required to develop alternative design considerations for the project features and evaluate those alternatives for their effectiveness and abilities to meet the overall project goals. Those alternatives were compiled and submitted to the NRCS for review and comments in the Preliminary Alternatives Feature Report in May 2018. Said report evaluated the various feature alternatives and a recommendation was made by LHA to use multiple feature designs for the project based on site specific needs and considerations. In July 2018, the NRCS concurred with the recommendations presented and authorized LHA to proceed to the next phase of the project, Project Feature Design. Following a 30% Design Review Meeting in March 2019 and consideration of comments resulting from that review meeting, NRCS authorized LHA to proceed to the 95% Design in June 2019. This report will outline the recommended features and further refine the design of those features based on site conditions, project goals, engineering standards, and construction practices.

LHA has completed several tasks associated with the BA-195 project. Below is a list of tasks completed under LHA's task order. Results of these efforts are referenced throughout parts of this report. All documents listed are included as appendices to this report.

- Secondary Monument Establishment Survey Report by LHA, Appendix C
- Water Level Determination Report by LHA, Appendix D

- Topographic & Bathymetric Survey Report by LHA, Appendix E
- Geotechnical Services Report by GEO, Appendix F
- Geotechnical Services Addenda by GEO, Appendix F-1
- Magnetometer Survey Report by LHA, Appendix G

In addition to the referenced tasks completed by LHA and GEO, below are additional supporting documents that are referenced throughout this report, all of which have also been included as appendices.

- Land Ownership Report, Appendix H
- Section 106 Cultural Resources Consultation, Appendix I
- Oyster Lease Map and Database, Appendix J
- Referenced Literature, Appendix K

Project Overview and Goals

The BA-195 project site is located in the coastal marshes of Jefferson and Plaquemines Parishes in southeastern Louisiana along the northern shore of Barataria Bay between Bayou St. Denis and Wilkinson Canal. (Figures 1.1 and 1.2)

Figure 1.1 – Vicinity Map

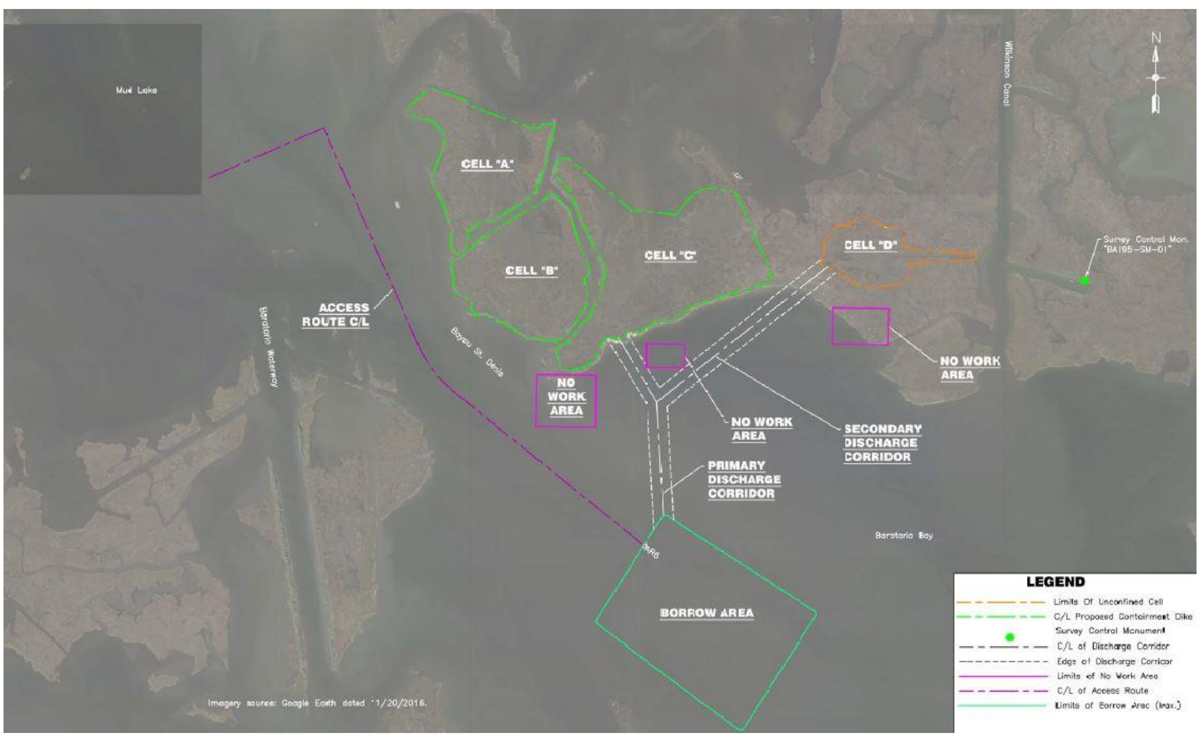


Figure 1.2 – Original Project Location and Features

The project was approved and funded for engineering and design through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) on Project Priority List 25. The project is sponsored by the NRCS and the Coastal Protection and Restoration Authority (CPRA) of Louisiana. The project area has been subject to significant wetland loss in the form of interior marsh loss and shoreline erosion along the bay rim. According to the NRCS preliminary project design investigation, the interior wetland loss is likely due to subsidence and sea-level rise, sediment deprivation, and the construction of access and pipeline canals.

Originally the project consisted of three fully-contained and one semi-contained marsh creation / marsh nourishment cells totaling approximately 500 acres. Due to numerous pipelines in the project area, the semi-contained cell has been eliminated and one of the fully-contained cells has been split into two cells. Currently, the project consists of restoring 426 acres of saline marsh by hydraulically dredging in-situ material from Barataria Bay and placing it into four fully-contained cells within the interior marsh (Figure 1.3). The goal of this project is to create a marsh platform that will support the growth of native marsh vegetation and will help protect the area from future land loss. The benefits from BA-195 are expected to last a minimum of 20 years, which is the life span of a CWPPRA project.

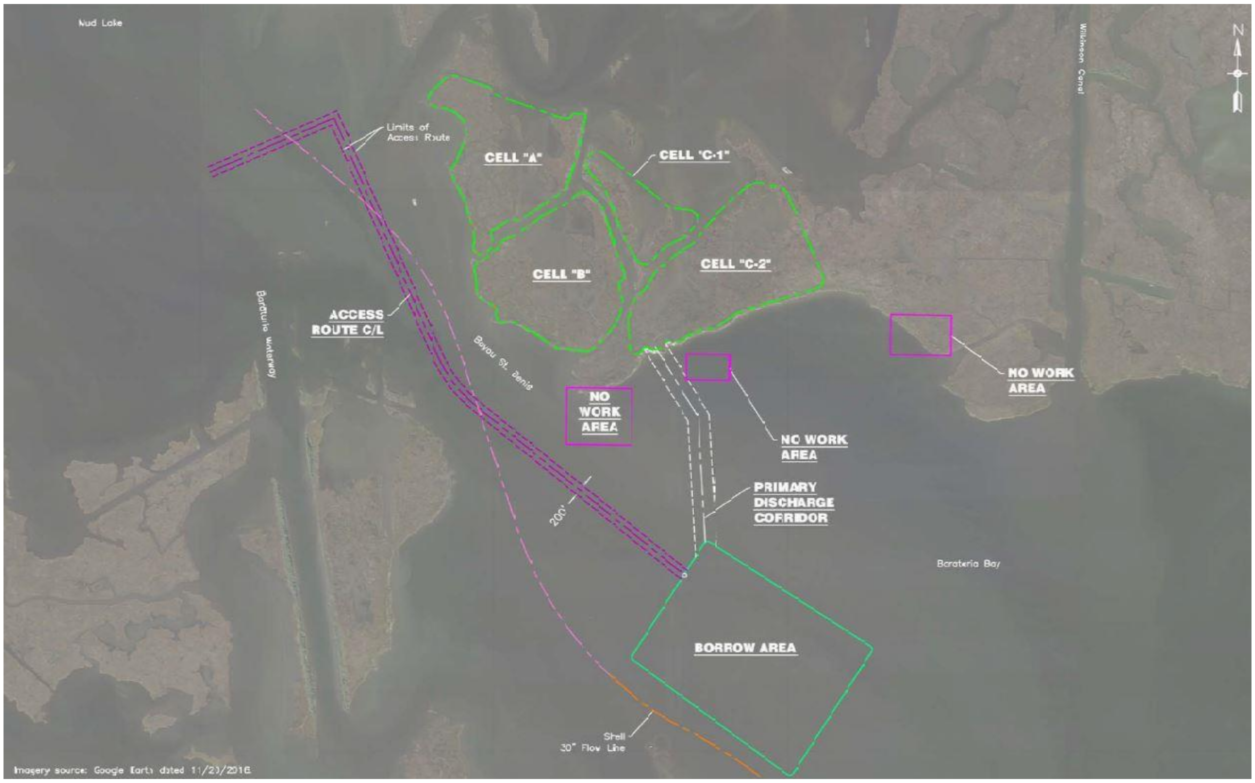


Figure 1.3 – BA-195 Revised Features.

Project Site Characteristics

The BA-195 project area is comprised mostly of expanding tidal bayous and ponds and deteriorating coastal saline marshes. Marshes are mostly vegetated with short, moderately dense *Spartina alterniflora* and *Juncus roemerianus*, which are common to the region. The geotechnical investigation report prepared by GEO indicates that the emergent ground is fairly stiff and can support walking and airboat pressures without showing much deflection. Beneath the crust and root masses, the soils are generally very soft organic clays or peat down to an approximate elevation of -5 ft[1]. From elevations -5 ft to -20 ft, soils are comprised of very soft to soft clay and

[1] Horizontal coordinates and elevations referenced throughout this report are referenced to the National Spatial Reference System and were derived by GPS observations. The horizontal and vertical datums for this reference system are NAD 83 and NAVD 88, respectively. The reference frame for NAD 83 and NAVD 88 is 2011, MA11, PA11 (Epoch 2010). The NAVD 88 elevations are based on Geoid 12A.

organic soils. Beyond elevation -20 ft, soils are generally very soft to soft clay with silt and sand lenses, seams, pockets and layers, and having moderate soil strength below elevation -45 ft.

The hydraulic and hydrologic characteristics of the project area are consistent with coastal marshes, with the majority of the area subject to tidal and salinity fluctuations. The BA-195 project site is susceptible to tropical storms and hurricanes, which have proven to be most detrimental by converting marshes into shallow open-water ponds. Southeast Louisiana has a predominant south-southeast wind direction which contributes to significant wave generation in large, open bodies of water within the coastal marshes and provides a source of scour and erosion in these areas. Mitigating efforts to combat wave generated erosion are discussed further in Limits of Construction section.

CPRA marsh creation guidelines identify the importance of incorporating sea level rise into the design of projects. In the previously referenced BA-195 Water Level Determination Report (Appendix D), LHA utilized the National Oceanic Atmospheric Administration (NOAA) published sea level trends based on observations at Grand Isle, Louisiana (~14 miles from the BA-195 site) dating back to the Year 1947. NOAA estimates that mean sea level in the Grand Isle area is increasing at a linear rate of +9.09 millimeters per year with a 95% confidence interval of ±0.45 millimeters. Recent projects designed by CPRA have used an accelerating eustatic sea level rise (ESLR) rate based on a scenario where sea level increases by 1 meter from a base year of 1992 through the year 2100. For 95% design of the BA-195 project, projected water levels through the project life will be based on an accelerating ESLR rate. Baseline water level data (2012-2017), ESLR rates, and resulting projected water levels will be presented later in the following section of this report.

Design Methodology and Data Collection

LHA used the data collected from the site and the corresponding reports that were prepared by LHA and GEO, as a basis for all design assumptions and considerations discussed herein. LHA and GEO used their professional knowledge and judgement gained from other marsh creation or similar type projects in which they have been involved to design features to meet the needs and objectives of the BA-195 project. The following sections will summarize LHA's understanding and interpretation of the data collected and outline the methodologies and considerations used to design the project features through the 95% design phase.

Survey Data and Survey Control:

As part of the initial data collection phase of this project, LHA was tasked with collecting all topographic and bathymetric survey data necessary for the design of the BA-195 project features. LHA was also required to establish a deep rod secondary control monument near the project site for design and construction purposes. The monument was established in accordance with *"A Contractor's Guide to the Standards of Practice for CPRA Contractors Performing GPS Surveys and Determining GPS Derived Orthometric Heights within the Louisiana Coastal Zone, 2016 Edition"* and was assigned the name of "BA195-SM-01."

Northing: 353,241.24 ft
Easting: 3,722,287.07 ft
Elevation: 2.530 ft, NAVD 88, Geoid 12A

The monument was used as the survey control for all subsequent surveys performed by LHA. A thorough discussion of the monument establishment process and the surveying procedures and methodologies can be found in the survey report in Appendix C. All elevations, including water level data, referenced herein are based on the same datum and reference frame as the "BA195-SM-01" monument.

Geotechnical Data:

GEO has provided a geotechnical investigation report containing information on soil properties at the project site, estimates of settlement and consolidation within the soil masses used for this project, and narratives containing design recommendations relative to the BA-195 project. Subsequently, GEO issued two addenda to the original report, which add clarification to topics outlined in the original report and provide additional insight on geotechnical related matters. The geotechnical report and addenda can be found in Appendix F and F-1.

Water Level Determination:

The data collection phase of this project also required LHA to obtain stage/tide data from an existing Coastal Reference Monitoring System (CRMS) gauge station within close proximity to the project area, and determine the average high, average low, and mean value of the daily average water levels observed. See Appendix D. LHA selected CRMS0237 due to its location relative to the project site and its hydraulic connectivity to tidally influenced water bodies. All data considered in this evaluation were collected over a five-year period, from April 01, 2012 through April 01, 2017. The data was reviewed and adjusted as necessary to make all elevations relative to vertical datum NAVD 88, Geoid 12A. The results of this evaluation resulted in the following water level determinations.

Table 1.1 - Calculated Averages Based on Observed Water Elevation at CRMS 0237	
Average High Level	+0.88 Feet
Average Low Level	-0.10 Feet
Average Daily Averages	+0.40 Feet

It has been determined that the optimal inundation range for coastal Louisiana saline marsh primary productivity is between the 20th and 80th percentile inundation levels; therefore, the referenced data set was also evaluated to determine the 20th and 80th percentile inundation levels based on a standard deviation curve. This inundation range, along with average high and average low water levels, projected into the future incorporating accelerating ESLR rates will be used to compare the performance of multiple initial marsh fill heights. Projected water levels and inundation levels are presented in Table 1.2. Note that the average low water and 80% inundation level are almost identical. The average high water and 20% inundation level are also approximately equivalent. For simplified discussion and presentation in this report, LHA will consider each pair as one and refer to only to the 20% and 80% inundation levels.

Table 1.2 - Water Level and Inundation Level Summary Through Project Target Year 20							
Year	Project Target Year	Accelerating ESLR (ft/yr)	Avg. Low Water Elev. (ft)	Avg. High Water Elev. (ft)	Avg. Daily Water Elev. (ft)	20% Marsh Inundation Level (ft)	80% Marsh Inundation Level (ft)
2012-2017			-0.1	0.88	0.4	0.89	-0.09
2018		0.0190	-0.08	0.90	0.42	0.91	-0.07
2019		0.0194	-0.06	0.92	0.44	0.93	-0.05
2020		0.0198	-0.04	0.94	0.46	0.95	-0.03
2021	0	0.0202	-0.02	0.96	0.48	0.97	-0.01
2022	1	0.0206	0.00	0.98	0.50	0.99	0.01
2023	2	0.0210	0.02	1.00	0.52	1.01	0.03
2024	3	0.0214	0.04	1.02	0.54	1.03	0.05
2025	4	0.0218	0.06	1.04	0.56	1.05	0.07
2026	5	0.0222	0.09	1.07	0.59	1.08	0.10
2027	6	0.0226	0.11	1.09	0.61	1.10	0.12
2028	7	0.0230	0.13	1.11	0.63	1.12	0.14
2029	8	0.0234	0.15	1.13	0.65	1.14	0.16
2030	9	0.0238	0.18	1.16	0.68	1.17	0.19
2031	10	0.0242	0.20	1.18	0.70	1.19	0.21
2032	11	0.0246	0.23	1.21	0.73	1.22	0.24
2033	12	0.0250	0.25	1.23	0.75	1.24	0.26
2034	13	0.0254	0.28	1.26	0.78	1.27	0.29
2035	14	0.0258	0.30	1.28	0.80	1.29	0.31
2036	15	0.0262	0.33	1.31	0.83	1.32	0.34
2037	16	0.0266	0.36	1.34	0.86	1.35	0.37
2038	17	0.0270	0.38	1.36	0.88	1.37	0.39
2039	18	0.0274	0.41	1.39	0.91	1.40	0.42
2040	19	0.0278	0.44	1.42	0.94	1.43	0.45
2041	20	0.0282	0.47	1.45	0.97	1.46	0.48

*The ESLR rate varies slightly from the RSLR used by LHA previously. Water levels shown above vary slightly (within 0.03’) from levels previously reported by LHA.

Magnetometer Survey:

The magnetometer survey performed by LHA during the data collection phase of this project resulted in the discovery of several pipelines and oil/gas wells within the project work area, which was consistent with the online GIS database found at www.sonris.com. Pipelines were located using magnetometers, gradiometers, and RTK surveying equipment and probed along their alignments every 200 linear feet within the project footprint. The result of this effort has provided the exact location and depth of cover of the found pipelines in the area. Reference Appendix G for the magnetometer survey report and drawings. The presence of oil and gas infrastructure within the project area and their impacts to project features is discussed in the following sections of this report.

Pipeline Coordination

As part of the initial 30% Design Phase, LHA was required to coordinate with pipeline companies known to have infrastructure located within the project area. NRCS provided LHA with a list of suspected pipeline owners, along with the appropriate contact information for each. The owners of all pipelines located by the magnetometer survey within the project area have been identified. Pipeline owners have been contacted and the details of the project, as well as a copy of the magnetometer survey drawings, have been provided to each. LHA requested that all owners review the documents and provide any site-specific requirements that might impact the design and/or construction of the project features. Since the 30% Design Meeting, LHA has again contacted all pipeline companies having infrastructure within or adjacent to the project area. Those companies are listed in Table 1.3 below.

Table 1.3 Pipeline Owners		
Pipeline Owner	Pipeline Location relative to project site	Comments
Hilcorp Energy Company	Has multiple pipelines/flowlines within the project work area.	Restrictions provided by Hilcorp
American Midstream Partners	Has multiple pipelines/flowlines within the project work area.	Draft Letter of No Objection provided
Shell Oil	Pipeline located south of borrow area.	Draft Letter of No Objection provided
Phillips 66	Pipeline located west of project area and crosses the dredge pipe corridor in open water.	No impacts anticipated
Enbridge/Spectra	Pipeline crosses the dredge pipe corridor in open water.	No impacts anticipated

American Midstream Partners, LP and Hilcorp Energy Company currently own all oil and gas infrastructure within the project work areas, with Hilcorp owning the majority. LHA has met with Hilcorp company representatives to discuss the BA-195 project and has provided the company with the 30% design drawings, outlining the planned work that will be conducted near and over their existing pipelines. Following submission of these documents, Hilcorp stipulated that they will not allow fill to be placed over their existing pipelines, nor will they permit equipment loads to be placed directly on their pipelines. These requirements have resulted in the re-alignment of the project features, the division of the marsh creation Cell C, as well as the exclusion of the unconfined marsh nourishment area, Cell D, from the project.

*The above image was provided to LHA by Hilcorp. Pipelines shown in yellow represent lines currently owned by Hilcorp. Dashed pink lines represent American Midstream pipelines. Solid magenta lines represent the approximate work limits. Bold red lines represent no work area as determined by the cultural resources coordination.

Figure 1.4 – Pipeline Infrastructure Map as provided by Hilcorp.

American Midstream and Shell Oil have provided draft Letters of No Objection for the BA-195 project. Letters have been reviewed by LHA and NRCS and any special requirements stipulated in each have been incorporated into the 95% design documents.

ACCESS ROUTES, BORROW AREA, & DREDGE PIPELINE CORRIDORS

Access to the BA-195 project will be by marine or amphibious vessels only. Based on the design surveys collected to date, the planned access route from the Barataria Waterway to the project borrow area has water depths ranging from 7 to 26 feet. The proposed access route will begin in the Barataria Waterway, continue in a northeasterly direction into Bayou St. Denis; then southeasterly into Barataria Bay until reaching the project's borrow area as shown in Figure 1.3 previously. Flotation dredging to gain access to the project borrow area is not anticipated. Dredge plant and associated equipment must be free floating along the access route at all times. Once in the borrow area, water depths range from 6 to 12 feet.

From the borrow area, a primary access route/dredge pipeline corridor has been defined and it extends in a northerly direction to marsh creation Cell C2. The primary corridor is significantly shallower ranging from 12 feet near the borrow area to zero (0) feet at the shoreline. The magnetometer survey performed in July 2017, defined approximately three (3) pipelines that cross the primary corridor at various locations. Water depths and depths of cover over these pipelines should be sufficient to allow for equipment access from the borrow area to the shoreline. All equipment used to access the marsh creation cells from the borrow area must be free floating over pipelines. The construction contractor will not be allowed to dredge, prop wash, or spud equipment within the access corridor. The pipeline locations, depth of water, and depth of cover will be provided to the construction contractor, such that protective measures such as timber mats can be implemented if needed. In addition to the dredge pipeline corridors, existing pipeline infrastructure traverses the four proposed marsh creation cells at various locations, most of which have very little to no soil cover and pose potential site access constraints. LHA has already aligned the boundary of Cell C1 and C2 to mitigate pipeline impacts, but the presence of American Midstream pipelines within the interior of the Cells A, C1 and C2, still pose some concern. American Midstream has issued a draft Letter of No Objection for the BA-195 project, stipulating that pipeline crossing be coordinated with their personnel and that their personnel must be present when excavating within fifty (50) feet of any American Midstream pipeline.

The construction contractor will need at least one (1) pipeline crossing in each cell to facilitate construction activities. The construction specifications will require the contractor to:

- identify the location of all pipeline crossings in a Work Plan that would be submitted to, and approved by, NRCS prior to any construction activities,
- coordinate with each corresponding pipeline owner,
- design a crossing that results in a “net zero” increase in surcharge loading to the pipeline(s) being crossed, and
- if the dredge discharge pipe must cross an exposed pipeline, the dredge discharge pipe will also need to be completely supported at the crossing(s).

Borrow Area

The BA-195 borrow area is located in Barataria Bay[2], about 0.75 miles south of the associated marsh creation cells (see Figure 1.3) and is approximately 228 acres in size. As stated previously, the borrow area is comprised of water depths ranging from 6 to 12 feet, with the majority of the area being approximately 6 feet in depth. GEO obtained soil samples from the borrow area to a depth of twenty (20) feet below the existing mudline, which showed the soils to consist of generally very soft clay and organics with occasional sand, silt, and shell lenses within the top 10 feet. The bottom 10 feet was predominantly very soft clay with silt layers and some shell. Based on the depth of soil borings taken within the borrow area and the material composition, LHA recommends a maximum cut elevation of -26 feet, NAVD 88[3]. The resulting in-place volume available for hydraulic dredging and pumping is 7.15 million cubic yards, which far surpasses the calculated fill volume of 1.60 million cubic yards required for the project. At this time, LHA is planning to maintain the current size of the proposed borrow area to allow the

[2] Approximate center of the proposed borrow area is located at N: 346,309.37, E: 3,714,396.92.

[3] Soil borings in the borrow area were 20 feet in depth below the existing mudline. More than fifty percent of the proposed borrow area has an existing mudline elevation of -6.0 ft, NAVD 88; therefore, the maximum proposed cut elevation is -26 feet, NAVD 88. The estimated volume of available borrow material reported herein is based on a maximum cut elevation of -26 feet, NAVD 88.

contractor the flexibility to dredge in areas within the borrow area that may be more suitable than others.

There is presently a 30-inch diameter Shell pipeline located approximately 300 feet south/southwest of the proposed borrow area based on the probing efforts performed previously. LHA does not anticipate any problems or special conditions necessary to complete the work as planned. In June 2019, LHA and NRCS personnel met with Shell to discuss the project and their concerns with hydraulic dredging activities being performed within 300 feet of their pipeline. From the meeting it was concluded by NRCS and LHA personnel that Shell had no objections to the proposed work. Since that initial meeting, Shell has provided a draft Letter of No Objection for the proposed features associated with the project.

The magnetometer survey performed in 2017 also discovered a fairly large metallic object just below the mudline near the northern boundary of the borrow area. LHA cross-referenced its position with permitted oil/gas wells in the area but found no record of a well in the specified location. LHA assumes the object is merely debris but is recommending that the area be avoided as a precaution during construction. The metallic object's location will be referenced in the 95% Design Drawings found in Appendix A.

Oyster Leases and Cultural Resources

Based on the oyster lease data provided by NRCS, the borrow area does impact five oyster leases. Reference the BA-195 Barataria Bay Rim Oyster Lease Map and corresponding BA-195 Oyster Lease Database documents found in Appendix J. Once construction funding is made available through CWPPRA, NRCS/CPRA will take the necessary steps to compensate lease holders for the affected leases.

NRCS has conducted Section 106 consultation with the Louisiana State Historic Preservation Officer (SHPO) and the Federally recognized tribes within an Area of Interest (AOI) that encompasses the project's Area of Potential Effect (APE). In response to a request by the SHPO, NRCS archaeologist conducted a cultural resources reconnaissance survey of the APE. The survey report recommended that the proposed construction items be allowed to proceed with three No Work Zones in place to avoid any potential adverse impact to previously identified resources should they continue to exist. The report was sent to the SHPO and federally recognized tribes for review and comment. The SHPO concurred that with the implementation of the three No Work Zones, no historic properties will be impacted by the project. No comments or concerns were received from any of the federally recognized tribes consulted during this project. Section 106 cultural resources consultation correspondence is included in Appendix I.

MARSH CREATION AND MARSH NOURISHMENT

Limits of Construction:

As referenced previously, the BA-195 project aims to create and/or nourish approximately 426 acres of marsh by pumping hydraulically dredged spoil material from an open water borrow source into confined areas. Initially, NRCS provided LHA with shape files (*.shp) showing the approximate boundaries of all the proposed project features. The limits of the marsh creation cells were used for purposes of planning survey and geotechnical field work only. The NRCS also provided LHA with shoreline erosion rates, as determined by the United States Geological Survey (USGS), along the Barataria Bay, Bayou St. Denis, and Mud Lake shorelines. Erosion rates are reported to range from 2 to 5 feet per year, with the greatest rate being along the Barataria Bay shoreline. LHA has used survey data and aerial imagery collected in 2017 to further refine the horizontal limits of the proposed MCAs, incorporating the projected loss of shoreline along these waterways. To help mitigate the impacts of waves on the project features, LHA has offset the southern dike alignments inland from the current shoreline to help ensure the earthen containment dikes (ECDs) will not be built at the water's edge. For design purposes, LHA has assumed that construction of the said features will not begin until the year 2021; therefore; three years (2018 to 2020) of shoreline erosion was used to determine the marsh creation cell boundaries.

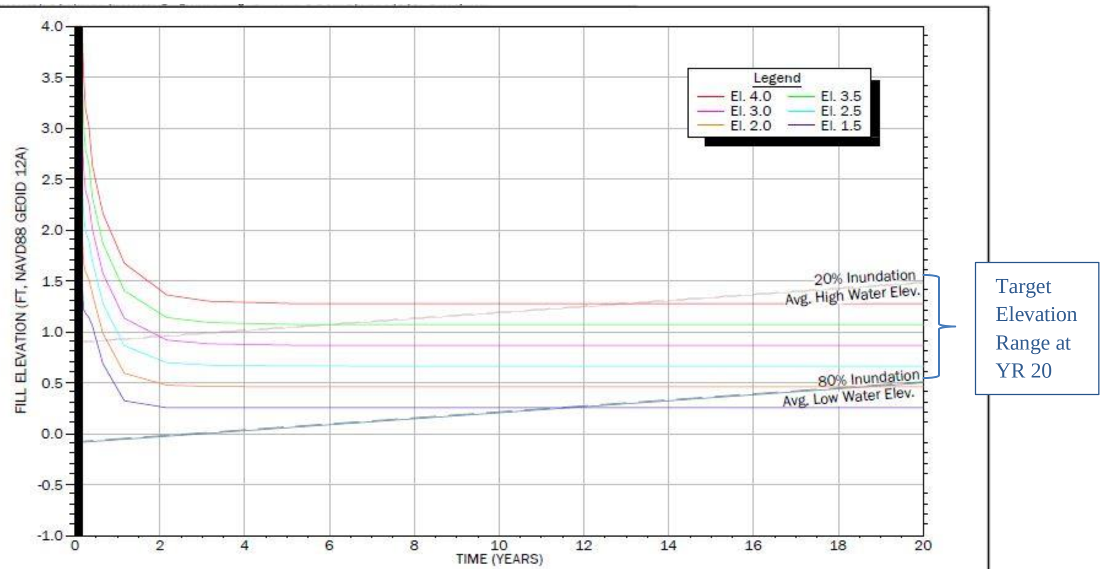
The northern dike alignments are mostly in open water and will be susceptible to wave generated erosion during the winter months when winds are predominantly out of the north. At a meeting with NRCS and CPRA personnel held on September 17, 2019, it was discussed if incorporating some level of reinforcement (i.e. articulated concrete mats) was warranted for the project. It was concluded that the ECDs are not considered to be a permanent feature of the BA-195 project and the added construction and maintenance costs were not justifiable. LHA has provided a higher level of contingency to the construction cost estimate to account for the additional maintenance that may be required during construction. ECDs for a given cell will only need to be maintained until the associated cell is accepted as complete by NRCS. No protective measures are being proposed for the ECDs.

<u>Marsh Creation/Marsh Nourishment General Overview</u>:

The BA-195 Project will consist of four fully-contained marsh creation cells (Cells A, B, C1 and C2) as depicted in Figure 1.3, previously. Fully-contained cells will be created by building earthen containment dikes (ECDs) using mechanical excavation equipment and in-situ borrow material. ECDs will be built to a specified top elevation and have geometry consistent with the recommendations found in the geotechnical investigation report. Once ECDs are constructed, hydraulically dredged material from the borrow area will be placed in each fully contained cell up to a specified volume. Once the specified volume for a given cell has been achieved, pumping into the associated cell will cease. After most of the settlement of the hydraulically placed fill has occurred (typically within the first three years post-construction), the ECDs will be either gapped and/or degraded to restore the natural hydraulic exchange of tidal water with the newly created marsh complex.

Fully-Contained Marsh Creation/Marsh Nourishment Fill Elevation:

Three settlement curves for the project's marsh fill elevation were provided by GEO in the original geotechnical report, each based on a different existing mudline elevation (-1.0 ft, -2.0 ft, and -3.0 ft) and an assumed 30-day fill period. Similar settlement curves were later provided based on the same existing mudline elevations, but with an assumed fill period of 60 days. The 60-day settlement curves can be found in Addendum 2 of the geotechnical report. (Appendix F.1) Each hyperbolic curve depicted various constructed fill heights (ranging from elevation 1.5 to elevation 4.0) and estimated settlement over a period of twenty years. These curves did not factor in regional subsidence or accretion on the marsh surface. See Figures 1.5, 1.6, and 1.7.



FILL ELEVATION (FEET NAVD88)							
INITIAL FILL PLACEMENT	END OF CONSTRUCTION	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS
1.5	1.5	0.9	0.4	0.3	0.3	0.3	0.3
2.0	2.0	1.2	0.7	0.5	0.5	0.5	0.5
2.5	2.5	1.5	1.0	0.7	0.7	0.7	0.7
3.0	3.0	1.8	1.3	0.9	0.9	0.9	0.9
3.5	3.5	2.2	1.5	1.1	1.1	1.1	1.1
4.0	4.0	2.5	1.8	1.3	1.3	1.3	1.3

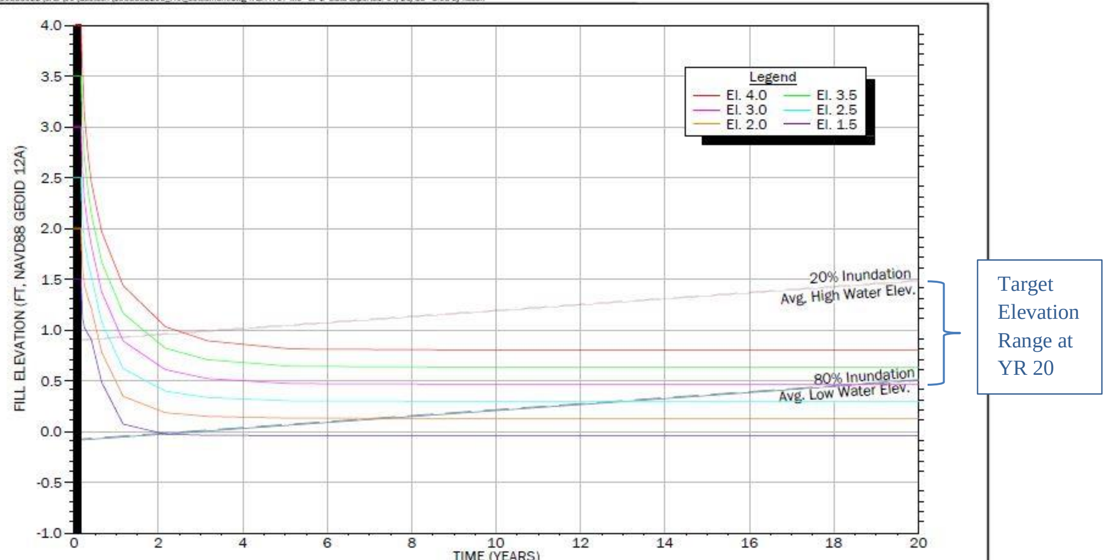
Marsh Fill Elevation vs Time - 60 Day Fill Period
Mudline El -1 ft.

BA-195 Barataria Bay Rim
Marsh Creation and Nourishment
Plaquemines and Jefferson Parishes, Louisiana

GEOENGINEERS

Figure H-6

Figure 1.5 - Marsh Fill Elevation vs. Time, Mudline El -1 ft
(Fig. H-6 from Geotechnical Report, Addendum 2)



FILL ELEVATION (FEET NAVD88)							
INITIAL FILL PLACEMENT	END OF CONSTRUCTION	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS
1.5	1.5	0.7	0.2	0.0	0.0	0.0	0.0
2.0	2.0	1.1	0.5	0.1	0.1	0.1	0.1
2.5	2.5	1.4	0.8	0.3	0.3	0.3	0.3
3.0	3.0	1.7	1.0	0.5	0.5	0.5	0.5
3.5	3.5	2.0	1.3	0.7	0.6	0.6	0.6
4.0	4.0	2.3	1.6	0.9	0.8	0.8	0.8

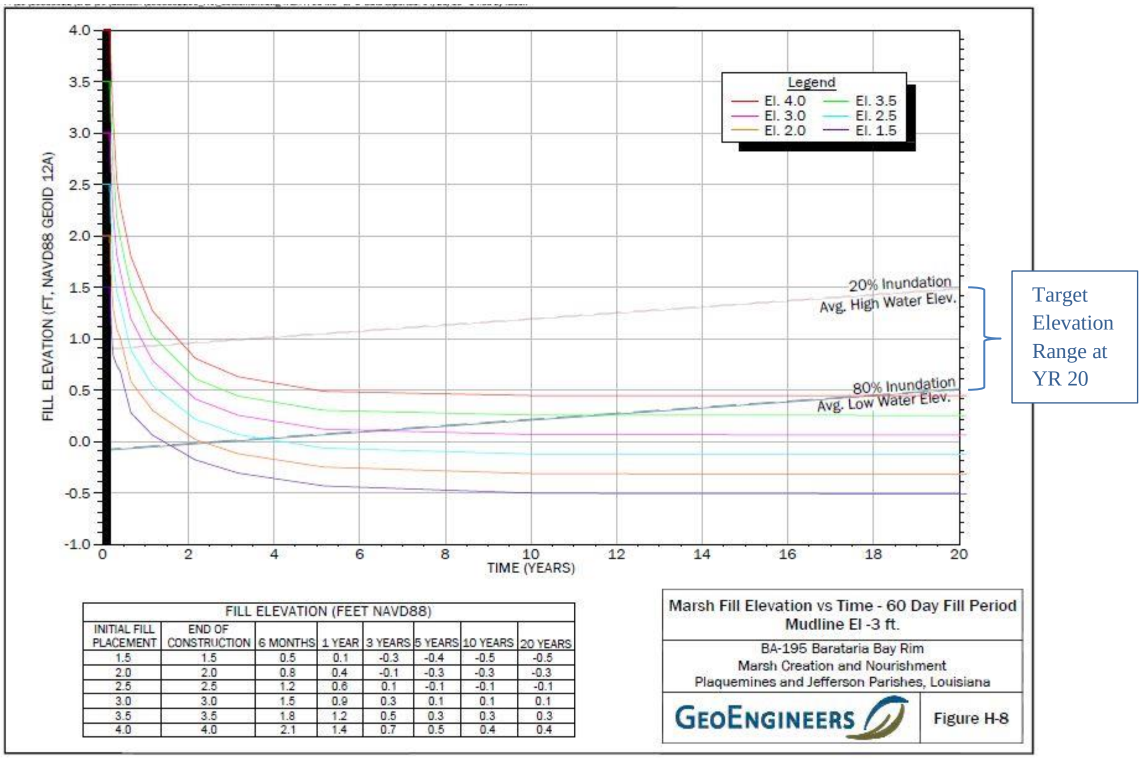
Marsh Fill Elevation vs Time - 60 Day Fill Period
Mudline El -2 ft.

BA-195 Barataria Bay Rim
Marsh Creation and Nourishment
Plaquemines and Jefferson Parishes, Louisiana

GEOENGINEERS

Figure H-7

Figure 1.6 - Marsh Fill Elevation vs. Time, Mudline El -2 ft
(Fig. H-7 from Geotechnical Report, Addendum 2)



FILL ELEVATION (FEET NAVD88)							
INITIAL FILL PLACEMENT	END OF CONSTRUCTION	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS
1.5	1.5	0.5	0.1	-0.3	-0.4	-0.5	-0.5
2.0	2.0	0.8	0.4	-0.1	-0.3	-0.3	-0.3
2.5	2.5	1.2	0.6	0.1	-0.1	-0.1	-0.1
3.0	3.0	1.5	0.9	0.3	0.1	0.1	0.1
3.5	3.5	1.8	1.2	0.5	0.3	0.3	0.3
4.0	4.0	2.1	1.4	0.7	0.5	0.4	0.4

Figure 1.7 - Marsh Fill Elevation vs. Time, Mudline El -3 ft
(Fig. H-8 from Geotechnical Report, Addendum 2)

Consideration was given to incorporating regional subsidence and accretion into the settlement curves based on the following:

- ACRE (2018) reports a subsidence rate range of 5 to 7mm / year for the lower Barataria Basin over the past 5 to 15 years. The project team used 6 mm/yr (0.0197 ft/yr) for this analysis.
- CPRA monitoring personnel have indicated that CRMS-measured accretion does not equate 1:1 to surface elevation change. The CRMS-based “surface elevation change” value, which is typically less than “accretion”, was used for this analysis.
- The surface elevation change rate used was from CRMS 6303 (located within the BA-37 marsh creation project) rather than from of a natural marsh station. The rate used was “post-inflection” meaning that it was derived after the surface elevation ceased

settling and began to rise (2015-2019). This surface elevation change rate is 0.0266 ft/yr.

- Applying regional subsidence throughout the project life and the post inflection surface elevation change beginning after Target Year (TY) 5 would result in a very small net elevation gain (0.008 ft/yr).

Due to the very small estimated elevation difference produced by this analysis, the project team opted to assume that regional subsidence and accretion/surface elevation change would simply offset each other and neither are incorporated into the settlement curves. This approach has been used on some previous CWPPRA projects. Using the 60-day fill period settlement curves for each mudline elevation (-1.0 ft, -2.0 ft, -3.0 ft), Table 1.4 presents the TY at which the predicted marsh surface elevation of Cells A, B, and C will fall below the 80% Inundation Level for fill heights of +2.5 ft, +3.0 ft, +3.5 ft and +4.0 ft.

Table 1.4 – Comparison of Acreage and Predicted Settlement Below Predicted 80% Inundation Level				
	Marsh Nourishment	Marsh Creation		
Elevation Range	>+0.5	+0.5 to -1.5	-1.5 to -2.5	≤ -2.5
Acres	65	311	47	3
Percent of Project Area	15.2%	72.9%	11.1%	0.7%
Mudline Curve	-1 ft	-1 ft	-2 ft	-3 ft
Year when +2.5 fill Height Curve ≤ 80% Inundation Level	>20	>20	13	3.5
Year when +3.0 fill Height Curve ≤ 80% Inundation Level	>20	>20	18.5	6.5
Year when +3.5 fill Height Curve ≤ 80% Inundation Level	>20	>20	>20	12
Year when +4.0 fill Height Curve ≤ 80% Inundation Level	>20	>20	>20	>20

*Note: Table represents Cells A, B, and C1 and C2.

There are 65 and 311 acres that originate in the >+0.5’ and the +0.5 to -1.5’ elevation ranges, respectively; this represents 88.1% of the total project acreage. The -1.0 ft mudline curve predicts that the elevation of these acres would remain above the 80% Inundation Level throughout the project life for the +2.5 ft, +3.0 ft, +3.5 ft, and +4.0 ft fill elevations.

There are only 3 acres with a pre-project mudline elevation <-2.5; this represents 0.7% of the total project acreage. The -3.0 ft mudline curve predicts that the elevation of these acres would fall below the 80% Inundation Level at TYs 3.5, 6.5 and 12 for the +2.5 ft, +3.0 ft, and +3.5 ft fill elevations, respectively. NRCS does not view this to be an issue as the WVA / land loss spreadsheet already predicts that 18 acres of the project area would be water at Year 20.

There are 47 acres that originate in the -1.5 to -2.5 elevation range; this represents 11.1% of the total project acreage. The -2.0 ft mudline curve predicts that the elevation of these acres would fall below the 80% Inundation Level at TYs 13 and 18.5 for the +2.5 ft and +3.0 ft fill elevations, respectively.

Based on all of the above the Design Team determined that the +3.0 ft fill elevation was the most appropriate. Using the +3.0 ft fill elevation should result in the following:

- Acres that originate at or above the -1.5 ft mudline elevation (88.1% of the total acreage) would remain above the 80% Inundation Level for the entire project life.
- 47 acres (11.1% of the total acreage) with a pre-project mudline elevation of -1.5 ft to -2.5 ft would remain above the 80% Inundation Level for the majority of the project life (18.5 of 20 years).
- For those 47 acres, the TY20 marsh elevation is less than 0.05 feet below the 80% Inundation Level.
- Of those 47 acres, 34 acres actually have a pre-project mudline elevation of -1.5 ft to -2.0 ft, so using a -2.0 ft pre-project mudline elevation is conservative; those 34 acres may remain above the 80% Inundation Level for the entire project life.

Construction Concerns

The settlement curves referenced previously are based on an assumed construction period of 60 days and several assumed parameters, many of which may not be practical or possible to replicate in a real-world setting. Using a constructed fill height suggested by the settlement curves alone could result in a significant overbuild or underbuild of the marsh creation areas. For example: If the fill is placed over a period of 90 days instead of the assumed 60 days, by the time the constructed height is achieved, excess settlement (more than accounted for in the settlement curves) may have already occurred, resulting in an overbuild of the area. If the fill is pumped in a period substantially less than 60 days, the material will likely settle out below the estimated range, resulting in a marsh creation area below the design target elevation. There are also several other factors to consider that can greatly affect the reproducibility of settlement curves such as soil material composition, water-to-solids ratio being pumped through the dredge discharge, and contractor's ability to dredge the full depth of the design cut template. There are also some subjective variables with regards to surveying the dredge slurry elevation, such as when to survey it and where the elevations should be taken within the slurry column. Due to these concerns and the Design Team's experience on previous marsh creation projects, the Design Team has elected to take a slightly different approach to determine the fill volume required to achieve the project goals, as well as means of determining completion and acceptance of a given cell.

Suggested Approach:

In December 2018, NRCS, CPRA, and LHA had a meeting to discuss quantity computations for marsh creation projects. Based on past projects, CPRA had determine that using the top of the settlement curve to compute quantities resulted in excessive contract quantities. From CPRA's experience it appeared that where the curve starts to flatten out (around years 1 to 2) seemed like the most appropriate elevation to use, however no formal procedure has been developed yet. LHA discussed this with GEO and they confirmed this observation and ultimately issued Addendum 1 to the geotechnical report. Addendum 1 suggests that dredged material will achieve a long-term density similar to its in-place density prior to dredging over a period of time. Based on this principal, the volume to achieve a desired long-term marsh elevation is the sum of the following:

- The volume of fill (long-term consolidated state) from the existing mudline/marsh in the fill area to the desired target elevation at TY20;
- The volume of fill required to overcome subgrade consolidation under the fill load;
- Estimated losses during dredging.

Using this methodology, the fill volume required for a given cell will be determined by calculating the volume required to fill the cell to the given elevation and measured from the existing mudline/marsh elevation. The +3.0 feet fill settlement curve (Figure 1.5) for the Mudline Elevation of -2.0 ft starts to flatten somewhere between +1.0 ft to +0.5 ft. The average elevation between the 20% and 80% inundation levels at TY20 was computed to be +0.95 ft elevation. Since this elevation appeared to correspond very well with CPRAs methodology, the Design Team decided to use the +0.95 ft elevation for quantity calculations. Topographic data collected at the site in 2017 was used to prepare a three-dimensional model created in AutoCAD Civil 3D (CAD). A uniform surface at the TY20 elevation was superimposed over the existing grade surface to calculate the fill volume required to achieve the target elevation. The existing grade surface used in this calculation was slightly modified to incorporate the borrow areas associated with the earthen containment dikes and their recommend cut-to-fill ratio as described on page 30 of this report. The cut-to-fill ratio associated with this calculation is 1.0, based on the recommendations outlined in Addendum 1 of the geotechnical report. Addendum 1 also estimates the average consolidation settlement of the underlying soils to be 0.1 feet; therefore, the calculated fill volume was increased to account for this average 0.1ft/ft^2. of settlement. Lastly, this cumulative fill volume was increased by 10 percent (cut-to-fill ratio of 1.1) to account for losses experienced during dredging and filling operations. The appropriateness of this cut-to-fill ratio is discussed in the Hydraulically Dredged Cut-to-Fill Ratio and Fill Volume Calculations section of this report.

Fully Contained Marsh Creation Settlement and ECD Gapping:

Once the hydraulically dredged material is placed into the cells, two types of settlement will occur: 1) settlement of the newly placed fill as a result of the water draining from the soil mass, and 2) consolidation of the native underlying soils due to the increased overburden pressure resulting from the newly placed material. The results of GEO's settlement analysis suggest that the majority of this settlement will occur within the first two years after placement. Settlement rates will become stabilized and ECDs should be ready for gapping and/or degrading by Year 3. The CWPPRA Engineering Work Group typically recommends that ECDs be gapped at 250-ft intervals, with gaps being 25-ft in width. LHA feels that this gapping sequence is appropriate and sees no reason to suggest otherwise. Actual gapping locations will need to be determined in the field as fill material settles. Gaps should be located such that they allow for tidal exchange with the surrounding waters and minimize channelization and erosion within the marsh complex. ECD gaps should be cut down to marsh elevation consistent with the area at the time of gapping efforts, with excavated material side cast into the surrounding areas.

Fully Contained Marsh Creation Cell Dewatering

Design of the dewatering systems used to efficiently drain the marsh creation cells during construction should be the responsibility of the construction contractor. Dewatering system designs should reflect the size and capacity of the dredge used during construction. (i.e. larger dredges may need more drainage capacity than smaller dredges.) LHA offers no recommendations on the type, size, or frequency of the dewatering systems; however, LHA does recommend that dewatering systems be sized and located to provide effective drainage of the marsh creation cells and are equipped with adjustable inlet controls (stop logs) to help manage water levels in the marsh cells. Stop logs can also help control the discharge of sediment from the marsh creation cells by allowing suspended solids in the effluent to settle out before discharge. The surrounding areas of the Bay contain valuable fisheries resources, namely oyster reefs. LHA does not anticipate any impacts to oyster resources resulting from increased turbidity and does not recommend any specific turbidity controls for the BA-195 project at this time.

Sedimentation within the interior channels should also be monitored during construction to ensure personnel servicing oil/gas facilities in the area have unrestricted access to their infrastructure. If sedimentation occurs within these interior channels as a result the work associated with this project, the construction contractor will be required to remove material by mechanical means for no additional costs. A pre- and post-construction survey of the interior waterways between marsh creation areas A, B, and C1 will be required to determine if sedimentation has occurred.

Unconfined or Semi-Confined Fill Area

The unconfined marsh creation/marsh nourishment area that was originally associated with the BA-195 project has been excluded due to potential impacts to Hilcorp pipelines.

Hydraulically Dredged Cut-to-Fill Ratio and Fill Volume Calculations

LHA's experience with various types projects has shown that cut-to-fill ratios are dependent on many variables, most of which cannot be accurately quantified during the design phases. The cut-to-fill ratio serves as a bulking factor and accounts for material losses during dredging operations. As stated in the geotechnical report, cut-to-fill ratios can range from 1.0 to 1.5 depending on material type, containment system, dredge/pipe/containment efficiencies, and dredging contractor's means and methods. Consistent with GEO's recommendations, LHA initially recommended a cut-to-fill ratio of 1.2 for the purposes of construction cost estimating and determining the volume adequacy of the borrow area. At a meeting held on September 17, 2019 with NRCS and CPRA personnel, the appropriateness of the 1.2 cut-to-fill ratio was discussed.

CPRA engineering staff suggested that a twenty (20) percent increase was overly conservative, and that a lesser value should be used, specifically 1.0 or a zero percent increase. NRCS has elected to use a cut-to-fill ratio of 1.l for marsh fill quantity computations, which is less conservative but still within the recommended range specified by GEO.

An additional consideration for calculating fill volume is to account for the consolidation of the underlying in-situ soil on which the hydraulic dredge material is being placed. Based on the recommendations provided by GEO, the estimated consolidation equates to approximately 0.1ft/ft^2. For the purposes of estimating a cut volume that will achieve the target elevation (settled marsh height) in each cell, LHA utilized the three-dimensional CAD model that was developed using survey data collected at the site. Data was used to create an existing surface (i.e. existing grade) with a fill template set to elevation +0.95 feet, NAVD 88. The existing surface was modified to account for the borrow areas needed to construct the ECDs required to contain the fill material of Cells A, B, and C1 and C2. ECD borrow area volumes were calculated using a cut-to-fill ratio of 2.0 as described further in this report. Table 1.5 below shows a summary of the estimated fill volume for each cell and its corresponding acreage. Volumes were calculated using the following formula.

$$\text{(Cell Fill Vol.) + (Cell Surface Area x 0.1')} = \text{Cumulative Cell Vol., ft}^3$$

$$\text{Cumulative Cell Vol. x 1.1 (Cut-to-Fill Ratio)} = \text{Total Estimated Cut Volume, ft}^3$$

$$\text{Total Estimated Cut Volume, ft}^3 \div 27 = \text{yd}^3$$

Table 1.5 – Fully-Contained MCA Cell Summary

Cell	Acreage*	Cut Volume, CY
A	115	386,452
B	128	455,938
C1	42	217,283
C2	141	540,839

*Acreages reported here are derived from the three-dimensional model created using AutoCAD Civil 3D and are measured to the ECD centerline.

**One acre is equal to 43,560 ft^2

Although the final constructed slurry elevation of the marsh cells is estimated to be +3.0 ft, NAVD 88 for each marsh creation cell, volume calculations were determined near the final settled constructed marsh elevation 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. As shown in the settlement curves provided, the fill elevation decreases at a much quicker rate within the first few years after construction as compared to 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 the 20-year target marsh elevation.

Earthen Containment Dikes (ECDs)

The fully-contained marsh creation cells will be constructed using ECDs to establish the horizontal boundaries of each cell. Based on the observed poor soil conditions at the site, the geotechnical investigation report concludes that the in-situ soils will not support the construction of an ECD up to elevation +4.5 ft in areas with existing mudline elevations below +0.5 ft without taking measures to reduce bearing pressure or strengthening the ECD foundation. As part of the Alternative Features design phase, GEO developed a series of alternatives to be considered for the ECD designs. Due to the complexity of this environment, LHA has recommended that multiple ECD designs be used based on the conditions of the site at a given location. All ECDs, unless specifically stated otherwise, will have a top width of five (5) ft and crown elevation of +4.5 ft, NAVD 88. Crown elevation is determined by the estimated fully-confined MCA constructed slurry elevation +3.0 ft plus 0.5 ft of allowable overbuild, plus 1.0 ft of freeboard (+3.0’ + 0.5’ + 1.0’ = 4.5’). ECDs should be constructed to the minimum grade specified and should not exceed elevation +5.0. ECDs should be maintained throughout pumping cycles in a given marsh creation cell. After a given cell has been accepted as complete by the NRCS, ECD maintenance of the associated cell may cease.

LHA's design does not incorporate the use of training berms as they are more a function of the construction contractor's means and methods of construction. The use of training berms is acceptable, but it should be left up to the construction contractor to determine the size and location of the training berms. Upon completion and acceptance of a given marsh creation cell, all training berms should be degraded to marsh elevation in their entirety.

<u>ECD Design – Type A (Referred to as Typical Section "A-A" in Project Drawings)</u>

For areas with mudline elevations at or above +0.5 ft that are vegetated, soil analyses suggest that geotextile reinforcement is <u>not</u> required. ECDs will be constructed with 5H:1V side slopes. ECDs should also be constructed in two lifts, with the first lift being the full base width and extend up to elevation +3.5 ft. The final lift to obtain the crown elevation of +4.5 ft should be installed after a period of thirty (30) from the initial placement of fill, or after the material has drained. (Note: The 30-day period does not imply that the entire ECD has to be complete for 30 days prior to installation of final lift. To clarify, the 30-day period begins immediately after placement of fill at a given location.)

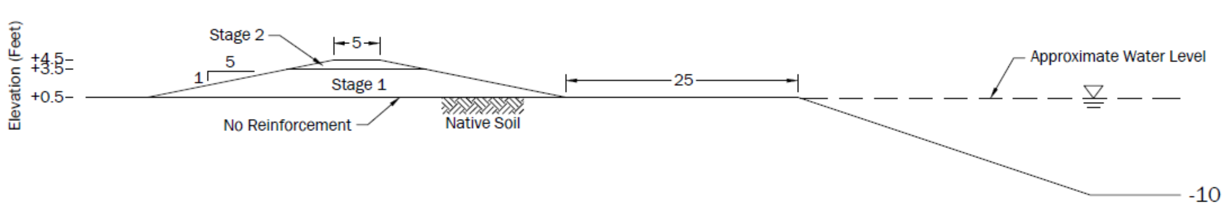


Figure 1.8 – Typical ECD Type A Cross-Section

<u>ECD Design – Type B (Referred to as Typical Section "D-D" in Project Drawings)</u>

This ECD design is to be implemented in areas that have a lower existing mudline elevation (-3.0 ft to +0.5 ft) and are not vegetated, thus requiring a taller ECD section. This design requires the

ECD foundation to be reinforced using geotextile reinforcement and should be constructed in at least two lifts. The initial lift should encompass the full base width of the ECD and should be built up to elevation +3.5 ft. After a period of 30 days to allow for soil material to rest and for the foundation soils to consolidate, the final lift should be installed. The presence of reinforcement and using multiple lift construction techniques will allow the side slopes to be increased to 3.5H:1V. Top width and elevation shall be the same as in Type A described previously.

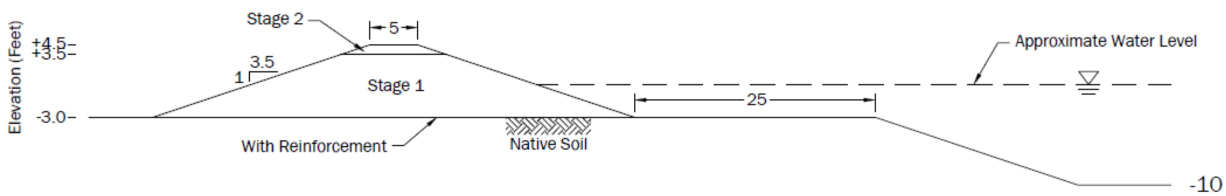


Figure 1.9 – Typical ECD Type B Cross-Section
*Note: Outside borrow area not shown in Figure 1.9 due drawing scale constraints. LHA recommends that an outside borrow area be allowed in certain areas requiring this ECD section.

The use of geotextile reinforcement will increase material and labor costs significantly; however, increasing the side slope from 5:1 to 3.5H:1V will reduce the amount of fill needed to construct the dikes. The increased slope will result in the dikes having a narrower base width, making them more practical to construct using amphibious equipment, namely marsh machines. Due to reach limitations of marsh machines, it would be beneficial to allow for borrow to occur on both sides of the ECD to insure proper grade of the back-slope (outside of the marsh creation cells). The outside borrow area should adhere to the same spatial requirements and geometry as the interior borrow area. Outside borrow areas should only be needed in areas having low mudline elevations synonymous with the Type “B” ECD as well as the ECDs having sheet piles as described in the ECD Gap Closure section of this report.

ECD Stability

Stability analysis for all ECD alternatives were performed by GEO. In general, all ECD alternatives yielded similar results with respect to slope stability. A minimum berm width of twenty-five (25) feet is recommended between the ECD toe and the top of the corresponding borrow area. Marsh excavators are approximately twenty (20) feet in width, therefore the ECD and borrow area cross-section should yield sufficient work space. On previous projects, NRCS has requested that the berm width be increased to thirty-five (35) feet and that construction equipment maintain a fifteen (15) feet wide buffer from the ECD toe. The typical cross-sections shown in Appendix A reflect the thirty-five (35) feet wide berm. The stability analyses performed by GEO were based on maximum cut depth to elevation -10.0 feet and a cut slope of 2H:1V for the ECD borrow areas. GEO has also confirmed that allowing outside borrow for ECDs located in deeper water will be stable using a borrow cross-section similar to that of the inside borrow area.

ECD Settlement

The geotechnical report outlines three types of settlement that ECDs will be subjected to during and after their construction. The first type of settlement that will be experienced is the construction settlement which will occur immediately during construction of the ECDs. As fill material is built up to the specified grade, the material will consolidate due to the immediate increase in over burden pressure. This settlement will equate to approximately 20 percent of the total foundation settlement. Since this settlement regime occurs instantaneously during construction, the settlement will not be apparent during post-construction monitoring surveys; however, additional material will be required during initial construction to account for the settlement. Settlement analyses suggests that the ECDs associated with this project could see anywhere from three to five inches of settlement during construction.

Once constructed, settlement will continue in the form of consolidation settlement of the underlying soils and shrinkage of the fill material placed above apparent water levels. As the ECDs are constructed, the overburden pressure on the native, in-situ soils increases. This forces water within these soils to drain laterally resulting in a consolidated layer of soil. Shrinkage settlement occurs in the newly placed fill material used to construct the ECDs and is the result of the water draining or evaporating from the soil mass. This tends to occur only in the soils that are stacked above the average water elevation in a given area. Soils at or below normal water elevations tend to stay hydrated and therefore do not shrink significantly. GEO prepared a settlement curve (See Figure 1.10) that depicts the average anticipated settlement rate of the ECDs within the first two (2) years post-construction. From the figure below, it apparent that approximately 100% of all settlement occurs within the first two years following construction.

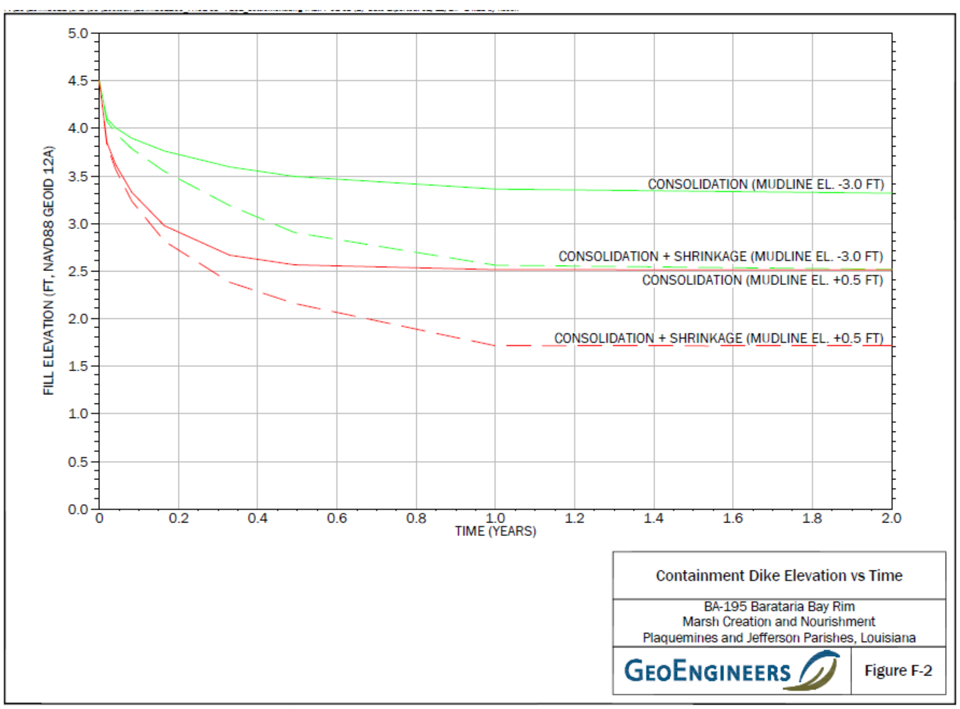


Figure 1.10 [Extracted from the project geotechnical investigation report]

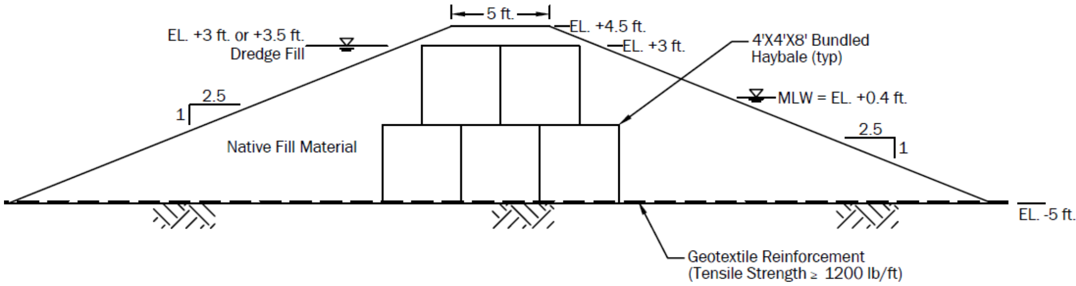
ECD Cut-to-Fill Ratio

The variability of the construction means and methods, determining an exact cut-to-fill ratio can be very difficult due to the quality of the available borrow material. Consistent with GEO's recommendations found in the geotechnical report, LHA recommends using a cut-to-fill ratio of 2.0 for the purposes of construction cost estimating as well as determining an adequate volume of borrow material for construction.

ECD Gap Closures

ECDs will intersect with existing waterways, bayous, access canals, pipelines, etc. at various locations throughout the MCAs. These areas may require additional means to achieve stable containment features due to lower mudline elevations. American Midstream pipeline crossings will also need to be constructed in a manner which minimizes the increased overburden pressure exerted on the pipelines. This is particularly important for pipelines that are exposed or have a minimum amount of soil cover. ECDs at pipelines and deep-water crossings will have a slightly different design template but will have construction tolerances similar to the typical ECDs described previously.

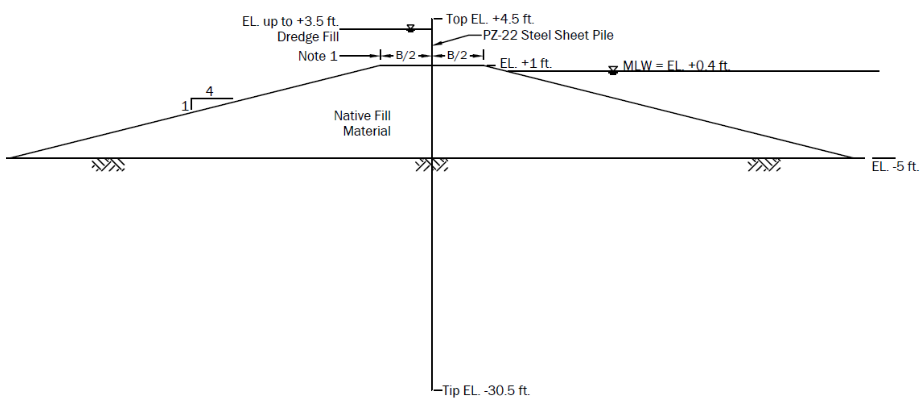
GEO has prepared an ECD design to be considered at locations where pipeline crossings are necessary. This configuration is an ECD with a hay bale core, which reduces the pressures exerted on the ground and the underlying pipelines. Hay bales can be placed on the existing grade and are then encapsulated with mechanically excavated native spoil material. The soil material should intermix with the hay to some extent and help reinforce the soil mass. GEO analyzed an ECD with hay bale core for stability and recommends they be built as shown in figure below. This recommendation is included in the 95% project drawings and has been presented to the owners of all pipelines to be crossed with ECDs, namely American Midstream. American Midstream has not shown any concerns with the proposed crossings.



Hay Bale Core ECD

Figure 1.11

Another gap closure alternative to be considered at deep-water crossings consists of driving steel sheet piles to a tip elevation of -30.5 ft and then placing spoil material on either side of the sheet pile for stability as shown in Figure 1.12.



Sheet Pile in Low Earthen Embankment

Figure 1.12

This method cannot be used in areas when pipelines are present but can be considered in any areas free of underground utilities. GEO has provided a minimum sheet pile size (PZ22) having an elastic section modulus of 18.1in^3/ft and a minimum thickness of 0.375 inches. This sheet size was selected by GEO based on geotechnical loading conditions only. LHA is of the opinion that sheet section will not be subjected to any significant environmental loads during construction, as long as the contractor maintains the ECD encapsulating the sheet pile. The use of steel or timber wale beams would add rigidity to the system, but should not be required. The presence of wale beams and other stiffening components will only add to the cost of construction and the removal of components during future maintenance events. Steel sheet piles should be extracted to the greatest extent practical without damaging the newly constructed marshes within the first three (3) years post-construction.

Post-Construction Operation and Maintenance

Marsh creation areas are typically self-mitigating and require minimal long-term operation and maintenance activities. LHA recommends the following operation and maintenance activities for the BA-195 project:

- Dike Gapping/Degrading: Between YR0 and YR3, degrade or gap containment dikes to restore hydraulic connectivity between the newly constructed marsh creation cells and the surrounding wetlands. Dikes should be gapped twenty-five feet at approximately 250-ft increments, at a minimum. This not only allows for exchange of tidal water, but also allows fisheries access to the marsh creation cells. This work should be initiated after most of the settlement has occurred and the marsh creation cells have revegetated. Sheet piles used as ECD gap closures should also be removed at the time of dike gapping/degrading.
- Vegetative planting: LHA feels that these MCAs will re-vegetate within one or two growing seasons. If some areas do not re-vegetate to an acceptable level, NRCS/CPRA should consider planting native marsh grasses in the unvegetated areas. NRCS has provided some estimated costs for vegetative planting that will be incorporated into the O&M estimate.

- Post-Construction monitoring surveys: A topographic survey of the marsh creation cells should be performed yearly within the first three years post-construction to determine if and when settlement is no longer apparent. These surveys will help determine when and where the containment dikes should be gapped or degraded. Once gapping or degrading has been completed, routine monitoring surveys may be conducted at a frequency acceptable to the NRCS/CPRA and may extend throughout the 20-year design life.

LHA has prepared preliminary cost estimates for the long-term operation and maintenance activities specified herein and can be found in Appendix B.

Construction Cost Estimate

LHA has prepared a construction cost estimate for the project features based on the current 95% design. Considering all aspects of the project discussed herein, a construction budget of $17.8 million is recommended for this project, which includes appropriate contingencies for each pay item. The unit costs used for this analysis were derived from dredge mobilization cost calculation spreadsheet provided by NRCS, historical bid costs for projects with similar features and site conditions, estimated labor and equipment costs, and based on the design engineer's experiences on similar projects. These costs can fluctuate with the economy as time progresses; therefore, the construction estimate will be periodically updated as the project develops. Refer to Appendix B for a more detailed construction cost evaluation and well as project O&M costs throughout the 20-year design life.

Changes from Phase 0 Approval

Originally the project consisted of three fully-contained and one semi-contained marsh creation / marsh nourishment cells totaling approximately 500 acres. Due to numerous pipelines in the project area, the semi-contained cell has been eliminated and one of the fully-contained cells has been split into two cells. Currently, the project consists of restoring 426 acres of saline marsh by hydraulically dredging in-situ material from Barataria Bay and placing it into four fully-contained cells within the interior marsh.

The construction budget (including contingency) has increased from $15.8 million to $17.8 million. The current estimated benefits of the project, subject to review and completion of an updated Wetland Value Assessment (Appendix L), differs from Phase 0 as shown in Table 1.6.

Table 1.6			
	Phase 0 (Cells A, B, C, and D)	95% Design (Cells A, B, C-1, and C-2)	Percent Change
Total Acreage of MC/MC	516	426	-17%
Net Acres at Year 20	251	226	-10%
AAHUs	158	141	-11%

Summary and Conclusion

Based on the concepts and methodologies discussed herein, LHA is of the opinion that the 95% design is in general conformance with the project objectives and budget. The estimated cost of construction is slightly more than the preliminary construction cost with contingency of 15.8 million as determined by NRCS; however, that cost was based on a limited amount of site-specific data. To date, the design team has had several conversations with pipeline owners to be affected by the project, and all major concerns have been eliminated. LHA and NRCS will continue to converse with pipeline owners to address any questions or concerns should they arise, as they relate to pipeline impacts and site access during and post-construction. Upon acquisition of construction funds, CPRA and NRCS will initiate to appropriate procedures for compensating the affected oyster lease holders, as well as engage in formal land rights agreements with landowners.

A list of landowners having interests in the project area has been included in Appendix H.

REFERENCES

Applied Coastal Research and Engineering (ACRE), 2018. Determining Recent Subsidence Rates for Barataria Basin, Louisiana: Implications for Engineering and Design of Coastal Restoration Projects. Final Report prepared for Louisiana Coastal Protection and Restoration Authority. Contract 4400009020, Task 3. 70p. See Appendix K.