Volume II
Geotechnical Engineering Report

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

for

State of Louisiana
Office of Coastal Protection and Restoration

March 23, 2012

GeoEngineers
Earth Science + Technology

Volume II
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GeoEngineers

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Volume II
Geotechnical Engineering Report

Bayou Bonfouca Marsh Creation Project (PO-104) St. Tammany Parish, Louisiana

File No. 16715-023-00

March 23, 2012

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INTRODUCTION

This report presents the results of GeoEngineers, Inc.'s (GeoEngineers) geotechnical services for the Bayou Bonfouca Marsh Creation Project (PO-104) in St. Tammany Parish, Louisiana. Our services have been completed in accordance with the scope of services dated February 2010, which was sent July 13, 2011 for our consideration. GeoEngineers' services were completed under LDNR Contract No. 2503-11-67 "Geotechnical Services for Coastal Restoration Projects" dated February 7, 2011.

PROJECT UNDERSTANDING AND SCOPE OF SERVICES

The Bayou Bonfouca Marsh Creation Project (PO-104) is located on the North shore of Lake Pontchartrain west of Slidell, Louisiana. Figure 1 shows the project location in the State of Louisiana as well as along the lake shore. The project will create 533 acres of marsh and nourish an additional 42 acres of existing marsh within Big Branch Marsh National Wildlife Refuge by hydraulically pumping soil from the bottom of Lake Pontchartrain into the marsh creation and nourishment areas and planting marsh grasses in the newly created marsh. Approximate coordinates for the center of the project are 30°14'44.78" N and 89°51'25.42" W (NAD 83). Relevant site features and soil boring locations are shown in Figure 2.

The following services were performed in connection with this project:

1. Contacted landowners to obtain permission to access their property with a marsh buggy-mounted drill rig.
2. Contacted Louisiana One Call to locate and mark subsurface utilities prior to commencing field operations.
3. Executed a field exploration program as described in Volume I – Geotechnical Investigation Data Report dated November 4, 2011.
4. Conducted a laboratory testing program consisting of shear strength, compressibility, and material characteristic (grain size, moisture content, plasticity, etc) testing on select samples to establish design soil parameters.
5. Developed design soil profiles for use in settlement and stability analyses.
6. Performed analyses for earthen containment levees to establish stable side slopes, acceptable crown elevation and width, consolidation settlement, and time rate of settlement. Settlement curves for the containment levees are presented at the end of this report.
7. Performed analyses for the dredged borrow and fill areas to estimate settlement of the dredged fill and marsh creation area foundation soils over the 20-year life of the project. Settlement curves for the dredged fill and marsh creation foundation are presented at the end of this report.
8. Addressed borrow area edges and their impacts on the stability of the Goose Point Fault.
9. Presented the results of field and laboratory work in a written geotechnical investigation data report (Volume I) dated November 4, 2011.

10. Presented the results of engineering analyses, conclusions, and recommendations in a geotechnical engineering report (this document – Volume II).
11. Presented a copy of the calculations package as prescribed in the scope of services (Volume III).
12. Provided an electronic copy of Volumes I and II and individual soil boring logs in .pdf format on a compact disc accompanying this report.

SITE CONDITIONS

Project Vicinity

The project is located at the northeastern corner of Lake Pontchartrain in St. Tammany Parish, Louisiana west of the city of Slidell. The surrounding area is undeveloped with the exception of an Exxon pipeline east of the marsh creation area behind soil boring B-1 and west of the marsh creation area behind B-2. The site surface conditions generally consist of open waterways and depleted marshes. The site was accessed from a public boat launch located at Heritage Park in Slidell, Louisiana.

Surface Conditions

The project vicinity and boring locations are shown in Figures 1 and 2, respectively. The project area consists of open waterways, channels, and depleted marshes. Vegetation growing in the marshes generally consists of tall grass and small shrubs. Submerged vegetation was observed in some areas of the project location.

Subsurface Conditions

The field exploration and laboratory testing program performed by GeoEngineers to support this project is described in the following paragraphs.

Field Exploration

Soil conditions were evaluated in the project area by advancing nine soil borings to depths ranging from approximately 40 to 60 feet below existing mudline and performing two field vane shear tests at each boring location. Five additional soil borings were each advanced to an approximate depth of 20 feet below mudline within the confines of the proposed marsh creation borrow area. The soil borings were performed in 0.5 to 11.5 feet of water. Samples were collected continuously in the upper 20-feet of the soil and on 5-foot centers thereafter to boring completion depths and the top 25 feet was backfilled with cement-bentonite grout.

The borings were completed between August 30 and September 13, 2011 using pontoon- and marsh buggy-mounted drill rigs. A geologist from GeoEngineers managed the drilling on a full time basis, examined and classified the soils encountered, obtained representative samples, and prepared a log of each borehole. The approximate soil boring locations are shown in Figure 2.

Borehole sampling was conducted in general accordance with applicable ASTM specifications. High-quality, undisturbed, cohesive and semi-cohesive soil (clay/clayey silt) specimens suitable for laboratory strength testing were obtained using a 30-inch-long, 3-inch outside diameter (O.D.), thinwall steel Shelby tube sampler. The sampler was hydraulically pushed into the ground a distance not exceeding 24 inches per specimen.

Immediately upon recovery, each sample was classified in the field by our geologist based on soil exposed on the bottom end of the Shelby tube. Each Shelby tube was then sealed and stored/transported in a vertical position. Shelby tubes were secured bottom down during transportation to our Baton Rouge laboratory to minimize sample disturbance.

Upon completion of sampling, boreholes were backfilled in accordance with state requirements. Then, the marsh buggy mounted drill rigs were repositioned adjacent (± 5 feet) to the previously completed boring where a GEONOR H-10 Vane Borer Instrument was used to perform two field vane shear tests at various depths in general accordance with ASTM D 2573. No field vane shear tests were conducted for the five borings in the borrow area. The field vane shear test consists of placing a four-blade vane in the in-situ soil and rotating it from aboard the drill rig to determine the torque required to shear a cylindrical surface with the vane. The resulting torque was used to determine the in-situ undrained shear strength.

Soil characteristics observed during drilling and laboratory testing are located on the soil boring logs in Appendix I-B in the Geotechnical Investigation Data Report (Volume I). Subsurface conditions vary widely across the project area. Generally there is very soft organic clay and peat followed by inorganic clay, silt, or sand. Material interface depths vary significantly from boring to boring. In all but two of the borings, medium to stiff clays were encountered 20 feet or less below the mudline and continued to the completion depth of the boring, except where interrupted by sand and silt layers. This is consistent with geological maps of the area which place the surface of Pleistocene deposits about 20 feet below the ground surface. Clay samples from soil borings B-2 and B-3 remained very soft to the completion depth of the borings. This may indicate the presence of an ancient channel through the Pleistocene materials which subsequently filled with softer material. Interpreted soil type profiles based on the results of field exploration and laboratory testing are presented in Figures 3 and 4; design soil profiles, including shear strength, are included in Appendix II-A.

Laboratory Testing

After transport to GeoEngineers' soil mechanics laboratory, Shelby tube samples were tested for miniature vane shear strength and removed from their tubes. After evaluating the samples to edit the field classification, if needed, the samples were preserved for further testing. Laboratory tests included soil compressive strength tests, moisture content tests, organic content tests, grain size determinations, specific gravity tests, consolidation tests with rebound, and Atterberg limit determinations. Specifics from the laboratory testing program are found in Appendix C of Volume I.

CONCLUSIONS AND RECOMMENDATIONS

As evidenced by the soil properties shown in design profiles in Appendix II-A, the location of the Bayou Bonfouca Marsh Creation (PO-104) project sits over relatively shallow Pleistocene deposits. The close proximity of low-moisture, low-organic content, overconsolidated soils to the organic material typically present in coastal marsh environments ensures good soil stability and low settlement potential for most of the project area. The profiles from two of the soil borings appear to be exceptions. Soil borings 2 and 3 may be in a historical channel in the Pleistocene deposits, and do not appear to share the design benefits afforded to the other soil boring locations. This is especially noticeable in the settlements estimated for these two borings relative to the estimated settlements at all the other locations.

After initial design and analysis were complete, changes were made to the marsh creation and containment footprints. These changes include the addition of a marsh creation cell to the north of soil boring B-1 and the removal the eastern portion of the large marsh creation cell east of soil boring B-6, as reflected in the project features shown on Figure 2. The new marsh creation boundaries exclude B-9; however, analyses based on B-9 have not been excluded from this report since they may still provide useful information about soils within the project area.

Bearing Capacity and Slope Stability Analyses

Containment Dikes

Subsurface conditions at the Bayou Bonfouca project site vary considerably from one boring to the next. In order to capture the general containment dike performance, GeoEngineers evaluated allowable bearing pressure and slope stability for each of the soil borings. Slope stability factors of safety were computed for the containment dike with and without fill. For some of the borings, the factor of safety was lower when the containment dike was modeled with hydraulic fill behind it. In these cases, the containment dike geometry was adjusted, if necessary, to accommodate the more critical case. The resulting geometries and factors of safety for both slope stability and bearing capacity are summarized in the table below. Figures II-B-1 through II-B-10 in Appendix II-B present a graphical summary of slope stability results for containment dikes with no fill.

SLOPE STABILITY WITHOUT FILL AND BEARING CAPACITY SUMMARY

Containment Site Soil Boring Identification	Acceptable Crown Elevation (ft, NAVD 88)	Assumed Foundation Elevation (ft, NAVD 88)	Acceptable Crown Width (ft)	Acceptable Side Slopes	Slope Stability Factor of Safety	Bearing Factor of Safety
B-1	5.5	0	5	3H:1V	1.34	2.87
B-2	5.5	0	5	3H:1V	1.15	1.31
B-3	5.5	0	5	3H:1V	1.57	1.85
B-4	5.0	-1.5	5	3H:1V	1.13	1.72
B-5	5.5	0	5	3H:1V	1.83	2.24
B-6	5.5	0	5	3H:1V	1.31	1.72
B-7	4.0	-1	2	2H:1V	1.18	1.73
B-8	4.0	-1	1	7H:1V	1.14	1.67
B-8f*	4.5	-1	2	4H:1V	1.23	1.22
B-9	5.5	-1	5	5H:1V	1.16	1.90

*B-8f includes geotextile fabric reinforcement to allow for smaller containment dike geometry. The bearing capacity calculation method used for the above safety factors does not account for effect of geotextile reinforcement.

Aside from soil borings B-2, B-3, and B-5, the slope stability safety factors in the above table are generally based on failure within the fill itself. Deeper failure mechanisms for these profiles do exist, but the safety factors are higher and are not reported in the table. Graphical summaries of the deeper failure mechanisms for borings B-1, B-4, and B-6 through B-9 are included in Appendix II-B.

The table below summarizes the results of slope stability analyses for containment dikes with hydraulic fill behind them. The fill material has a unit weight of 96 pounds per cubic foot (pcf) and shear strength of 1 pound per square foot (psf) and is placed so the fill surface is one foot below the maximum crown elevation of the containment dikes. Figures II-B-11 through II-B-19 present a graphical summary of slope stability results for containment dikes with maximum fill.

SLOPE STABILITY WITH MAXIMUM FILL SUMMARY

Containment Site Soil Boring Identification	Acceptable Crown Elevation (ft, NAVD 88)	Assumed Foundation Elevation (ft, NAVD 88)	Acceptable Crown Width (ft)	Acceptable Side Slopes	Slope Stability Factor of Safety
B-1	5.5	0	5	3H:1V	1.33
B-2	5.5	0	5	3H:1V	1.11
B-3	5.5	0	5	3H:1V	1.33
B-4	5.0	-1.5	5	3H:1V	1.13
B-5	5.5	0	5	3H:1V	1.78
B-6	5.5	0	5	3H:1V	1.31
B-8	4.0	-1	1	7H:1V	1.14
B-8f*	4.5	-1	2	4H:1V	1.17
B-9	5.5	-1	5	5H:1V	1.16

*B-8f includes geotextile fabric reinforcement to allow for smaller containment dike geometry

Containment levee geometries were designed to provide at least marginally stable slopes (yielding a factor of safety greater than 1.1) with dredged marsh fill at its maximum elevation. Assumptions and other slope stability analysis particulars are located in Appendix II-B and in Appendix III-C in Volume III. At soil borings B-4 and B-8, the stable crown elevation is lower than at the other locations. Potential marsh fill elevations in these areas will be limited to one foot below the stable crown elevation. This limitation impacts other containment sites as well. Reducing the crown and fill elevation at other locations will increase the stability at those locations. Geotextile reinforcement was only considered where its use provided means for significant reduction in fill volume (i.e., soil boring B-8).

Many of the safety factors in the table above are based on failure within the containment dike fill. For these cases, deeper failure mechanisms also exist, albeit with higher safety factors than those shown in the table. Graphical summaries of the deeper failures for these cases are included in Appendix II-B.

Marsh fill and foundation settlement calculations indicate that the marsh creation area may not need to be filled to the maximum allowable fill elevation (refer to the section on marsh fill and foundation settlement, below). The table below shows the results of slope stability calculations based on reduced fill elevations. Figures II-B-20 through II-B-28 present a graphical summary of slope stability results for containment dikes with reduced fill elevations.

SLOPE STABILITY WITH REDUCED MARSH FILL SUMMARY

Containment Site Soil Boring Identification	Design Crown Elevation (ft, NAVD 88)	Assumed Foundation Elevation (ft, NAVD 88)	Acceptable Crown Width (ft)	Acceptable Side Slopes	Slope Stability Factor of Safety
B-1	4.0	0	5	3H:1V	1.84
B-2	4.0	0	5	3H:1V	1.22
B-3	5.0	0	5	3H:1V	1.47
B-4	5.0	-1.5	5	3H:1V	1.13
B-5	4.0	0	5	3H:1V	2.45
B-6	4.0	0	5	3H:1V	1.77
B-8	4.0	-1	1	7H:1V	1.14
B-8f*	4.0	-1	2	4H:1V	1.28
B-9	4.0	-1	5	5H:1V	1.46

*B-8f includes geotextile fabric reinforcement to allow for smaller containment dike geometry

As with the other safety factor results discussed in this report, many of the safety factors reported in the above table are based on failure within the containment dike fill. Safety factors due to deeper failure mechanisms are higher and are thus not presented here. Graphical summaries of the deeper failures are included in Appendix II-B.

Two duck ponds are included in the plans for the large marsh creation area east of soil boring B-6. These ponds will be formed by constructing open containment dikes around the pond area and filling the marsh creation area, including the pond, to a fill elevation of +1 foot. At that point the openings in the containment dikes will be closed and fill placement will resume in the marsh creation area outside the ponds, resulting in a 2-foot fill surface differential between the marsh creation area and the ponds when marsh creation construction is complete. To analyze this condition, the final fill differential of 2 feet was used in conjunction with parameters from soil borings B-7, B-8, and B-9. The table below summarizes the results of these analyses. Figures II-B-29 through II-B-32 present a graphical summary of slope stability results for these duck pond containment dikes.

Results for deep failures with higher safety factors are not reported here. However, graphical summaries of deep failures are included in Appendix II-B.

SLOPE STABILITY FOR DUCK POND CONTAINMENT DIKES

Containment Site Soil Boring Identification	Acceptable Crown Elevation (ft, NAVD 88)	Assumed Foundation Elevation (ft, NAVD 88)	Acceptable Crown Width (ft)	Acceptable Side Slopes	Slope Stability Factor of Safety
B-7	4.0	-1	2	2H:1V	1.37
B-8	4.0	-1	1	7H:1V	1.46
B-8f*	4.5	-1	2	4H:1V	1.71
B-9	4.0	-1	5	5H:1V	1.92

*B-8f includes geotextile fabric reinforcement to allow for smaller containment dike geometry

Goose Point Fault

The borrow area for the Bayou Bonfouca Marsh Creation project lies just north of the Goose Point Fault, an extension of the Baton Rouge-Denham Springs Fault system that lies near the north shore of Lake Pontchartrain. The approximate location of the Goose Point fault in relation to the project area is shown as one of the project features in Figure 2. The borrow area excavation does not appear to cross the fault and is on the immobile portion of the fault. If the excavation does cross the fault, material will be removed from topmost portion of the sliding portion of the fault, which will reduce the driving pressure on the down slope material. Conversations with Dr. Mark Kulp, a geomorphologist, concluded that no noticeable impact on the fault will occur due to dredging from the borrow area.

Settlement Analyses

Containment Dikes

Settlements of the foundation soils beneath the earthen containment levees were computed based on the levee geometries determined from the slope stability analyses tabulated in the "Slope Stability and Bearing Capacity Summary" table, above. Reducing the crown elevation and width will decrease the amount of settlement under the earthen containment levees. The table below summarizes settlement results for the containment dikes with a crown elevation of +4.5 feet. Graphical and tabular summaries of containment dike settlement for multiple crown elevations are located in Appendix II-C.

The table below does not consider regional subsidence. Settlement of the fill within itself is dependent on several factors, including organic content, natural moisture content, construction methods, and others. Elastic settlement within sand layers will occur quickly and will likely result in an increase in the quantity of fill required to reach the design construction elevation. Regional subsidence rates are relatively constant across the entire region surrounding the project area as well as inside the project boundaries.

CONTAINMENT DIKE SETTLEMENT SUMMARY FOR CROWN ELEVATION AT +4.5 FT

Boring Id.	Construction Settlement (ft)	Shrinkage Settlement (ft)	Consolidation Settlement (ft)					Long Term Settlement (ft)
			6 months	1 year	5 years	10 years	20 years	
B-1	0.04	0.37	0.10	0.14	0.18	0.19	0.19	0.19
B-2	0.17	0.56	0.33	0.39	0.58	0.69	0.81	0.87
B-3	0.16	0.56	0.39	0.47	0.71	0.77	0.79	0.79
B-4	0.05	0.19	0.21	0.22	0.22	0.22	0.22	0.22
B-5	0.03	0.19	0.03	0.04	0.06	0.07	0.07	0.07
B-6	0.06	0.74	0.18	0.23	0.29	0.29	0.29	0.29
B-7	0.06	0.74	0.12	0.16	0.26	0.28	0.28	0.28
B-8	0.04	0.19	0.17	0.18	0.19	0.19	0.19	0.19
B-8f	0.04	0.19	0.19	0.19	0.20	0.21	0.21	0.21
B-9	0.07	0.19	0.26	0.31	0.33	0.33	0.33	0.33

Construction settlement is defined here as elastic settlement occurring during construction. Construction settlement will not be identifiable except for an increase in the amount of fill required for construction of the containment levees to their design constructed elevations. Construction settlement was estimated here as 20 percent of the total consolidation settlement under the containment dike. For soil boring B-5, construction settlement also includes elastic settlement in sand.

Marsh Fill and Foundation Soils

Marsh fill and foundation settlement results are summarized in the charts and tables in Appendix II-D. All elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88). The table below contains a summary of construction settlement due to placement of hydraulic fill to various elevations. Construction settlement is estimated as 20 percent of the consolidation settlement caused by the initial load from the hydraulic fill.

MARSH FOUNDATION CONSTRUCTION SETTLEMENT

Boring Id.	Construction Settlement in Feet for Various Initial Fill Elevations				
	Fill at +2.5 ft	Fill at +3.0	Fill at +3.5	Fill at +4.0	Fill at +4.5
B-1	0.08	0.09	0.10	0.11	0.13
B-2	0.27	0.32	0.37	0.43	0.48
B-3	0.25	0.29	0.33	0.36	0.40
B-4	0.05	0.05	0.06	0.06	0.07
B-5	0.04	0.05	0.05	0.06	0.07
B-7	0.10	0.11	0.13	0.15	0.17
B-8	0.05	0.05	0.06	0.06	0.07
B-9	0.08	0.09	0.10	0.11	0.12

For the marsh creation areas on the west of Bayou Bonfouca, it appears that an initial marsh fill elevation between 2.5 and 3.0 feet will be sufficient to reach the target marsh elevation of +1.1 feet. For the northernmost marsh creation area, it appears that a starting elevation of approximately 4.0 feet on the west side of the area and between 2.5 feet and 3.0 feet in the center and on the east side of the area will be suffice to reach the target marsh elevation. For the marsh creation area adjacent to soil boring B-6, it appears that a starting fill elevation between 2.5 feet and 3.0 feet will be sufficient to reach the target marsh elevation.

Based on the results of a settling column test and the method outlined in the United States Army Corps of Engineers' EM-1110-2-5027, we computed a bulking factor (a fill-to-cut ratio) of approximately 2.2. However, due to hydraulic dredging losses, practical experience shows that the cut-to-fill ratio will likely be about 1.5.

Construction Considerations

Marsh Fill Dewatering

The practice of making a small, shallow breach at regular intervals in the containment levees to allow water to pass through is common for marsh creation projects. GeoEngineers believes that this method will be adequate to drain the hydraulically dredged fill placed in the marsh creation areas.

Containment Dike Considerations

In order to avoid potential stability problems during construction of the containment dike, GeoEngineers recommends constructing the earthen containment levees from the bottom up with two or more lifts to ensure gentle application of pressure on area soils. GeoEngineers also recommends not stockpiling fill material in one location to allow it to dewater, as a large pile of soil with steep slopes could result in bearing failure of the foundation soils.

For the northernmost marsh creation area, marsh fill and foundation settlement calculations resulted in two distinct initial hydraulic fill elevations required to reach the target marsh level after 20 years. A training dike to separate the areas that correspond to these settlements is planned between soil borings B-3 and B-4. Containment dike side slopes and crown width may remain constant around the entire marsh creation cell, but a transition at the training dike to the lower crown elevation will help save on earthwork costs.

LIMITATIONS

The information presented in this report is based on the soil borings and soil testing completed for this study, and judgments made by the certifying engineers. This report is specific to this site and should not be used other than for the design of the Bayou Bonfouca Marsh Creation (PO-104) project located in St. Tammany Parish, Louisiana. Additional geotechnical data and sample calculations are in Volumes I and III.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions express or implied should be understood.

Any electronic form or hard copy of this document (email, text, table, and/or figure), if provided, and any attachments are only a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix II-E titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

FIGURES

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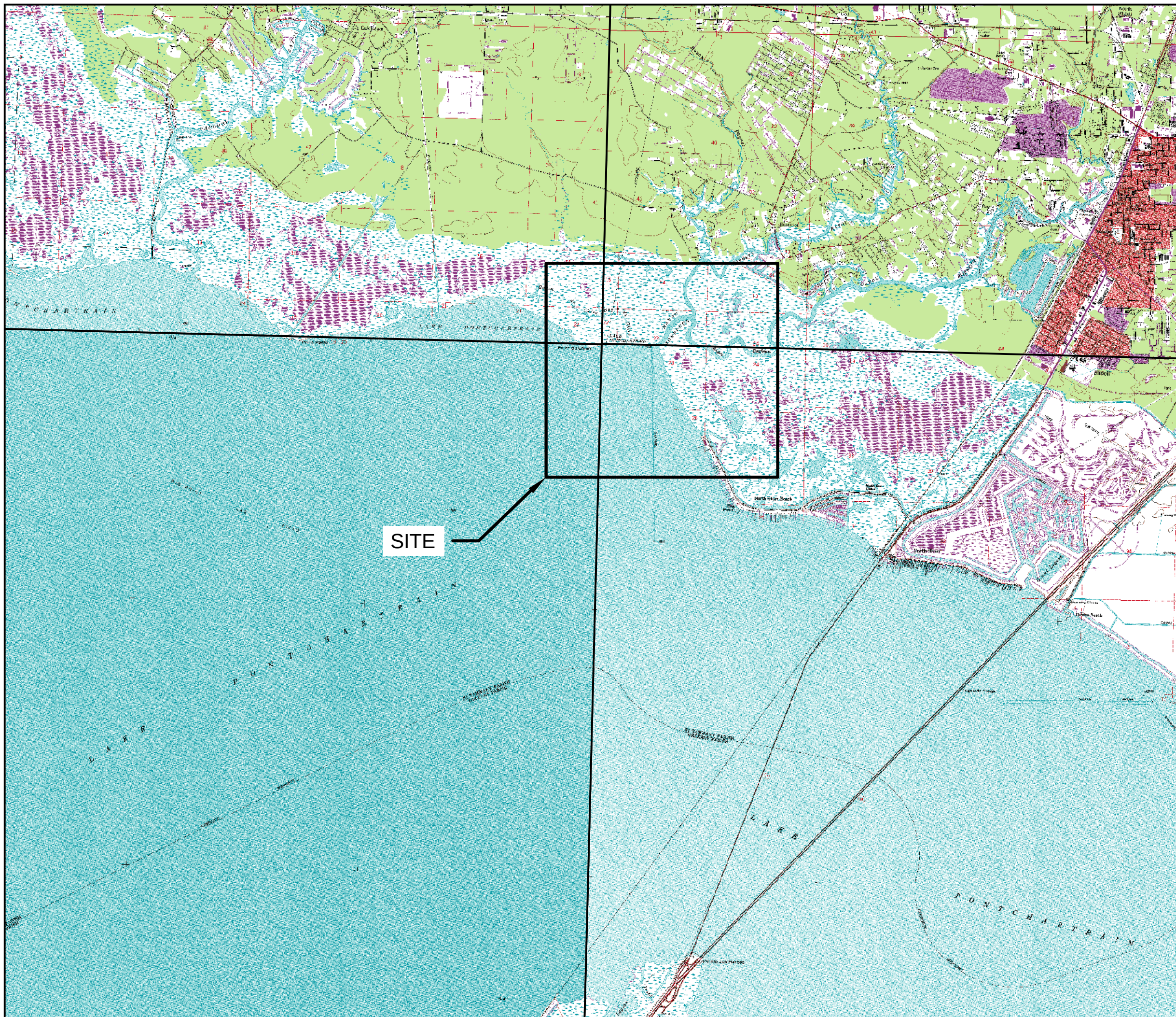

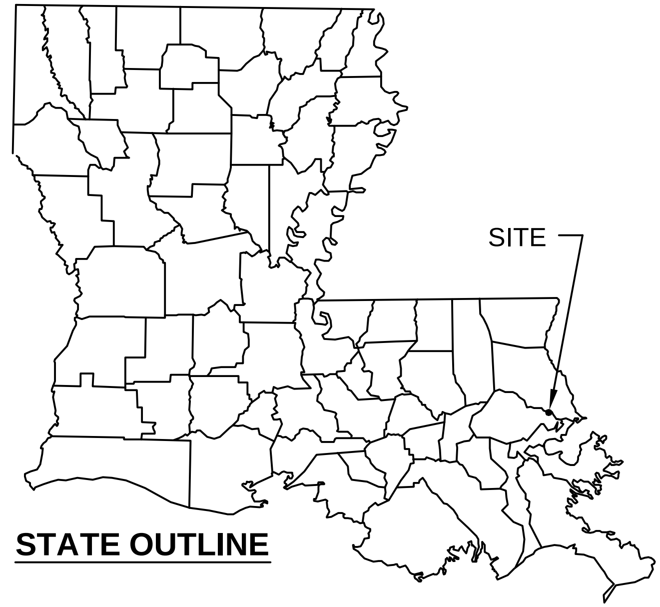

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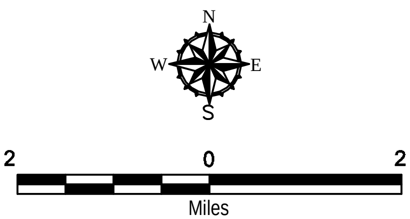

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Topographic map taken from USGS, 24K Template, Quads: North Shore, South Point, Slidell and Lacombe, Dated: 1994

VICINITY MAP

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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Figure II-1

Legend

- B-1 Borehole Location
- A A' Cross Section
- Approximate Goose Point Fault
- Marsh Creation Areas
- Ponds
- Borrow Area

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FEET

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Reference: Aerial image taken form Google Earth Pro, Licensed to GeoEngineers Inc., Dated 3/22/2010

BORING LOCATION PLAN

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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Figure II-2

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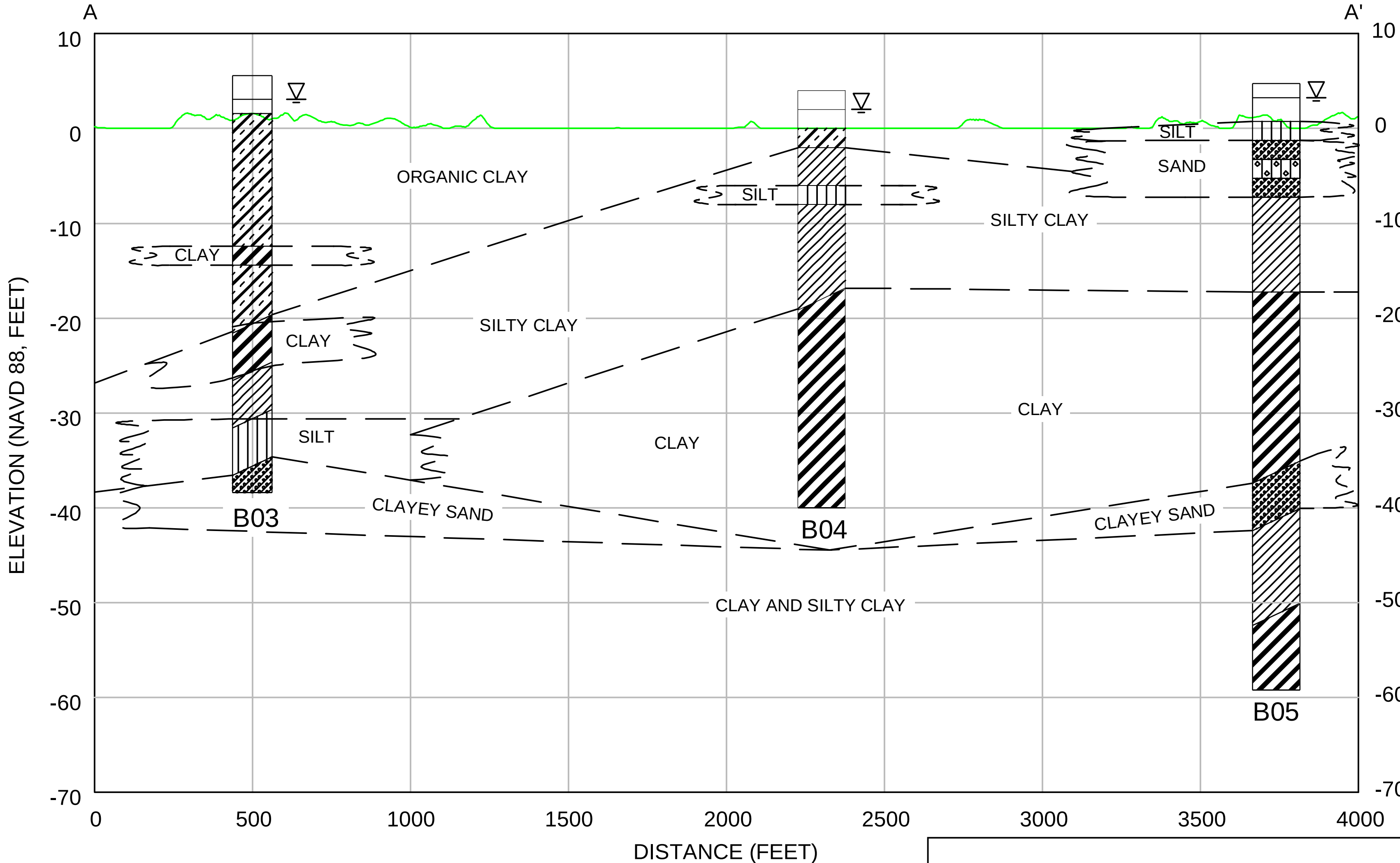

SUBSURFACE PROFILE A-A'

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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Figure II-3

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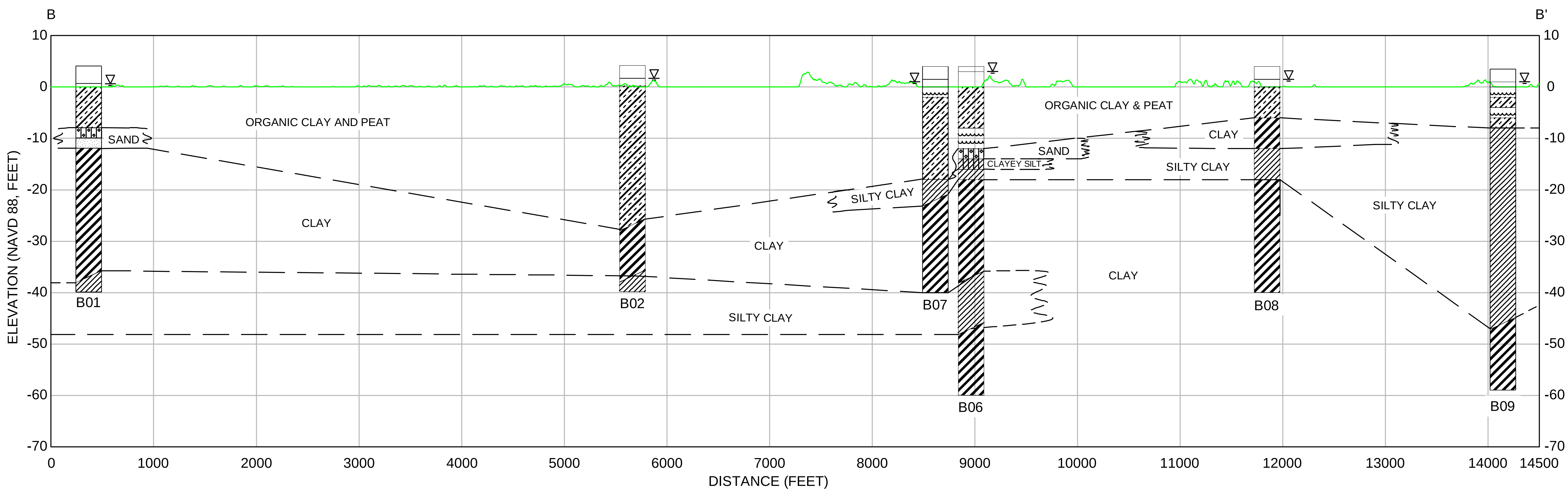
Reference: Elevation data taken from USGS, State of Louisiana, 1999-2006, 1/9-Arc Second National Elevation Dataset, Dated 8/2/2008



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SUBSURFACE PROFILE B-B'

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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Figure II-4

JMP : KMC

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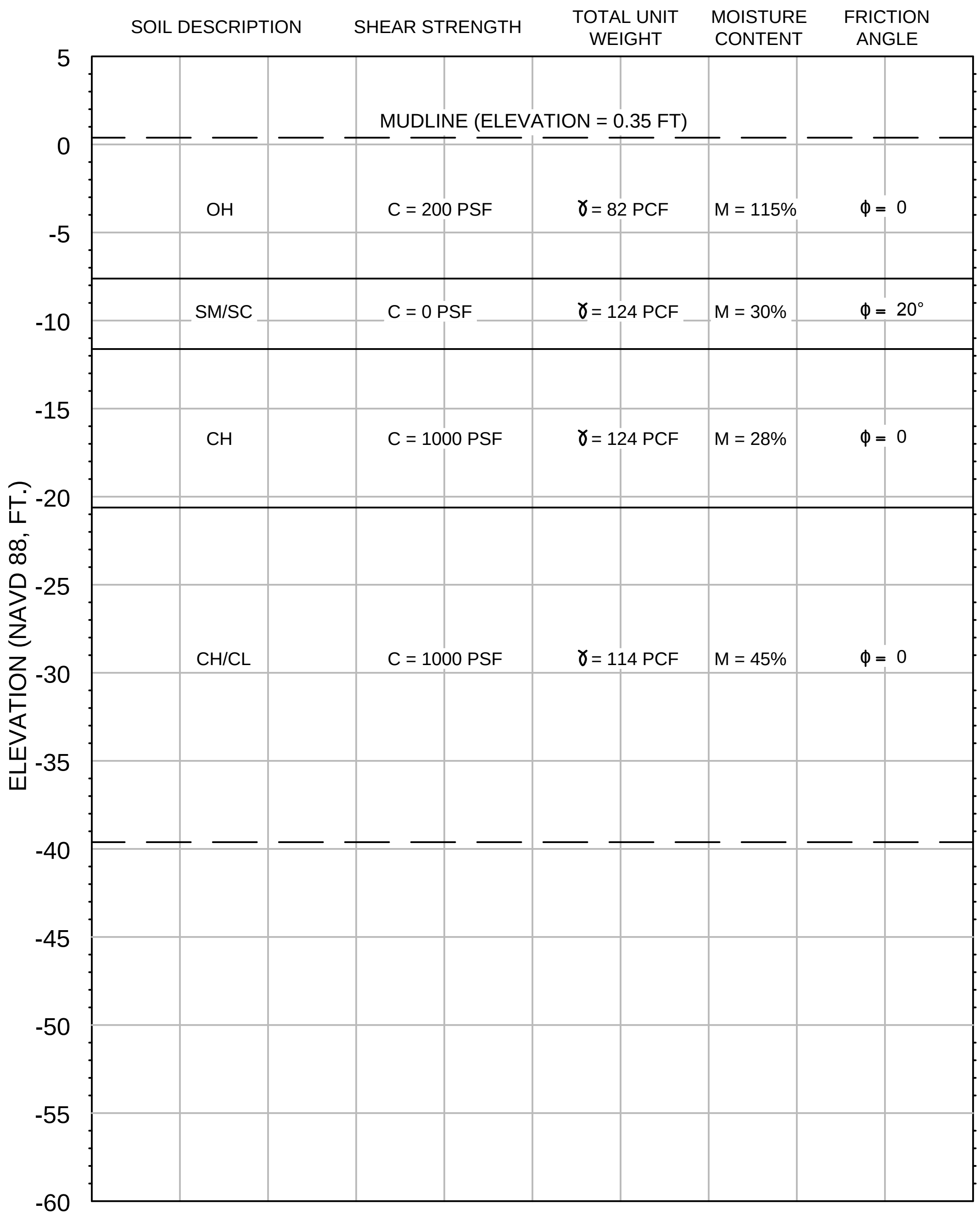
APPENDICES

APPENDIX II-A
Design Soil Profiles

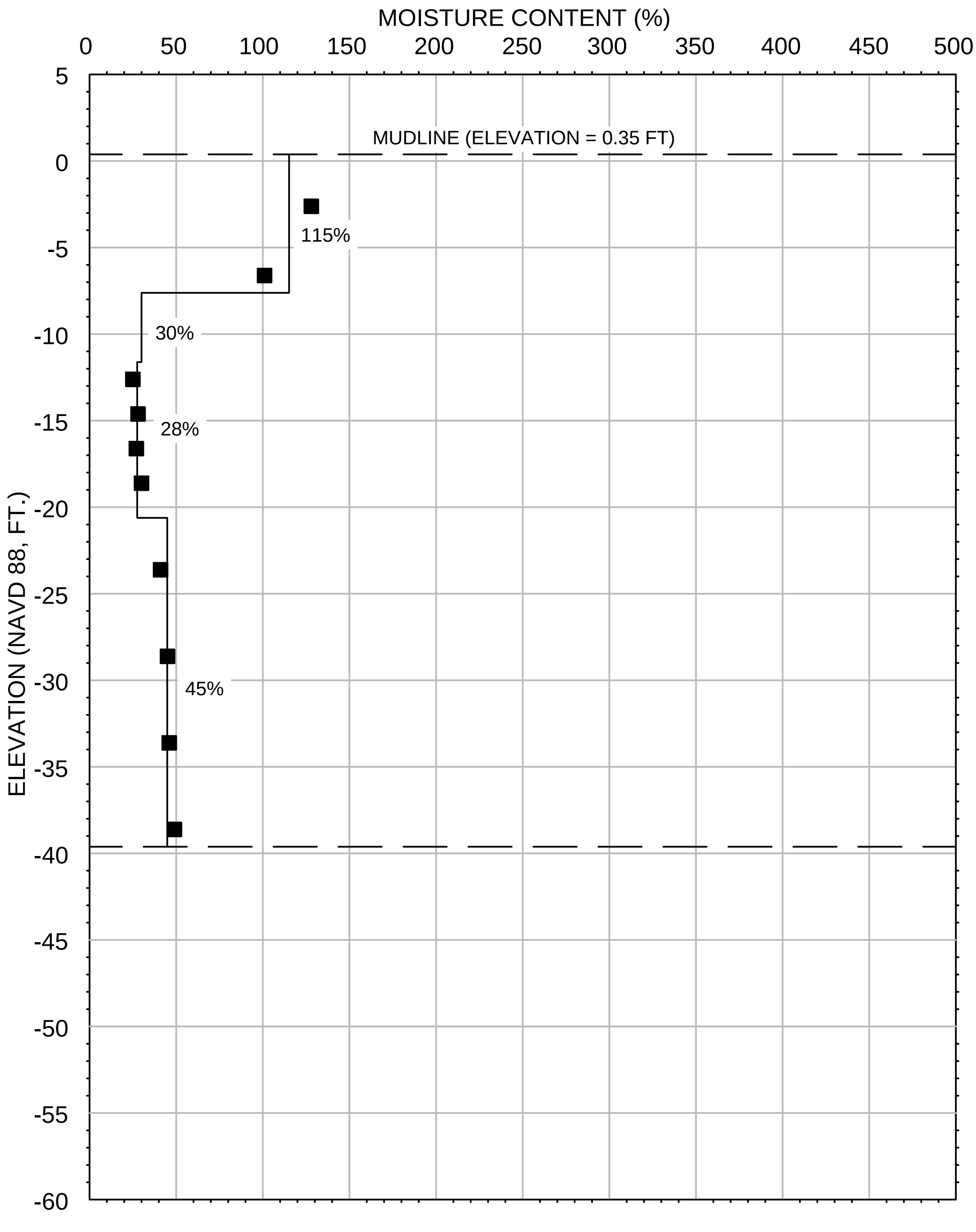


SOIL SUMMARY
B-1

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-1□



LE□END

■ B-1

MOIST□RE □ONTENT VS ELEVATION
B-1

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-1□

JPV : KMC

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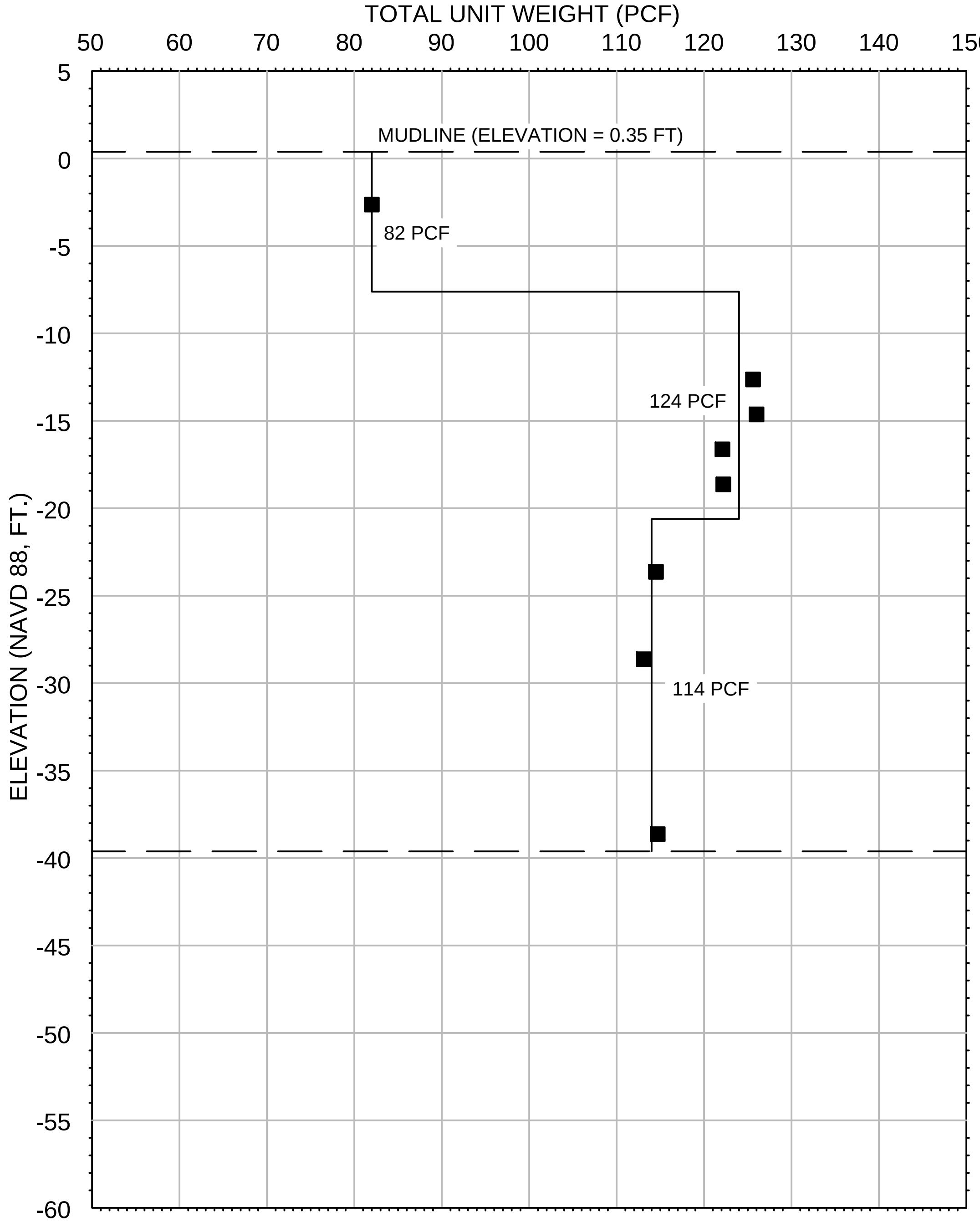

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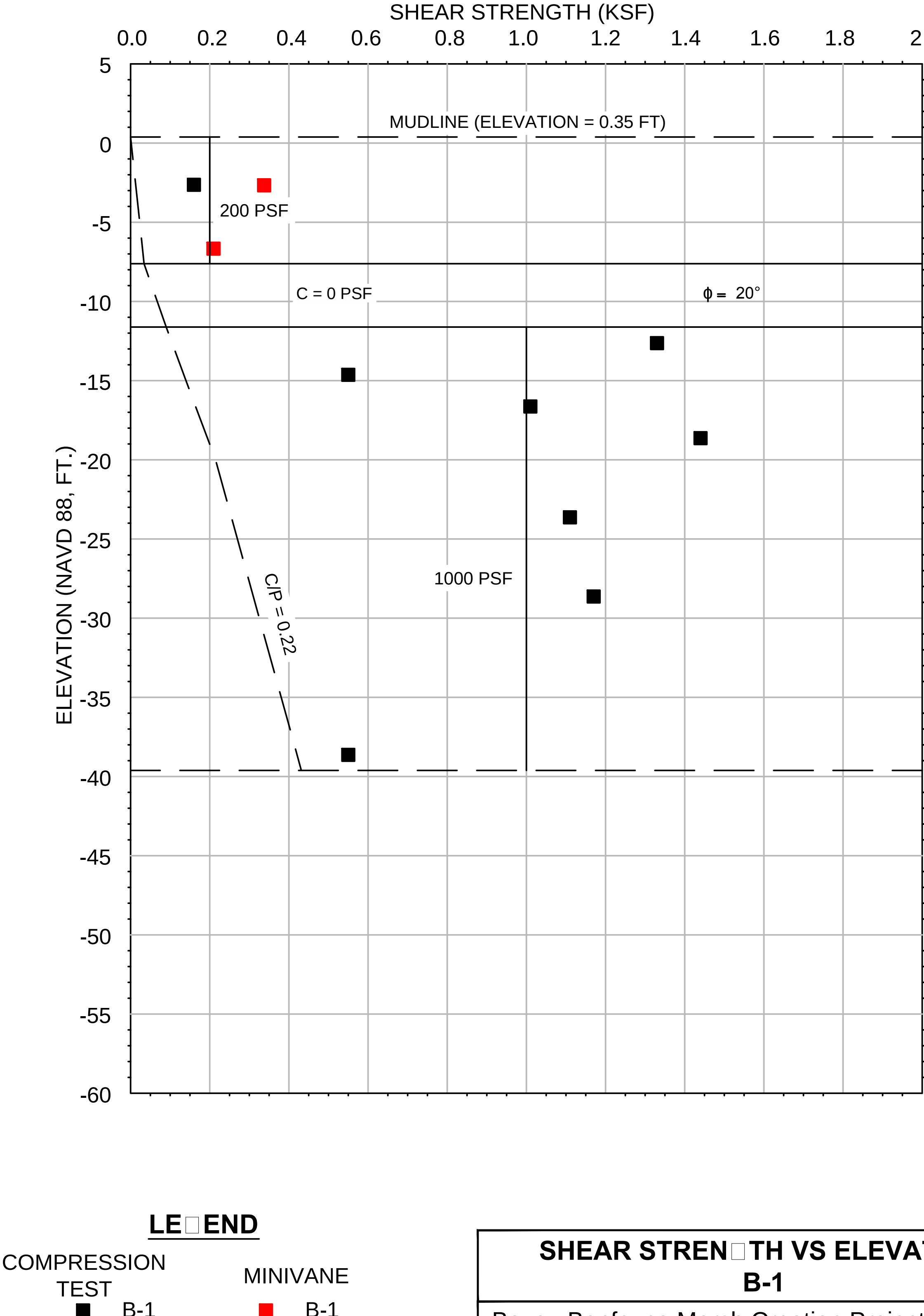
■ B-1

TOTAL □NIT □ EI□HT VS ELEVATION
B-1

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-1□

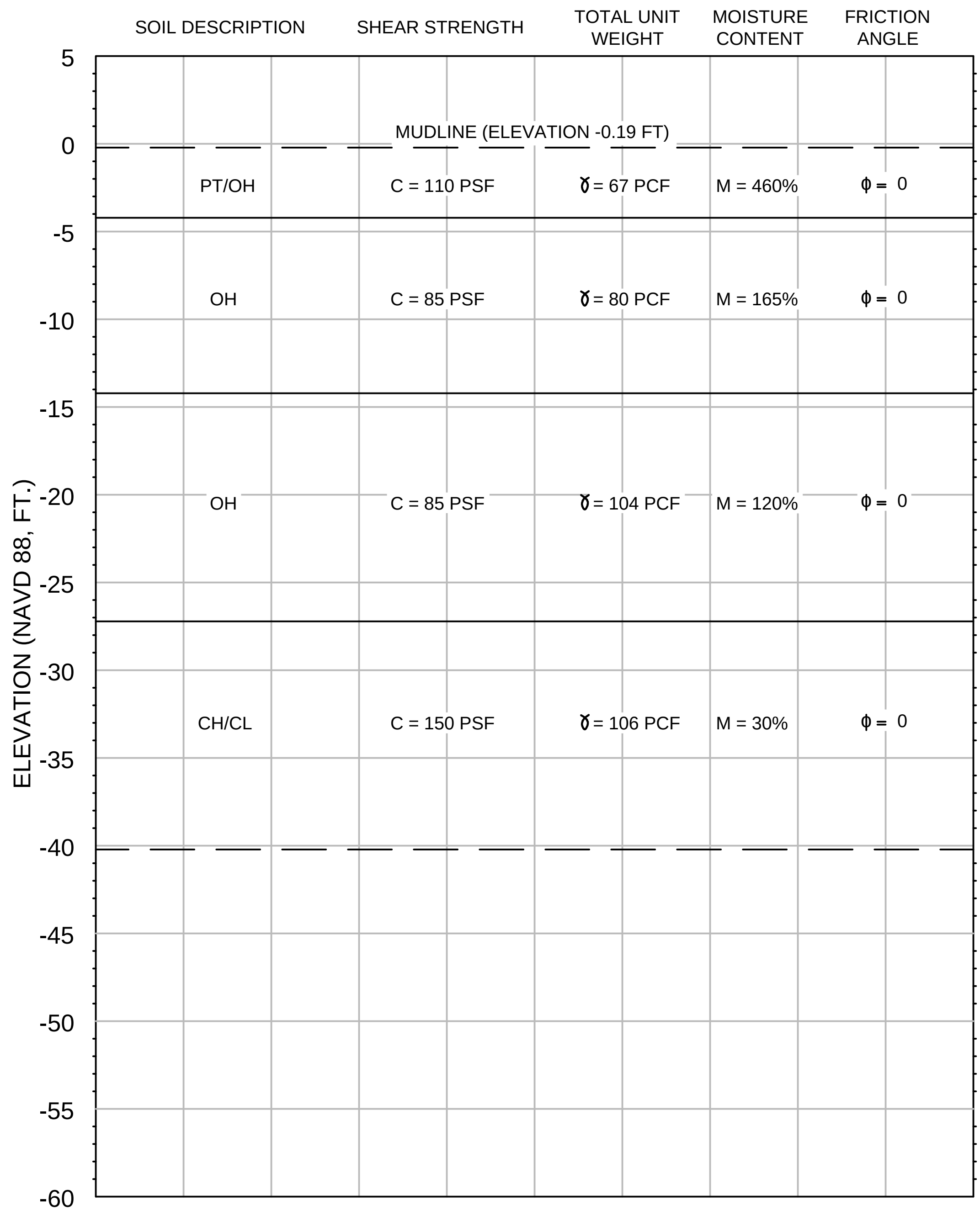


SHEAR STRENGTH VS ELEVATION
B-1

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-1d

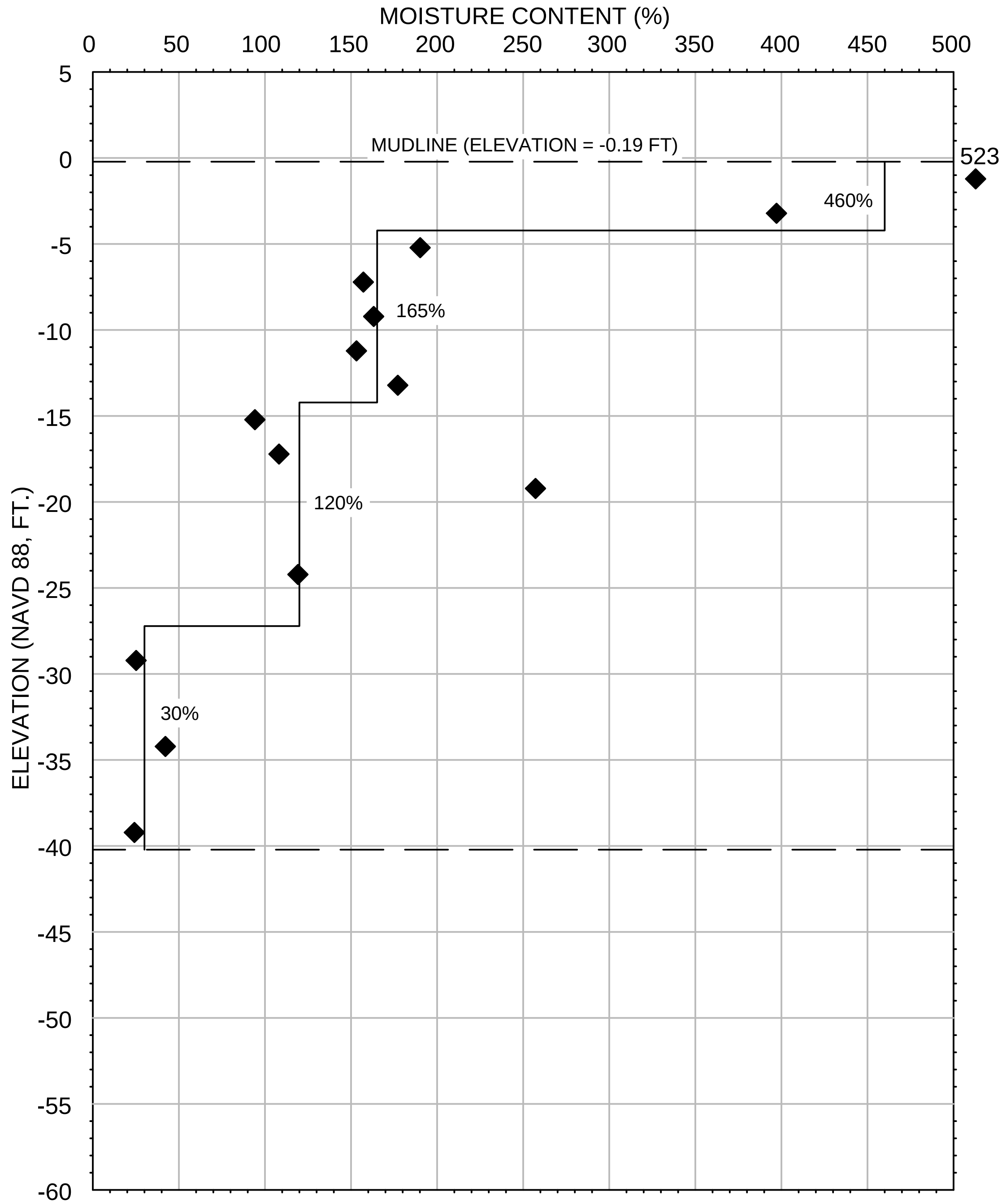


SOIL S□MMAR□
B-2

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-2□



LE□END

◆ B-2

MOIST□RE □ONTENT VS ELEVATION
B-2

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-2□

JPV : KMC

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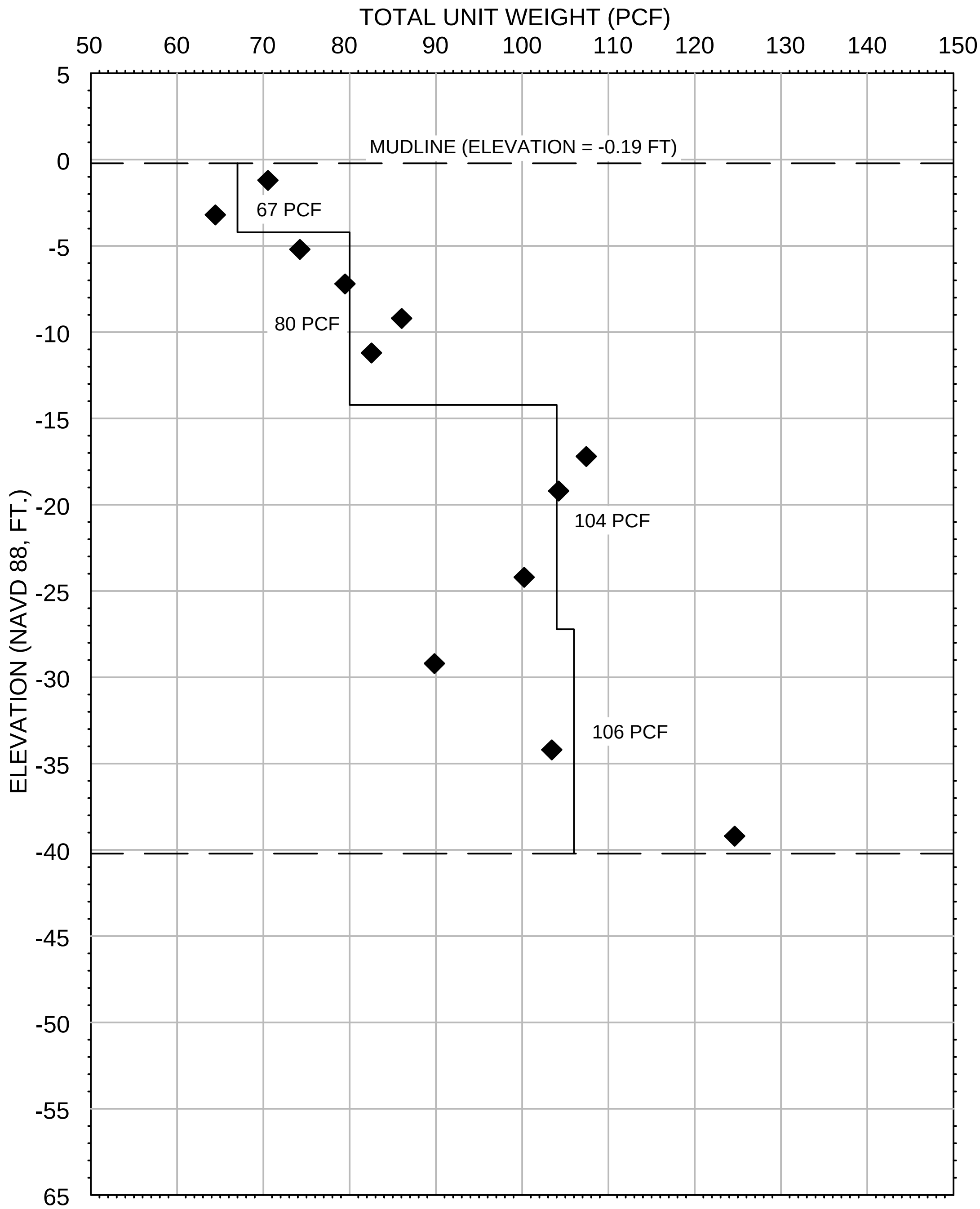

LE□END

◆ B-2

TOTAL □NIT □ EI□HT VS ELEVATION
B-2

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-2□

JPV : KMC

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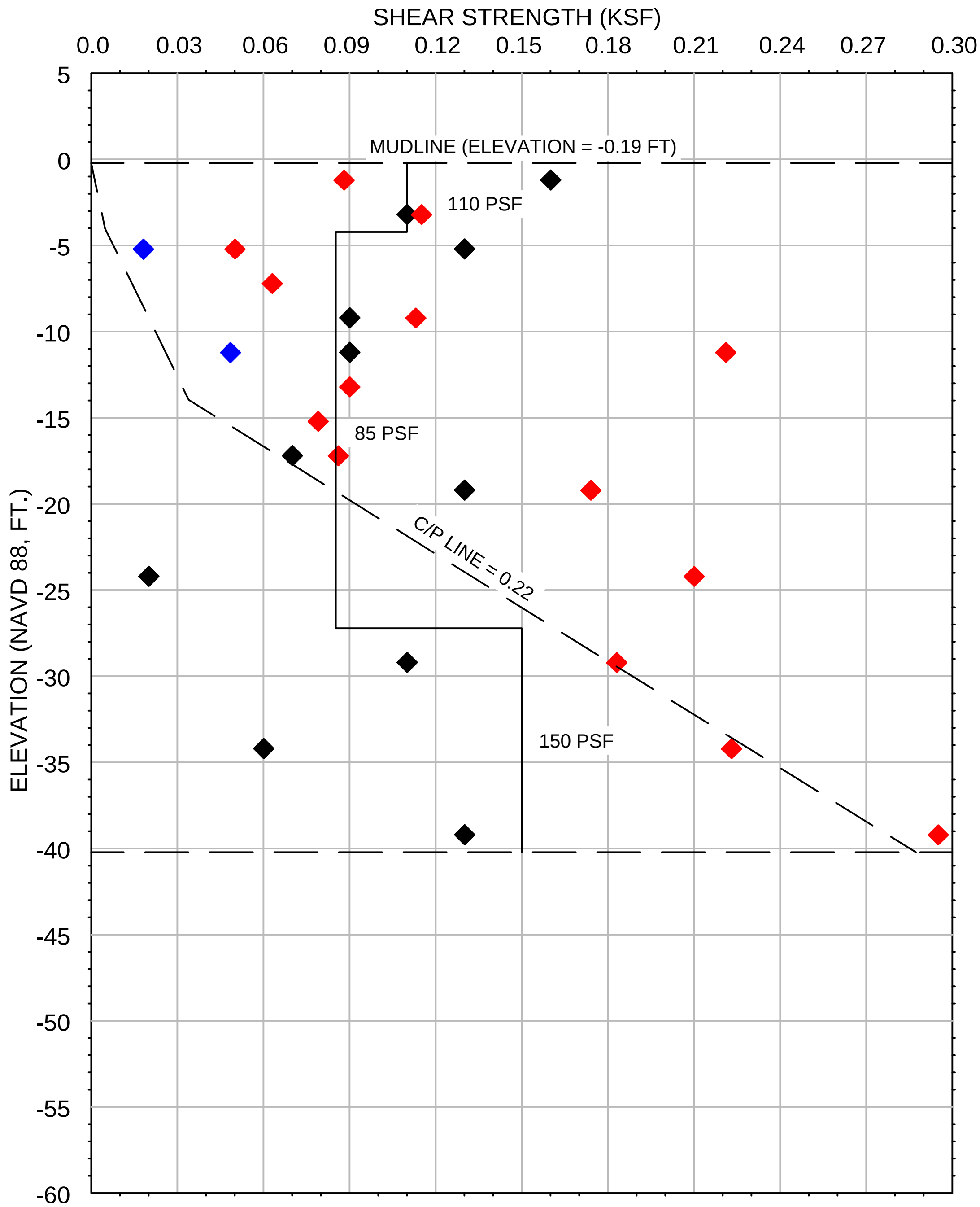

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COMPRESSION TEST B-2

MINIVANE B-2

FIELD TEST B-2

SHEAR STREN□TH VS ELEVATION
B-2

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-2d

JPV : KMC

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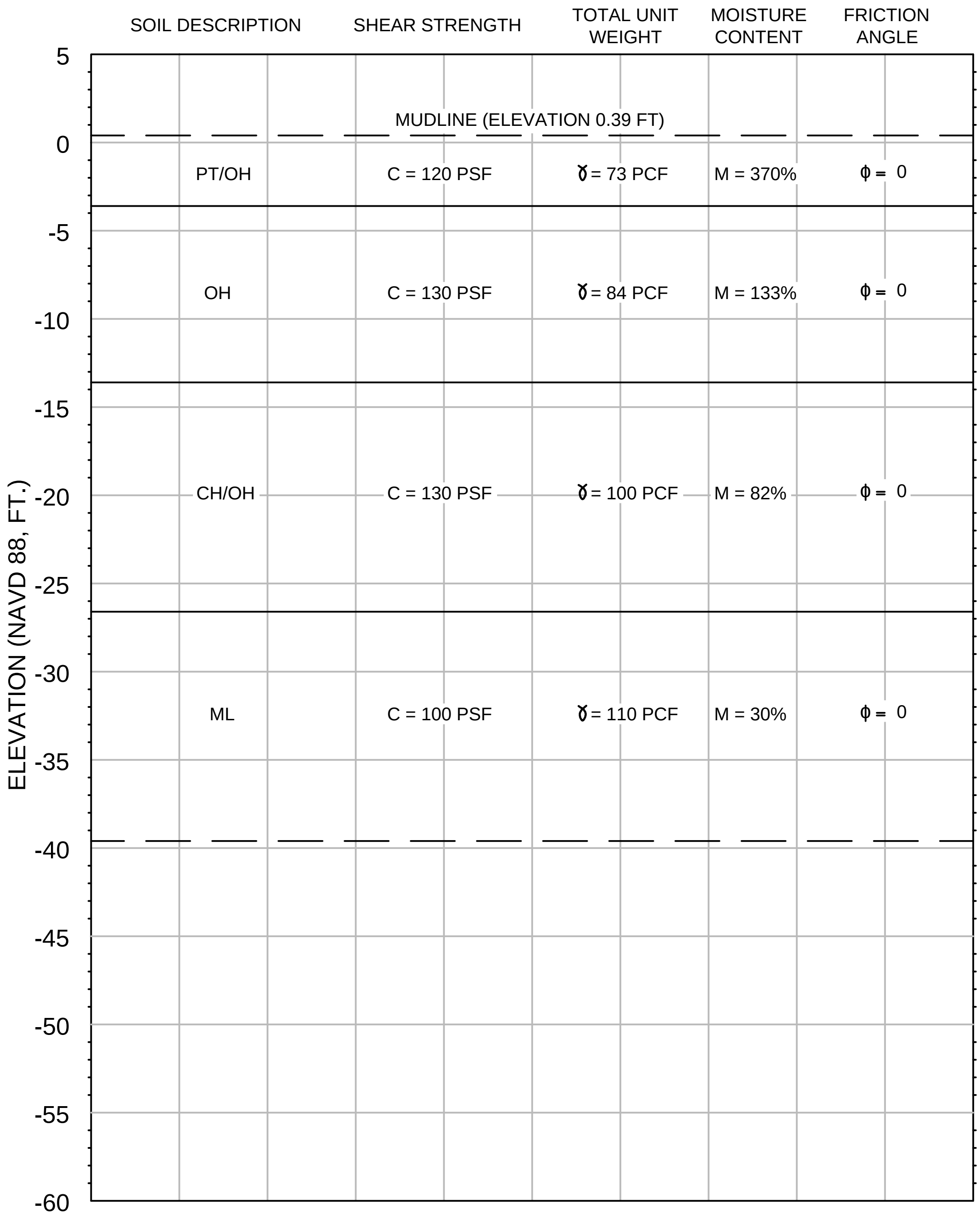

SOIL SUMMARY
B-3

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-3

JPV : KMC

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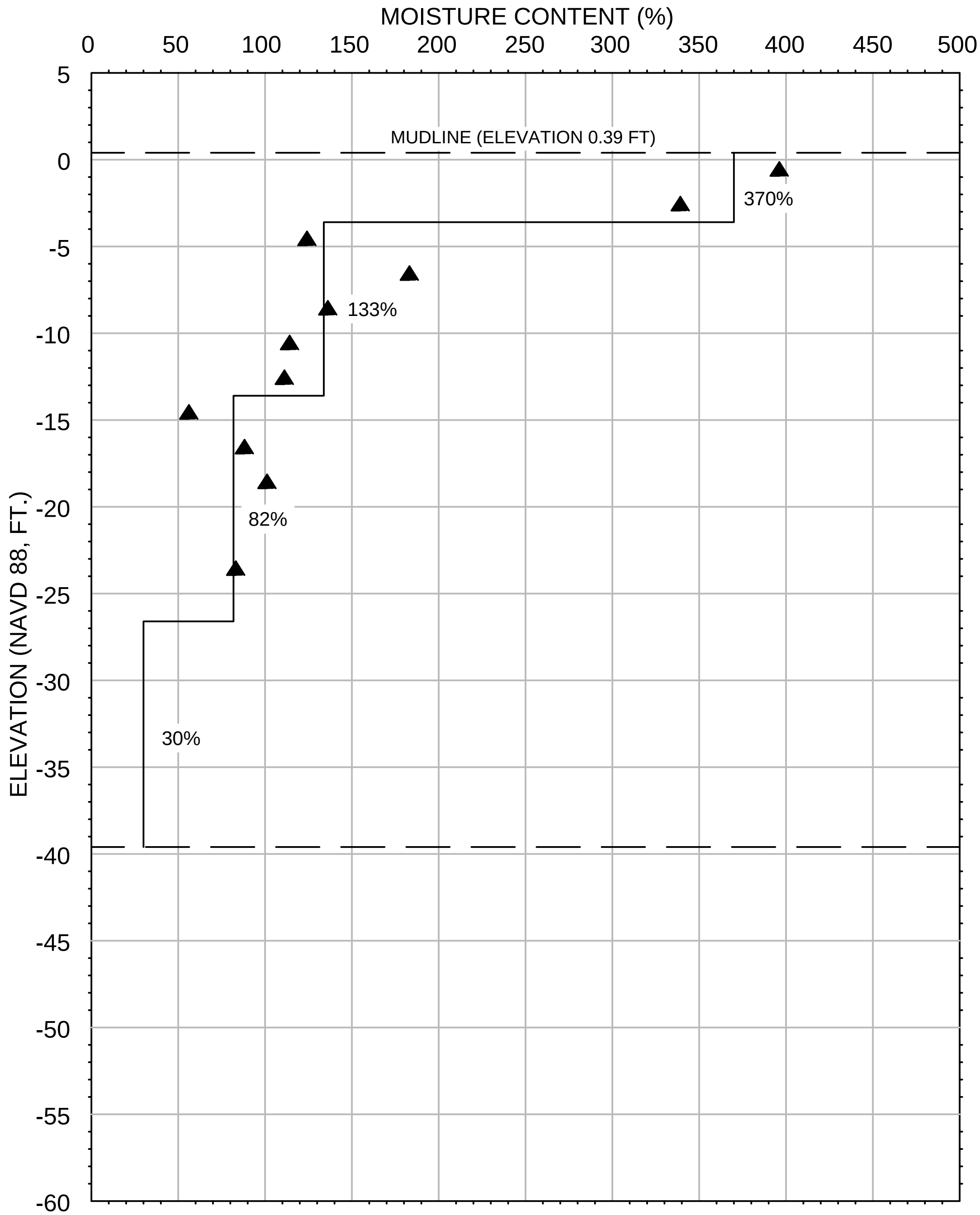

LE□END

▲ B-3

MOIST□RE □ONTENT VS ELEVATION
B-3

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-3□

JPV : KMC

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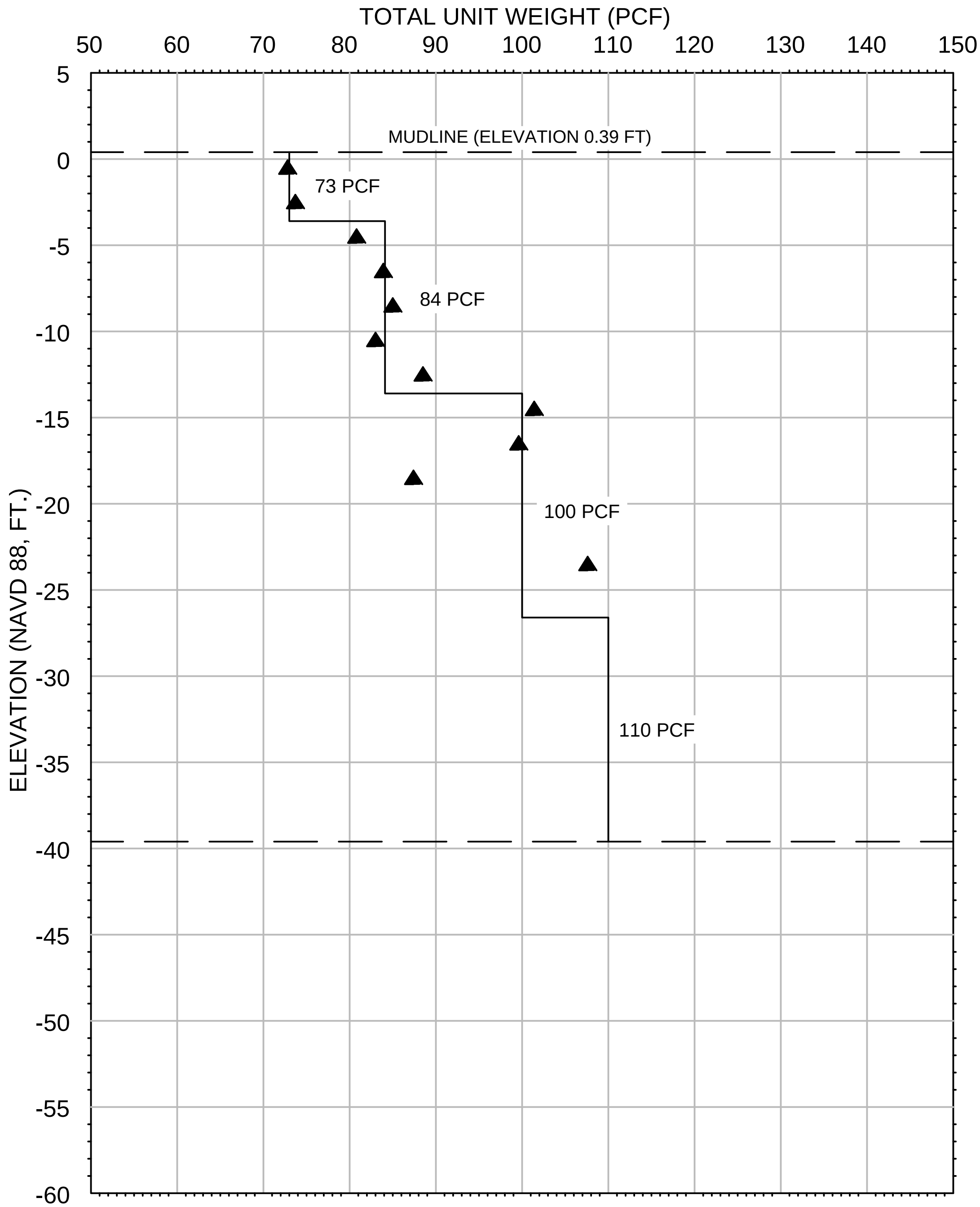


LE□END

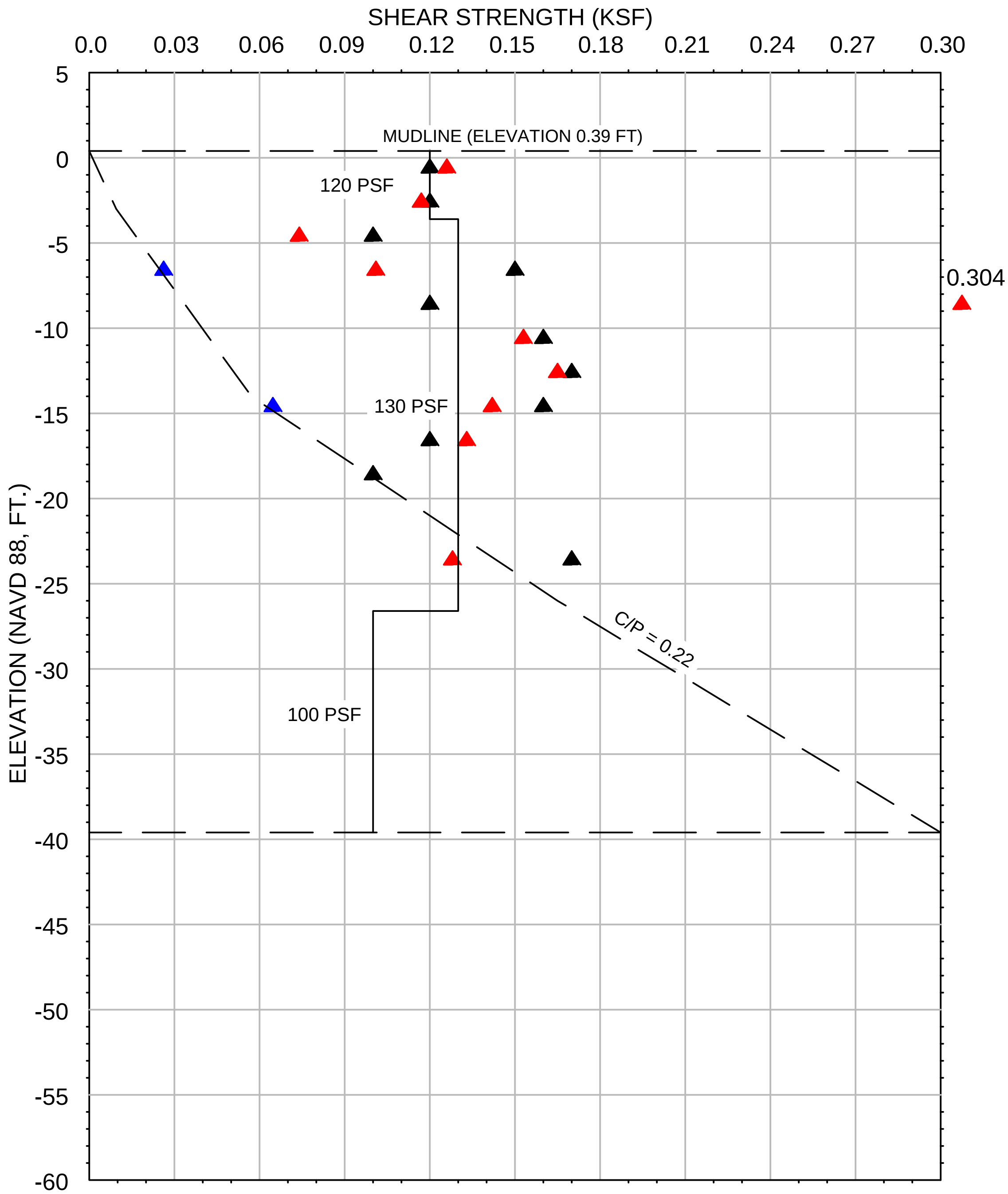
B-3

TOTAL □NIT □ EI□HT VS ELEVATION
B-3

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-3□



LEGEND

COMPRESSION TEST ▲ B-3

MINIVANE ▲ B-3

FIELD TEST ▲ B-3

SHEAR STRENGTH VS ELEVATION
B-3

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-3d

JPV : KMC

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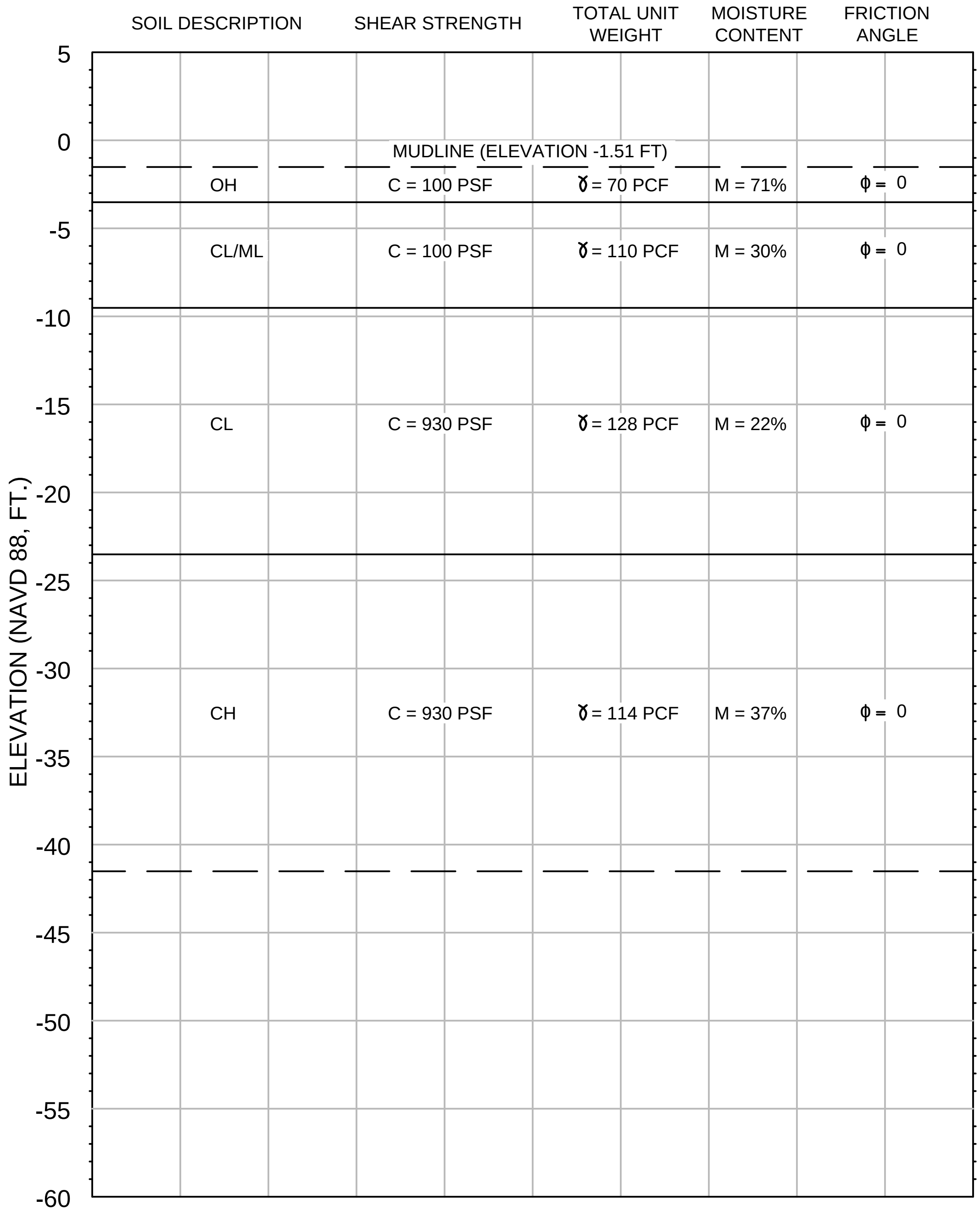

LEGEND

▼ B-4

SOIL SUMMARY
B-4

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-4

JPV : KMC

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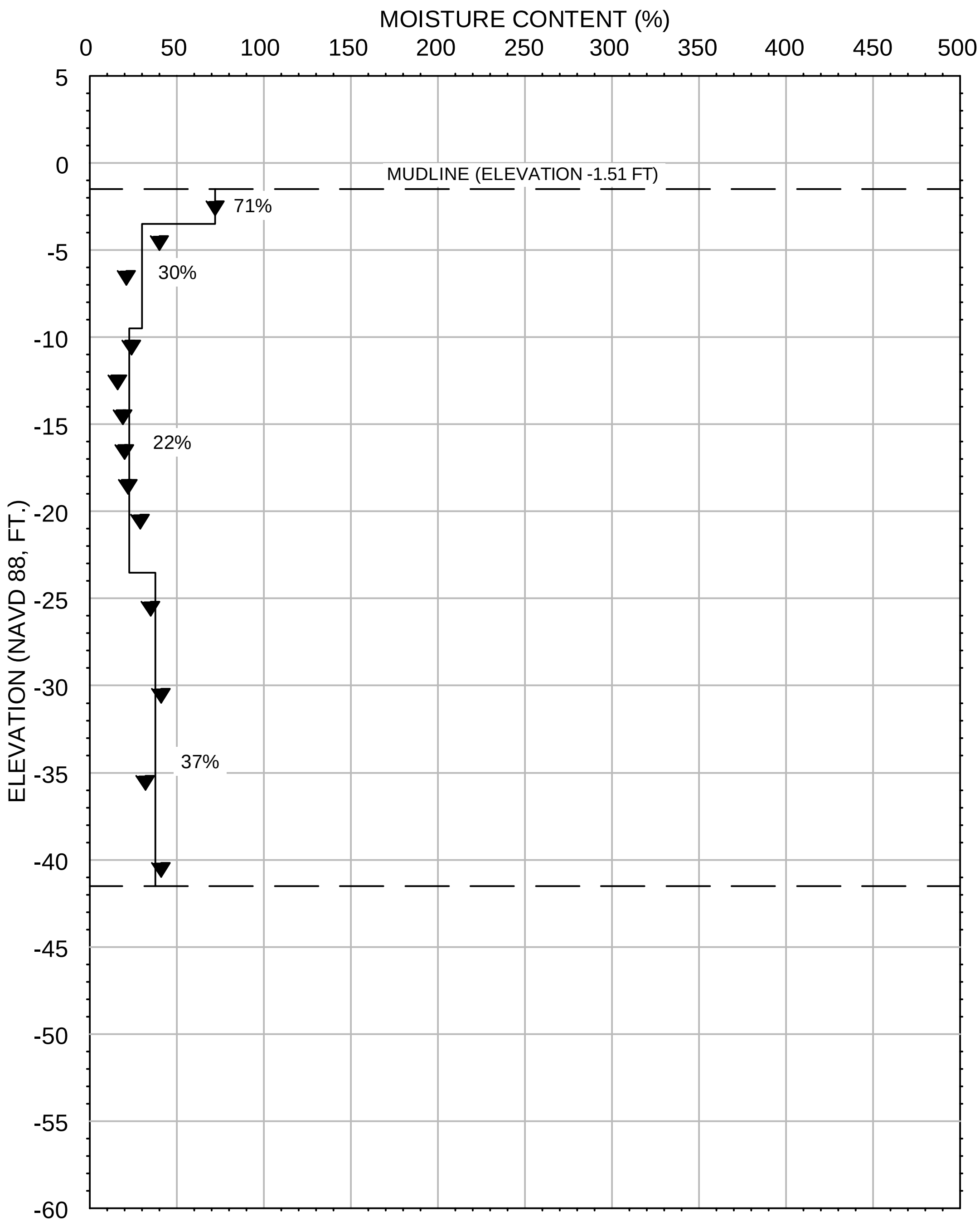


LEGEND

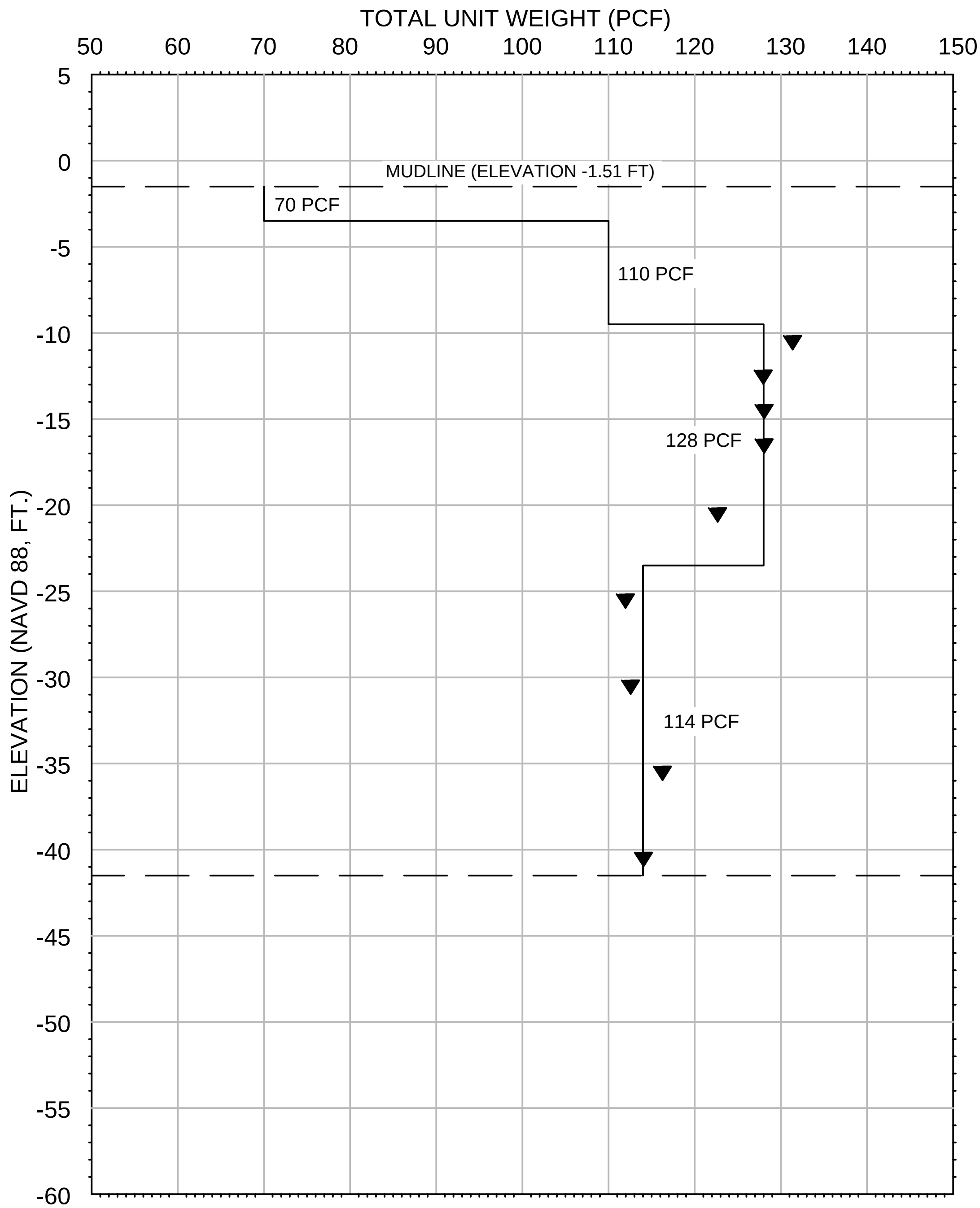
▼ B-4

MOISTURE CONTENT VS ELEVATION
B-4

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-4b



LEGEND

▼ B-4

TOTAL UNIT WEIGHT VS ELEVATION
B-4

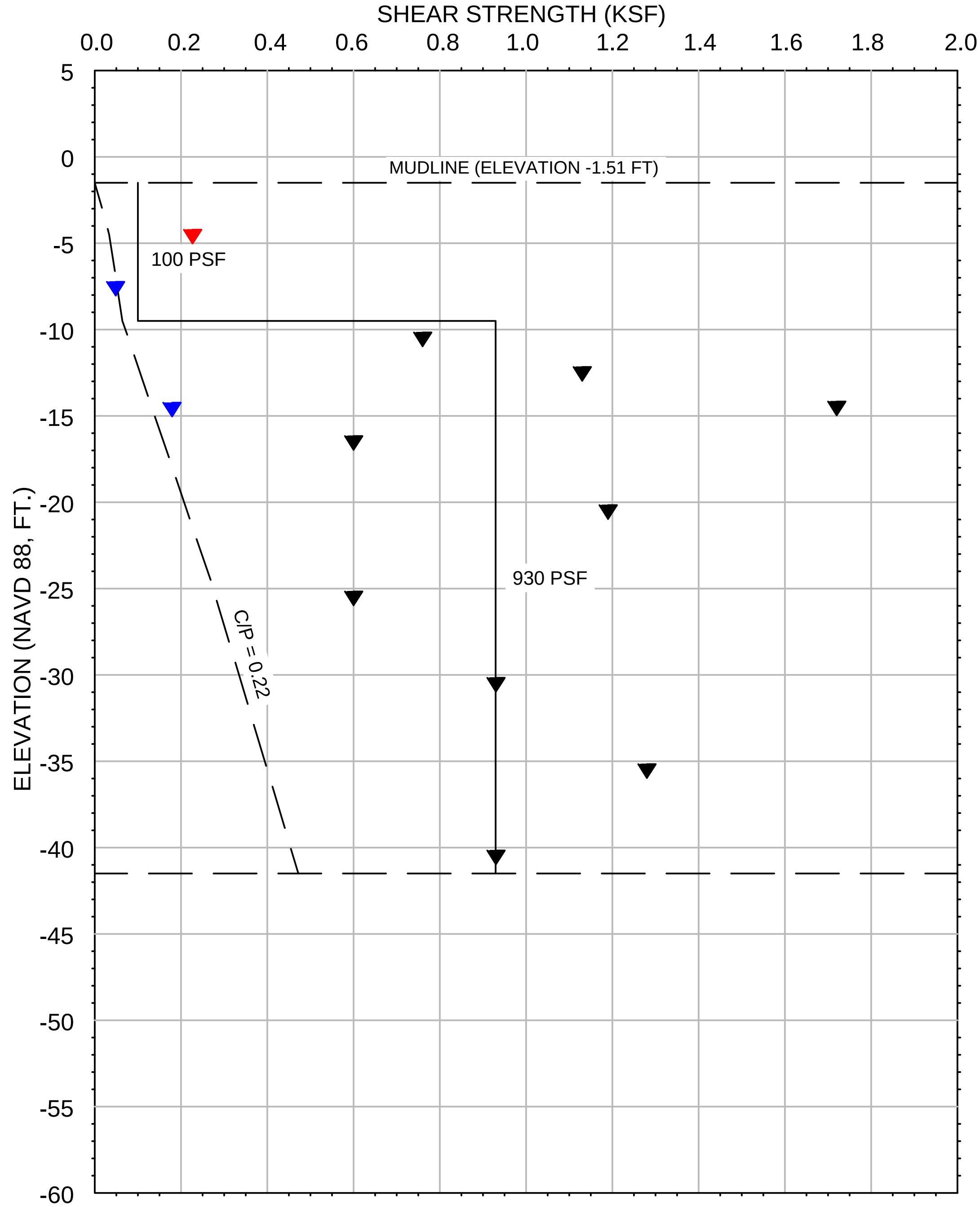
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-4□

JPV : KMC

P:\16\1671502300\CAD\GRAPH-MC.dwg\TAB:Chart A-4c modified on Mar 21, 2012 - 2:39pm



LEGEND

COMPRESSION TEST ▼ B-4

MINIVANE ▼ B-4

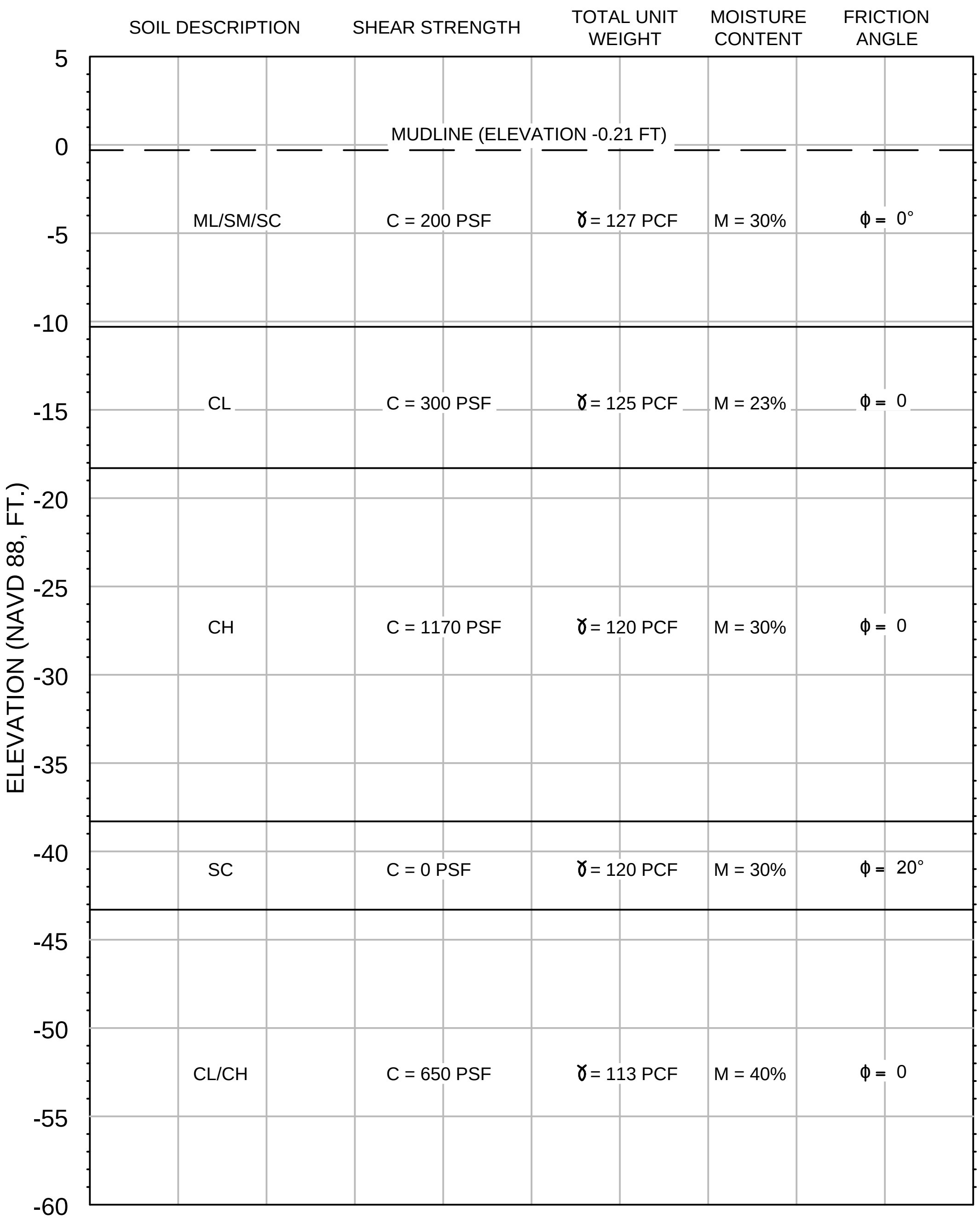
FIELD TEST ▼ B-4

SHEAR STRENGTH VS ELEVATION
B-4

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-4d



LE□END

▶ B-5

SOIL S□MMAR□
B-5

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-5□

JPV : KMC

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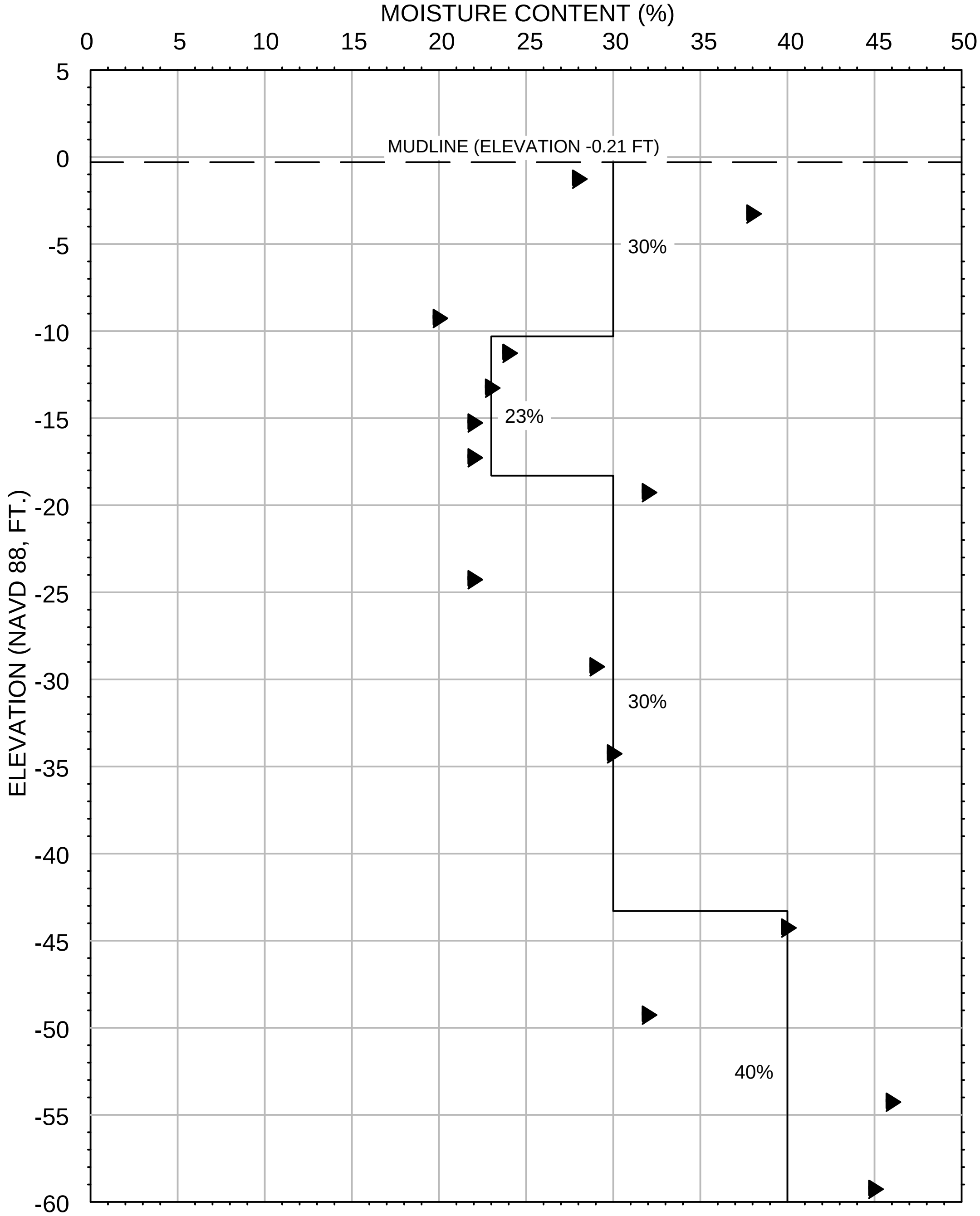

LE□END

▶ B-5

MOIST□RE □ONTENT VS ELEVATION
B-5

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-5□

JPV : KMC

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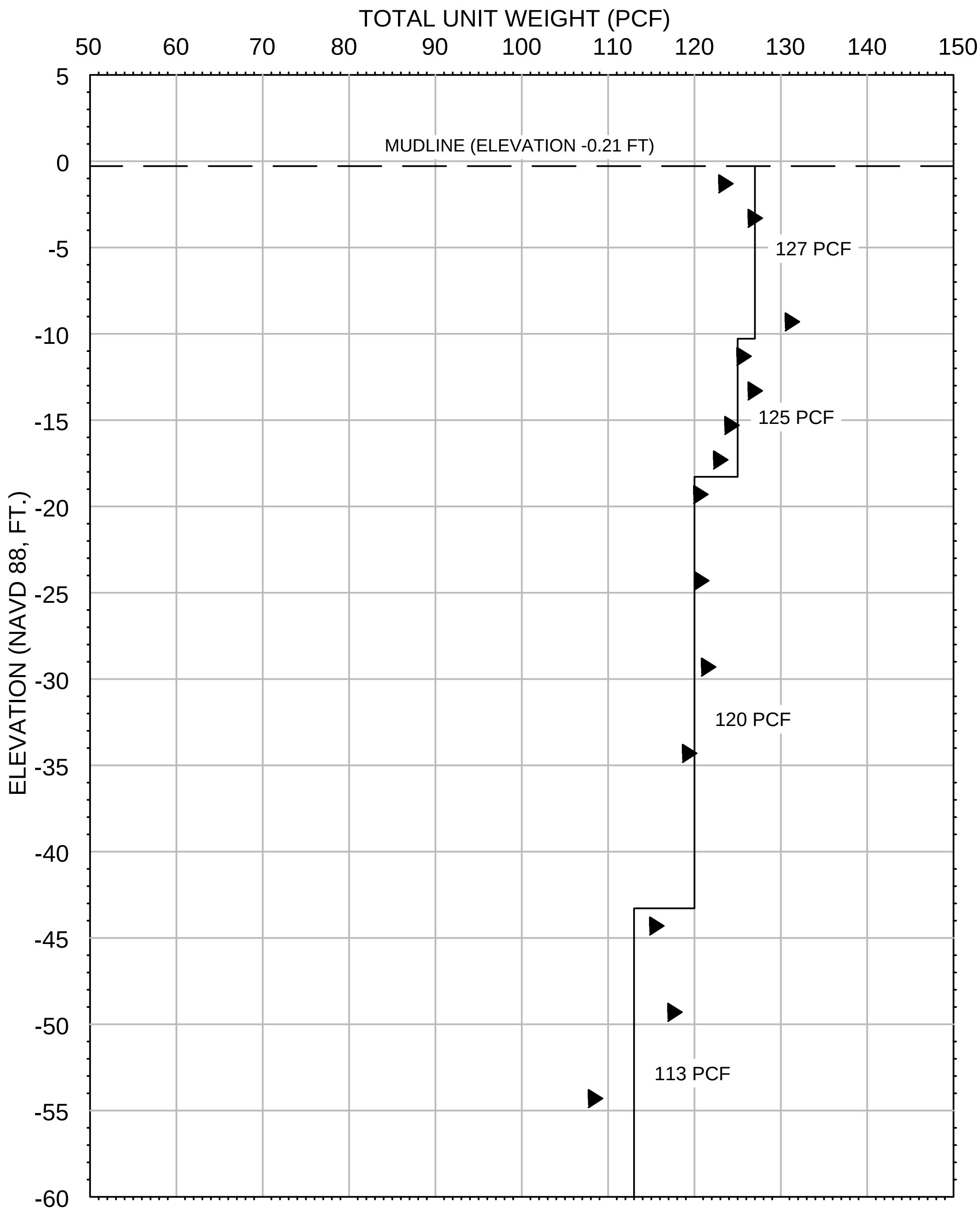

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▶ B-5

TOTAL □NIT □ EI□HT VS ELEVATION
B-5

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-5□

JPV : KMC

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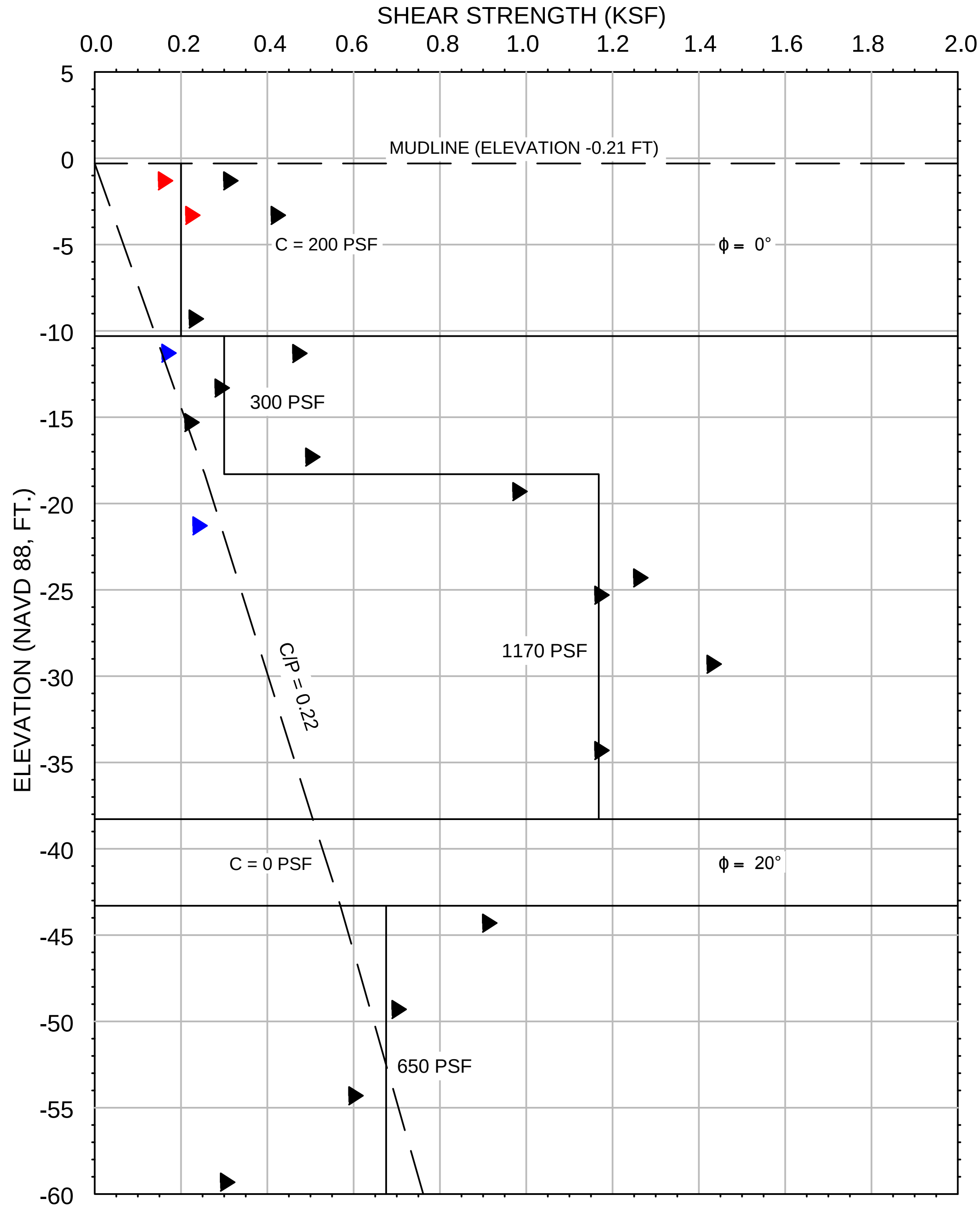


NOTE: Sand layer at top of profile has enough clay content to affect its behavior. For bearing and stability calculations use clay-like properties, but assume in compressible for settlement purposes.

LE□END

COMPRESSION TEST ▶ B-5

MINIVANE ▶ B-5

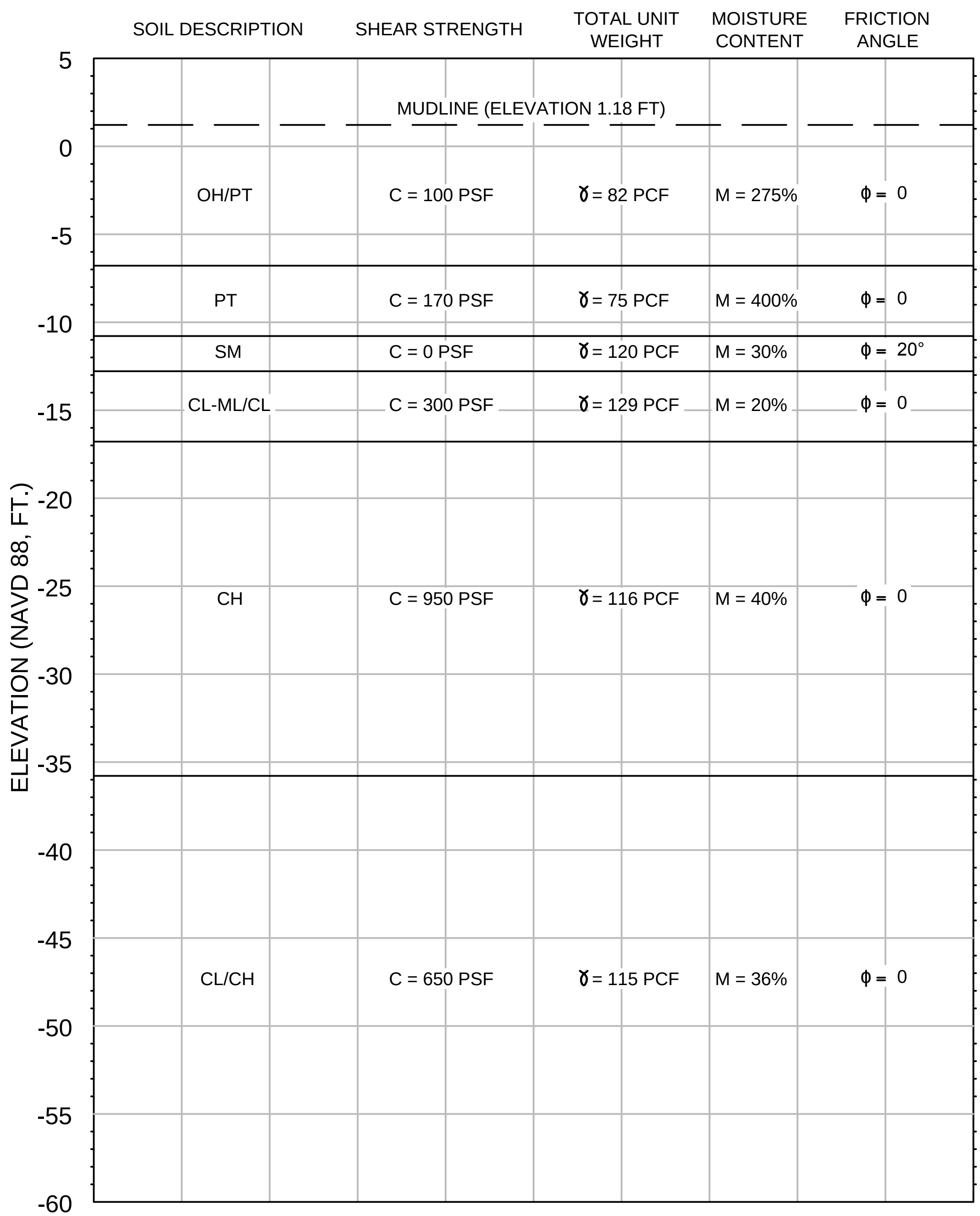
FIELD TEST ▶ B-5

SHEAR STREN□TH VS ELEVATION
B-5

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-5d



LEGEND

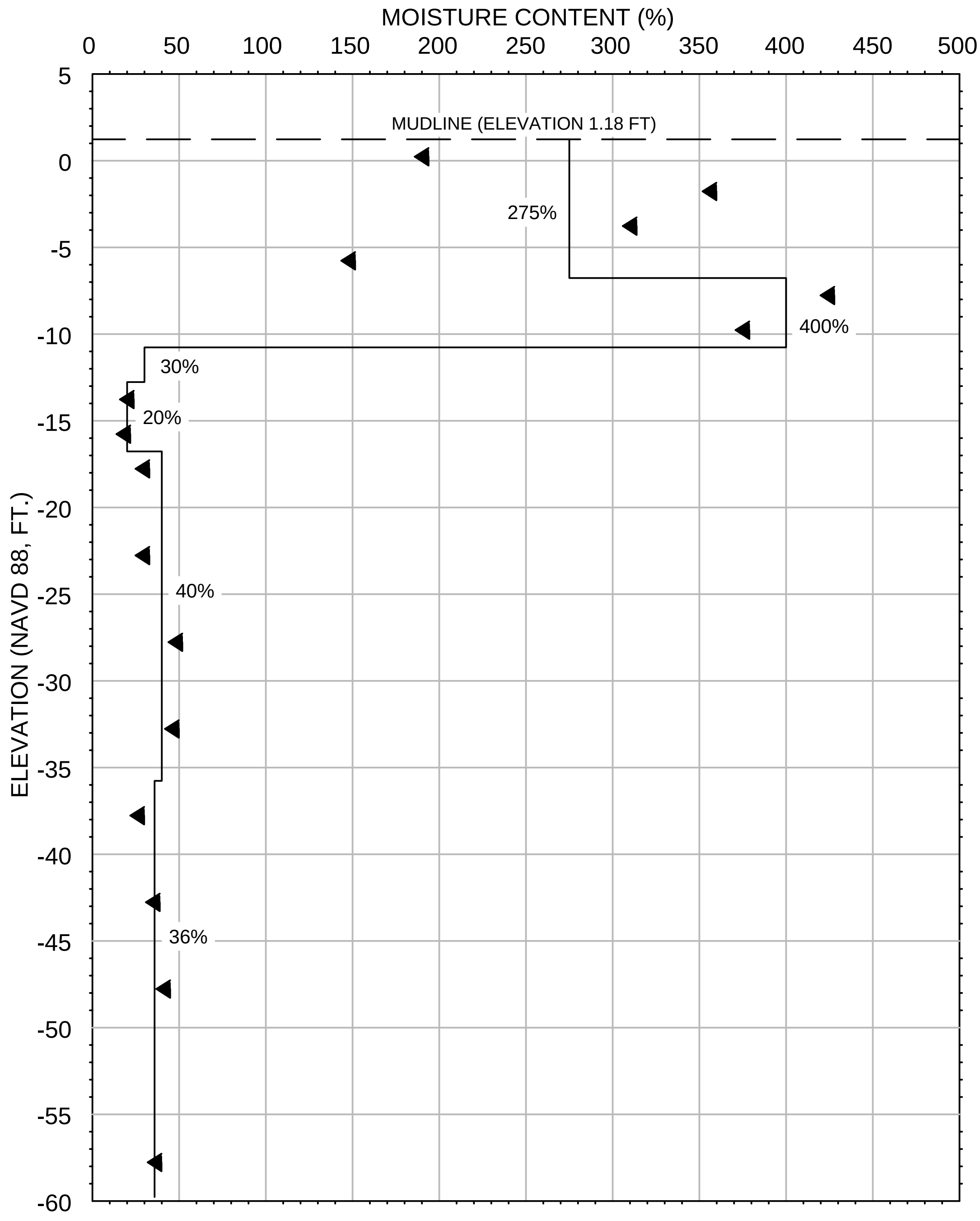
◀ B-6

SOIL SUMMARY
B-6

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-6



LE□END

◀ B-6

MOIST□RE □ONTENT VS ELEVATION
B-6

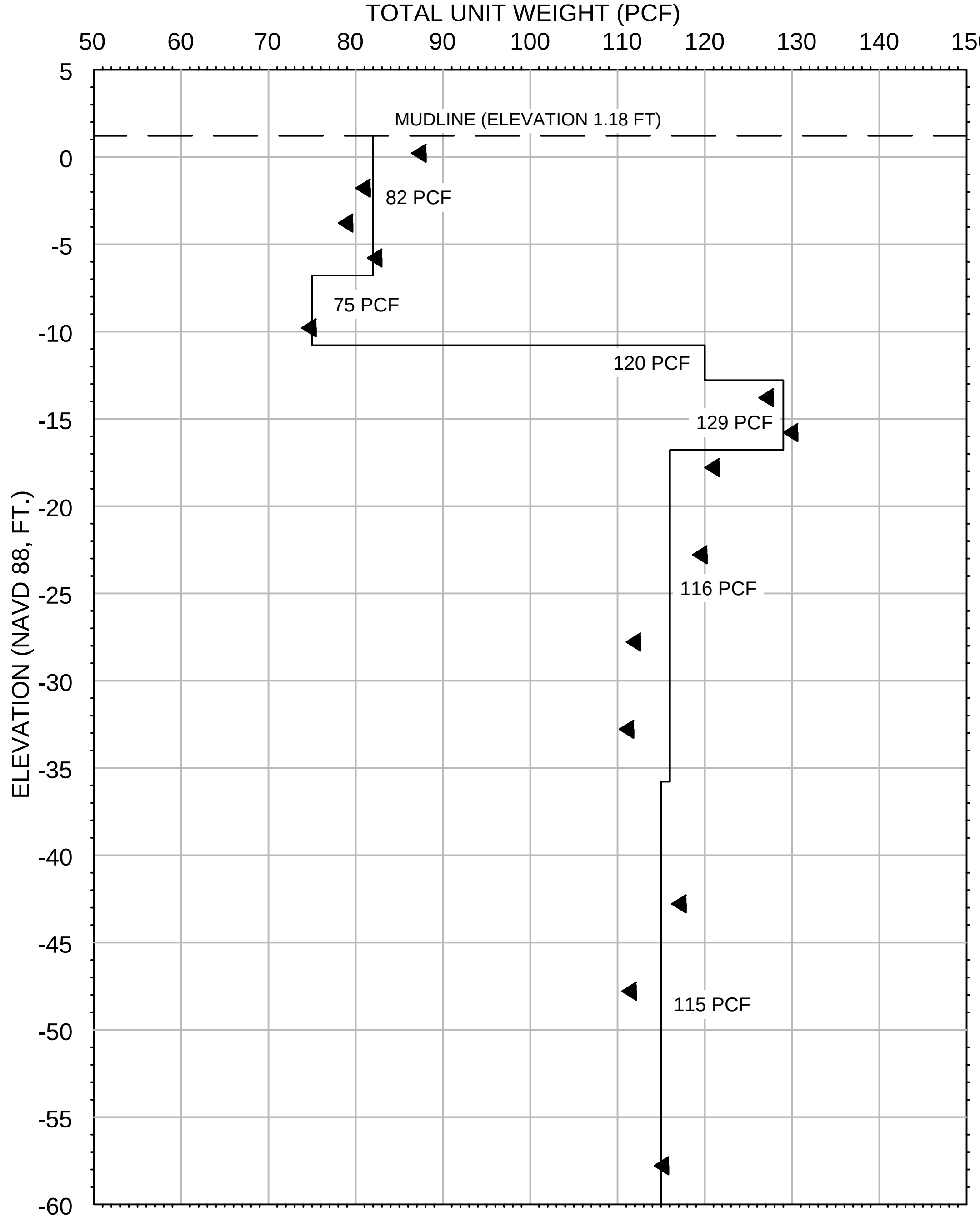
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-6□

JPV : KMC

P:\16\1671502\300\CAD\GRAPH-MC.dwg\TAB:Chart A-6b modified on Mar 21, 2012 - 2:40pm

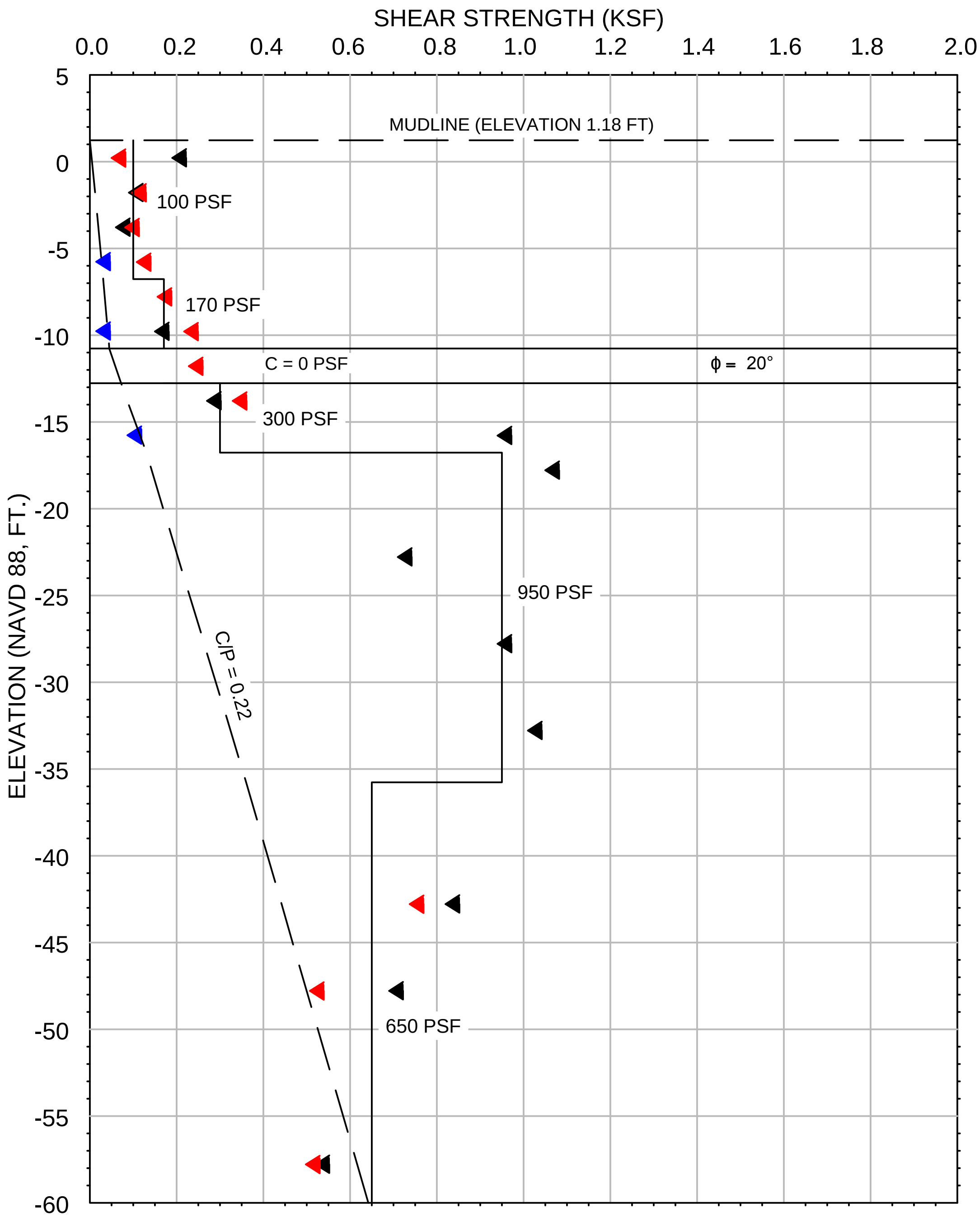


TOTAL □NIT □ EI□HT VS ELEVATION
B-6

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-6□



LE□END

COMPRESSION TEST B-6

MINIVANE B-6

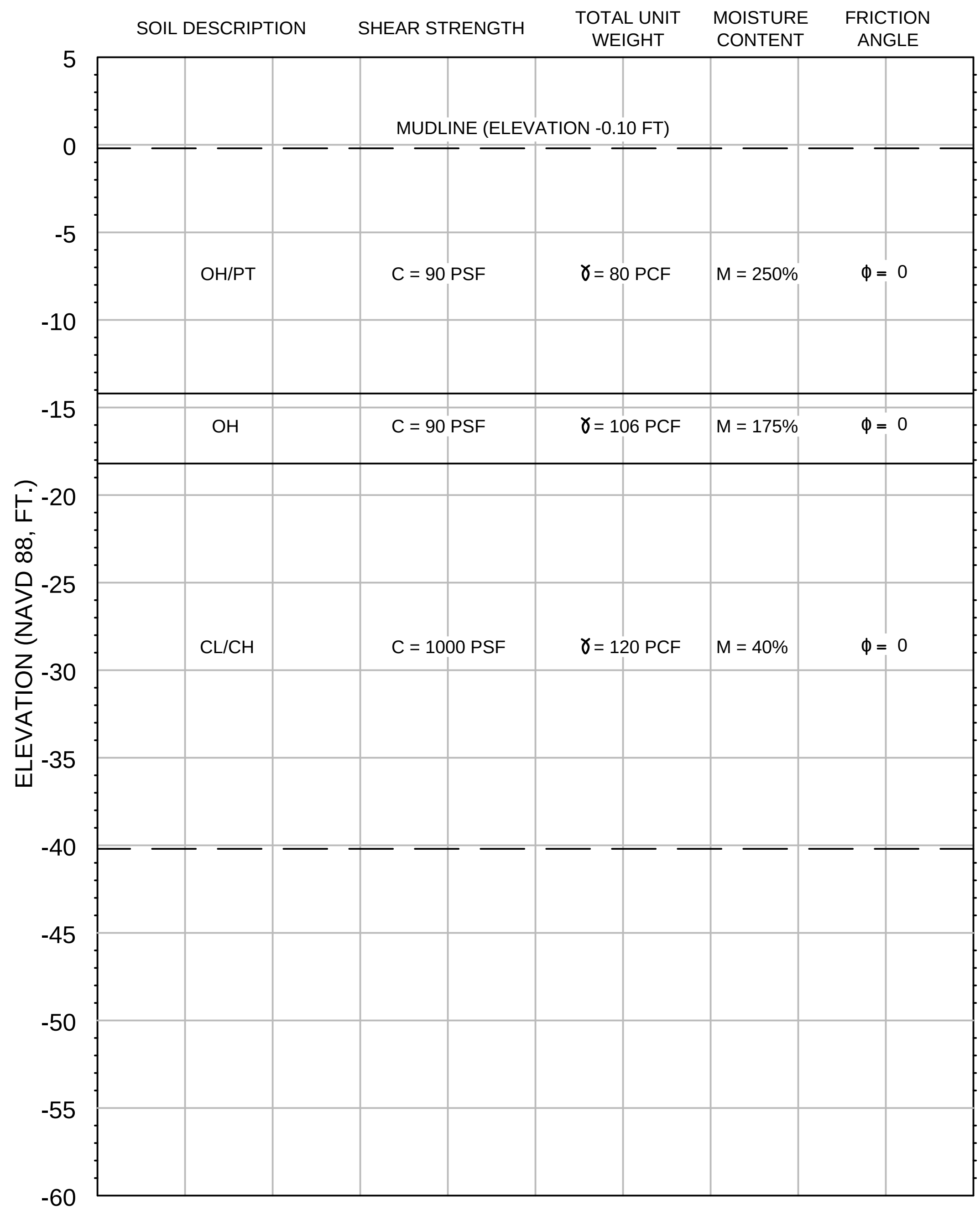
FIELD TEST B-6

SHEAR STREN□TH VS ELEVATION
B-6

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-6d



LEGEND

● B-7

SOIL SUMMARY
B-7

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-7

JPV : KMC

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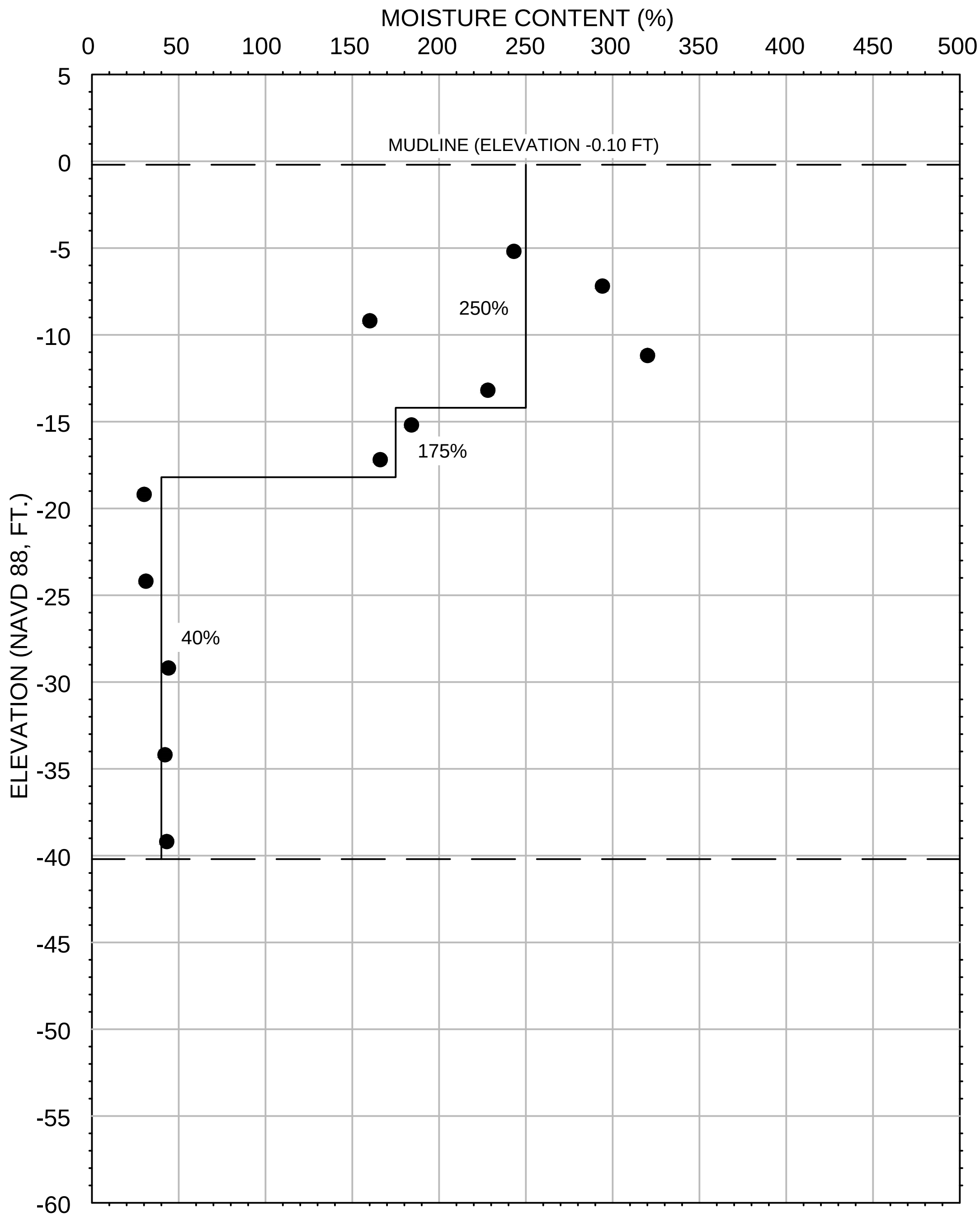

LE□END

● B-7

MOIST□RE □ONTENT VS ELEVATION
B-7

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-7□

JPV : KMC

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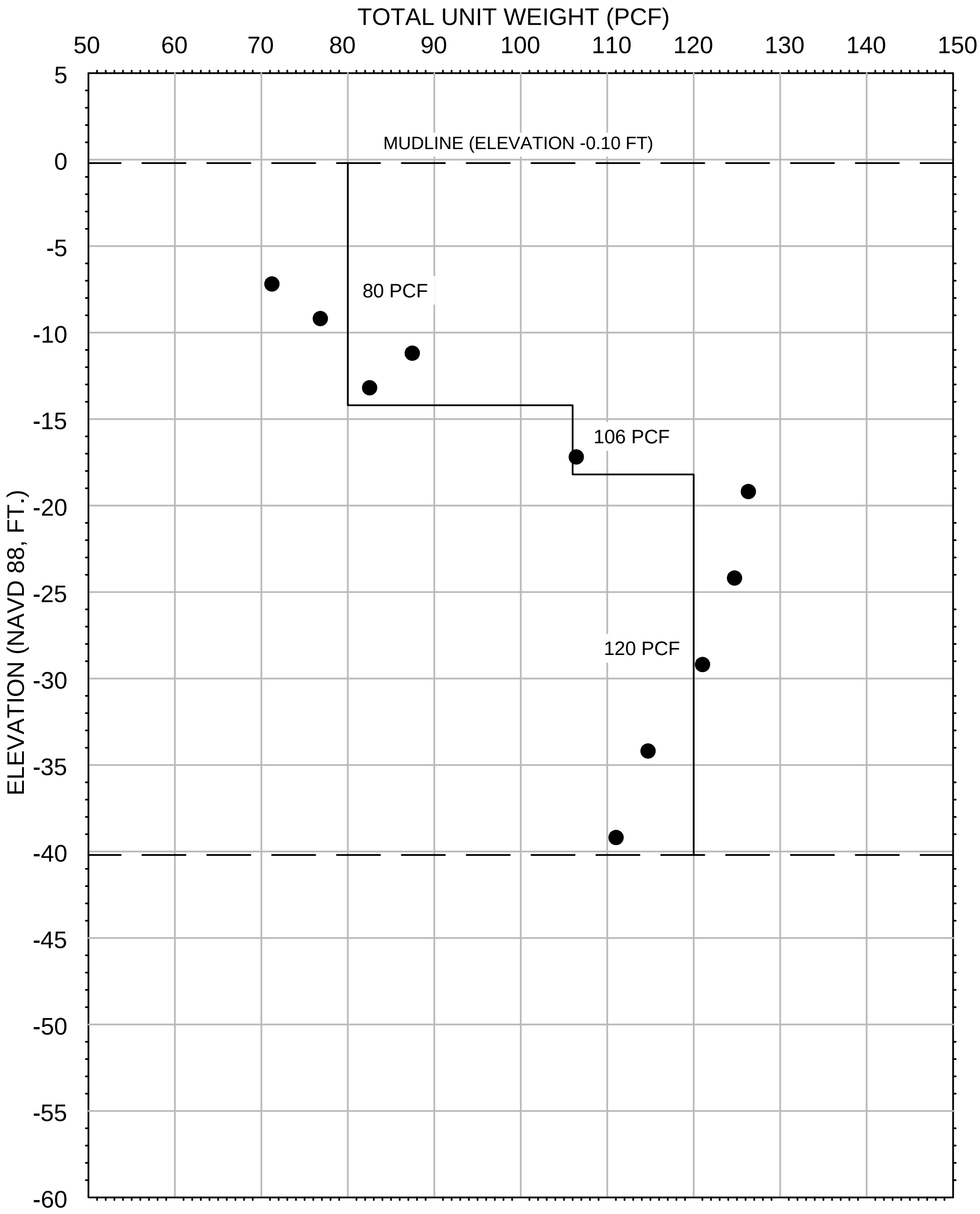

LE□END

● B-7

TOTAL □NIT □ EI□HT VS ELEVATION
B-7

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-7□

JPV : KMC

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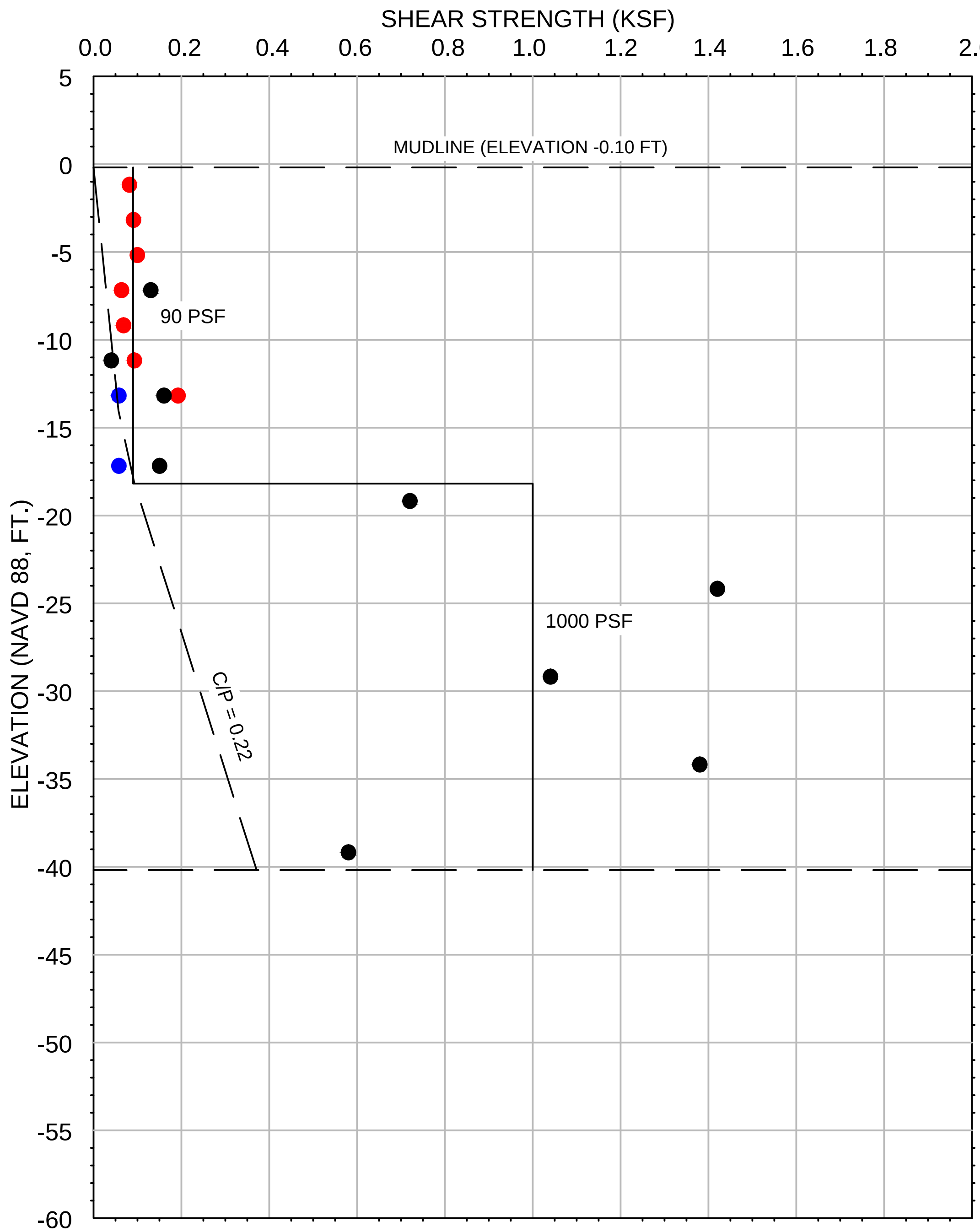


LE□END

COMPRESSION TEST ● B-7

MINIVANE ● B-7

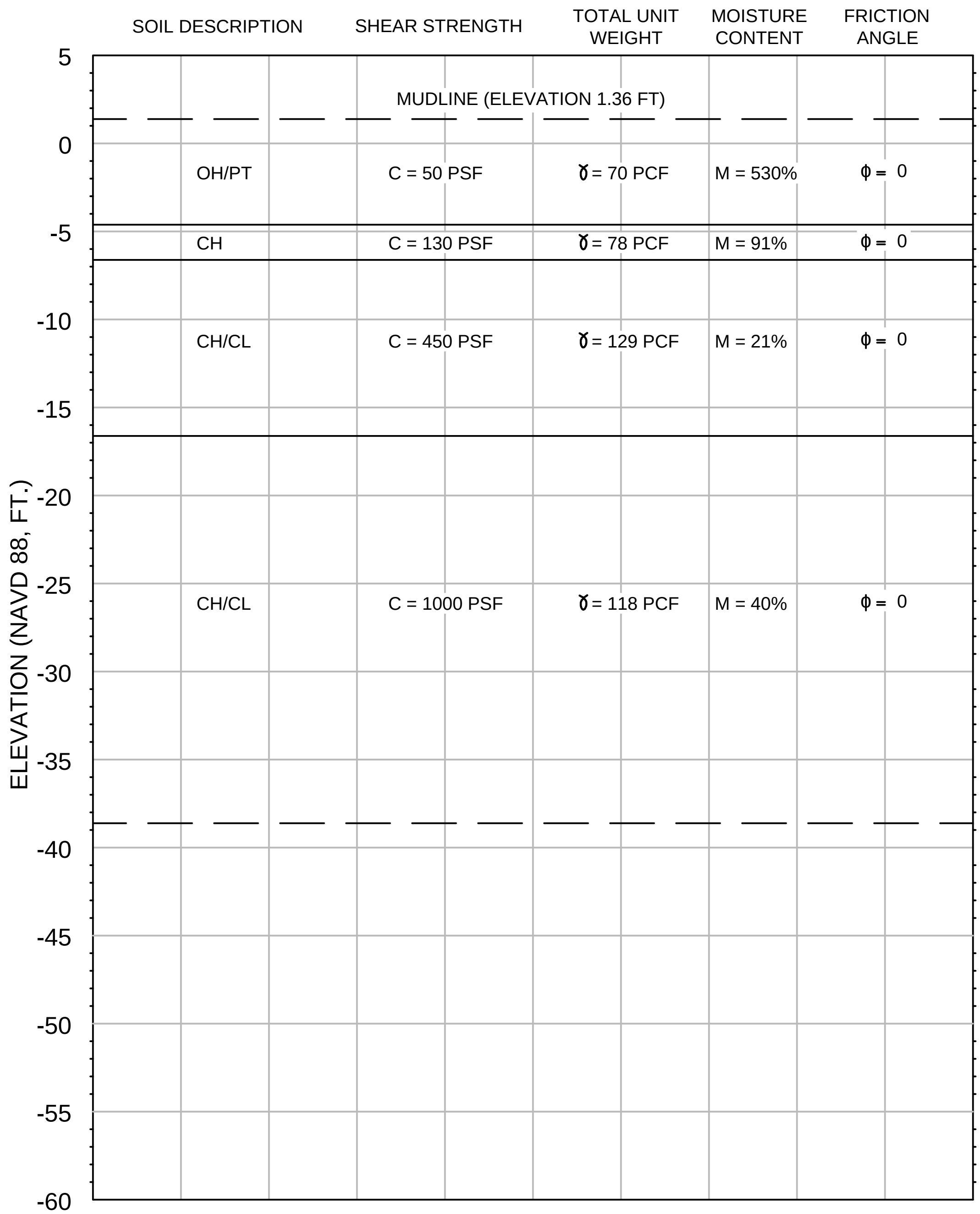
FIELD TEST ● B-7

SHEAR STREN□TH VS ELEVATION
B-7

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-7d



LE□END

⧗ B-8

SOIL S□MMAR□
B-8

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-8□

JPV : KMC

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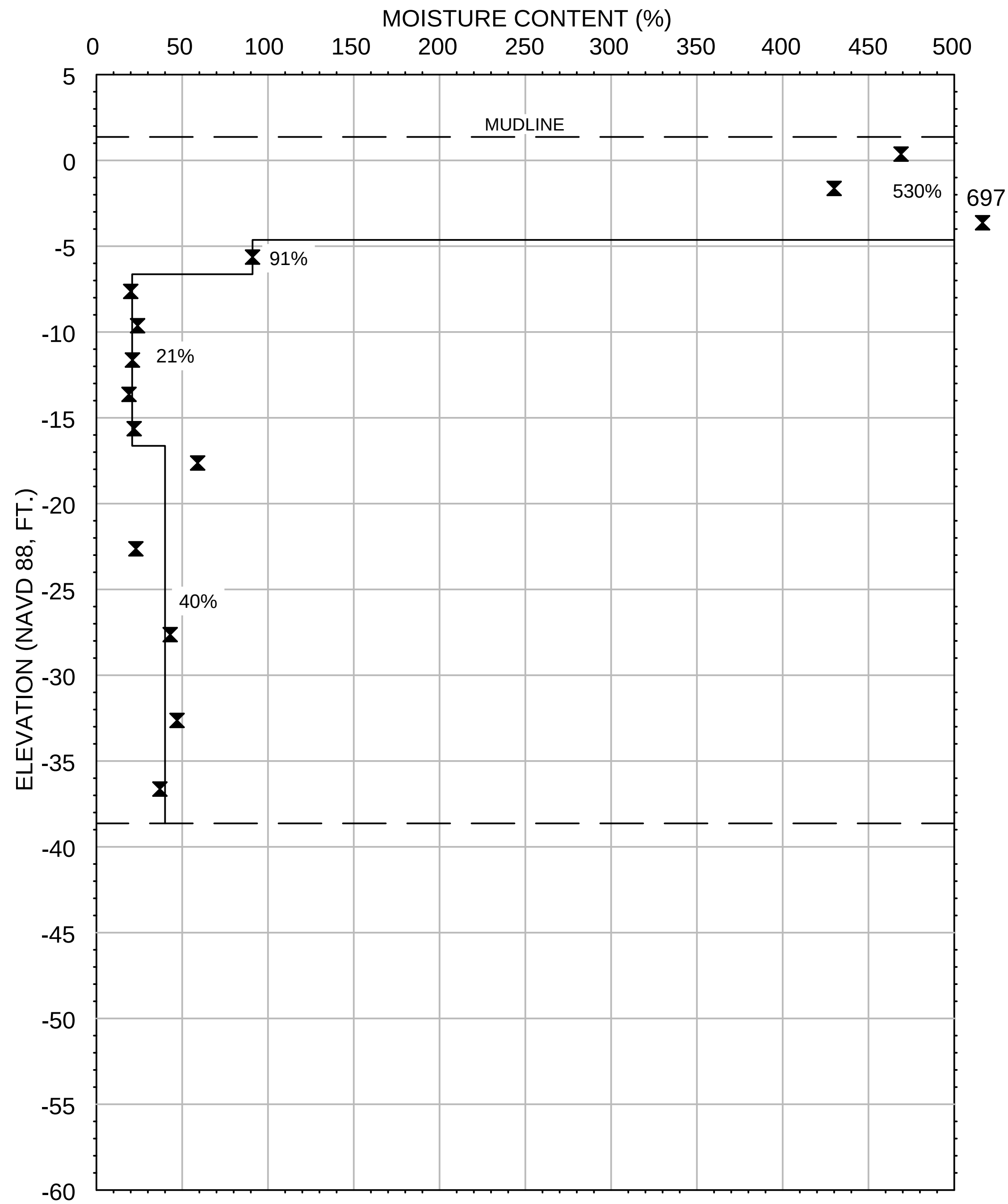


LE□END

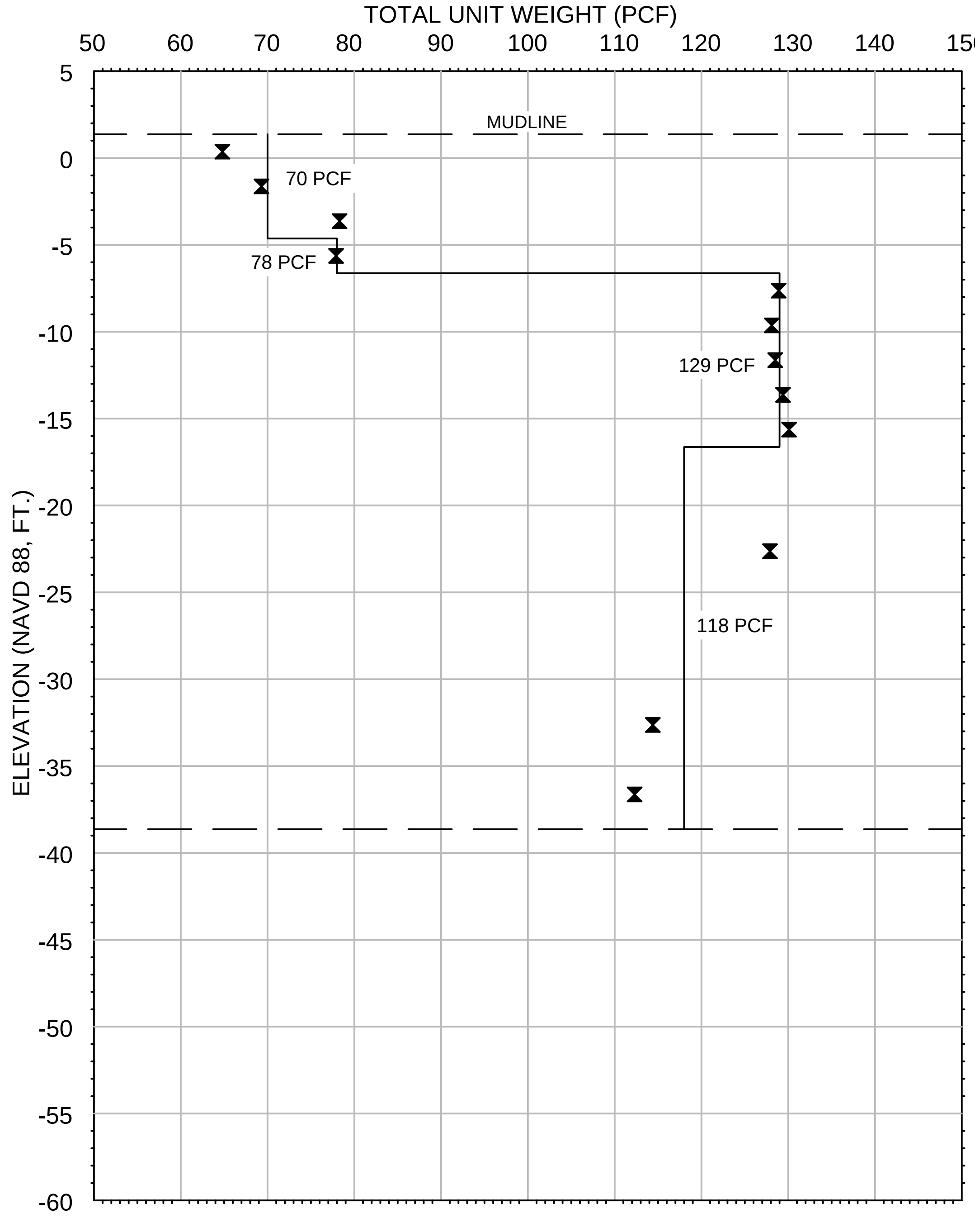
B-8

MOIST□RE □ONTENT VS ELEVATION
B-8

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-8□



JPV : KMC

P:\16\1671502\3\00\CAD\GRAPH-MC.dwg\TAB:Chart A-8c modified on Mar 21, 2012 - 2:40pm

LE□END

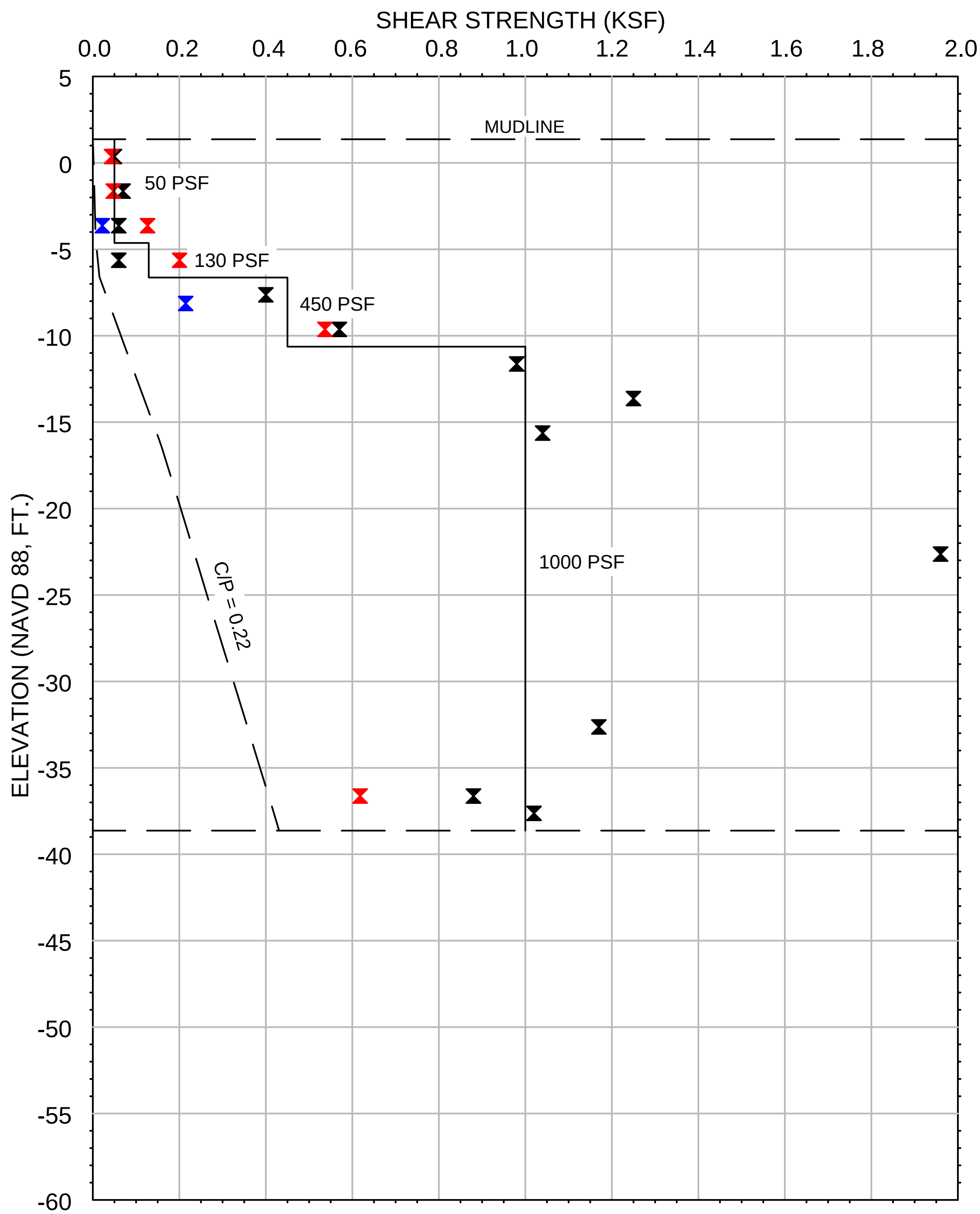
B-8

TOTAL □NIT □ EI□HT VS ELEVATION
B-8

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure
II-A-8□



LE□END

COMPRESSION TEST	MINIVANE	FIELD TEST
B-8	B-8	B-8

SHEAR STREN□TH VS ELEVATION
B-8

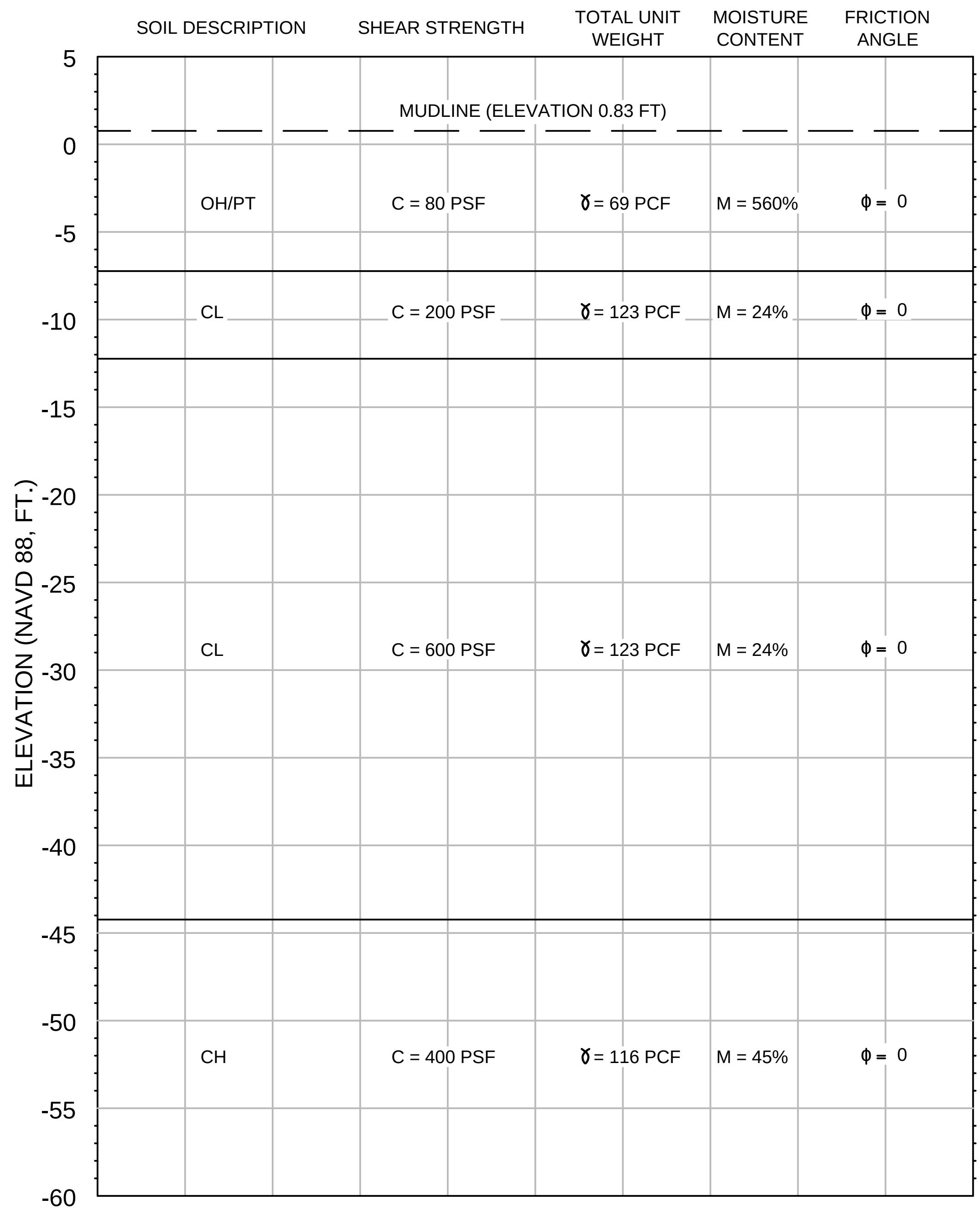
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-8d

JPV : KMC

P:\16\1671502\300\CAD\GRAPH-MC.dwg\TAB:Chart A-8d modified on Mar 21, 2012 - 2:40pm



LE□END

⧓ B-9

SOIL S□MMAR□
B-9

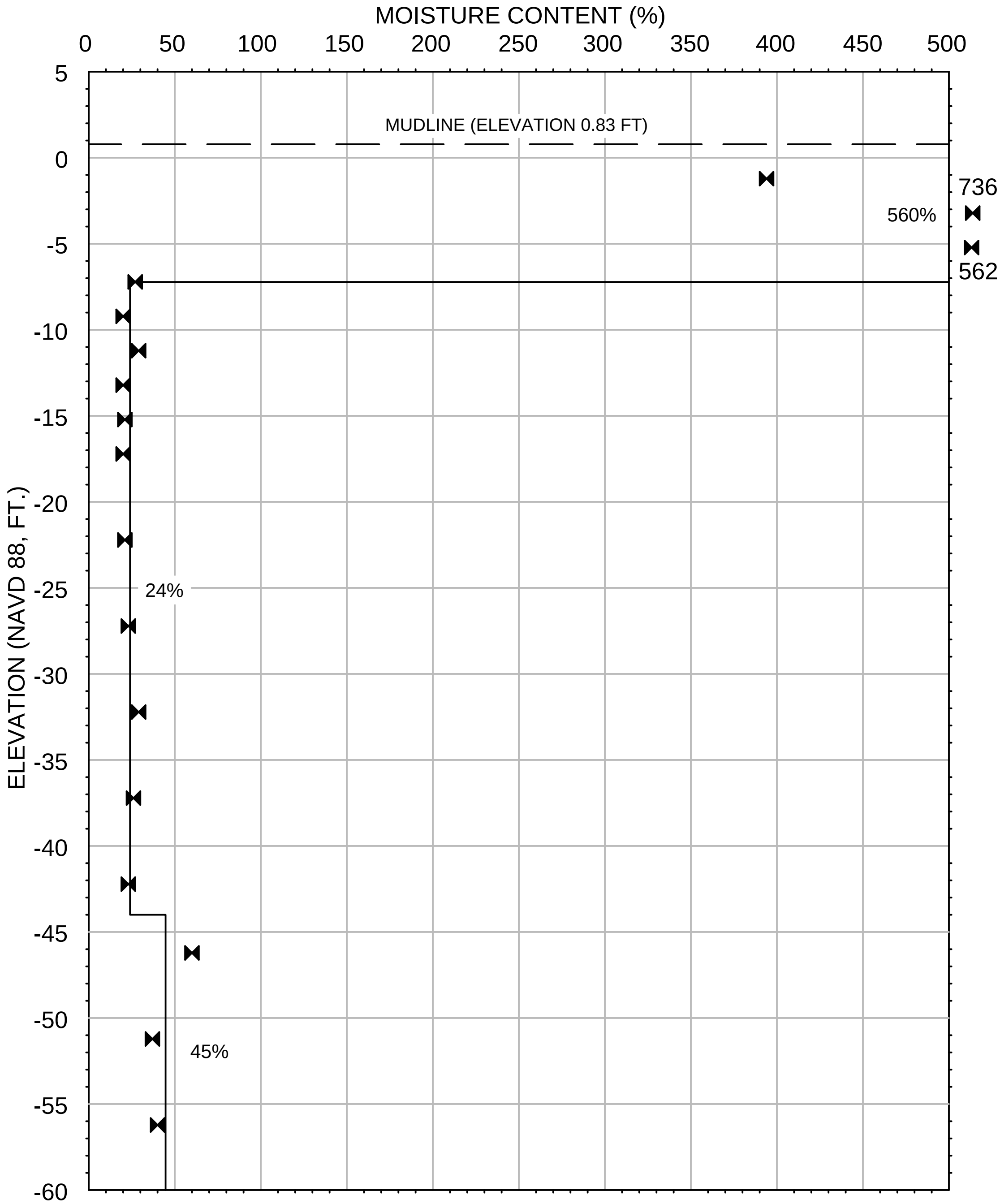
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-9□

JPV : KMC

P:\16\1671502300\CAD\GRAPH-MC.dwg\TAB:Chart A-9a modified on Mar 21, 2012 - 2:40pm



LE□END

B-9

MOIST□RE □ONTENT VS ELEVATION
B-9

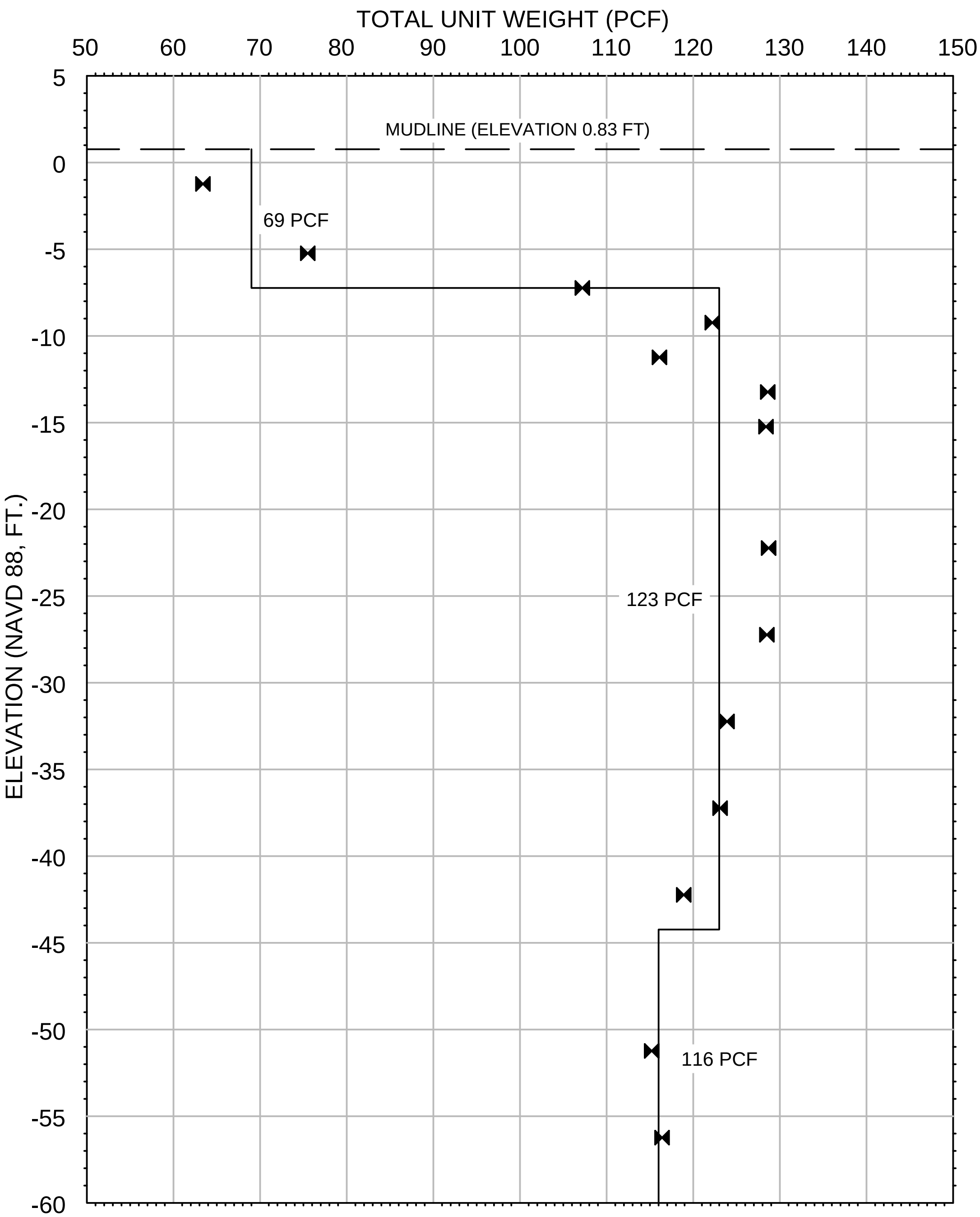
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-9□

JPV : KMC

P:\16\16715023\00\CAD\GRAPH-MC.dwg\TAB:Chart A-9b modified on Mar 21, 2012 - 2:40pm



LE□END

B-9

TOTAL □NIT □ EI□HT VS ELEVATION
B-9

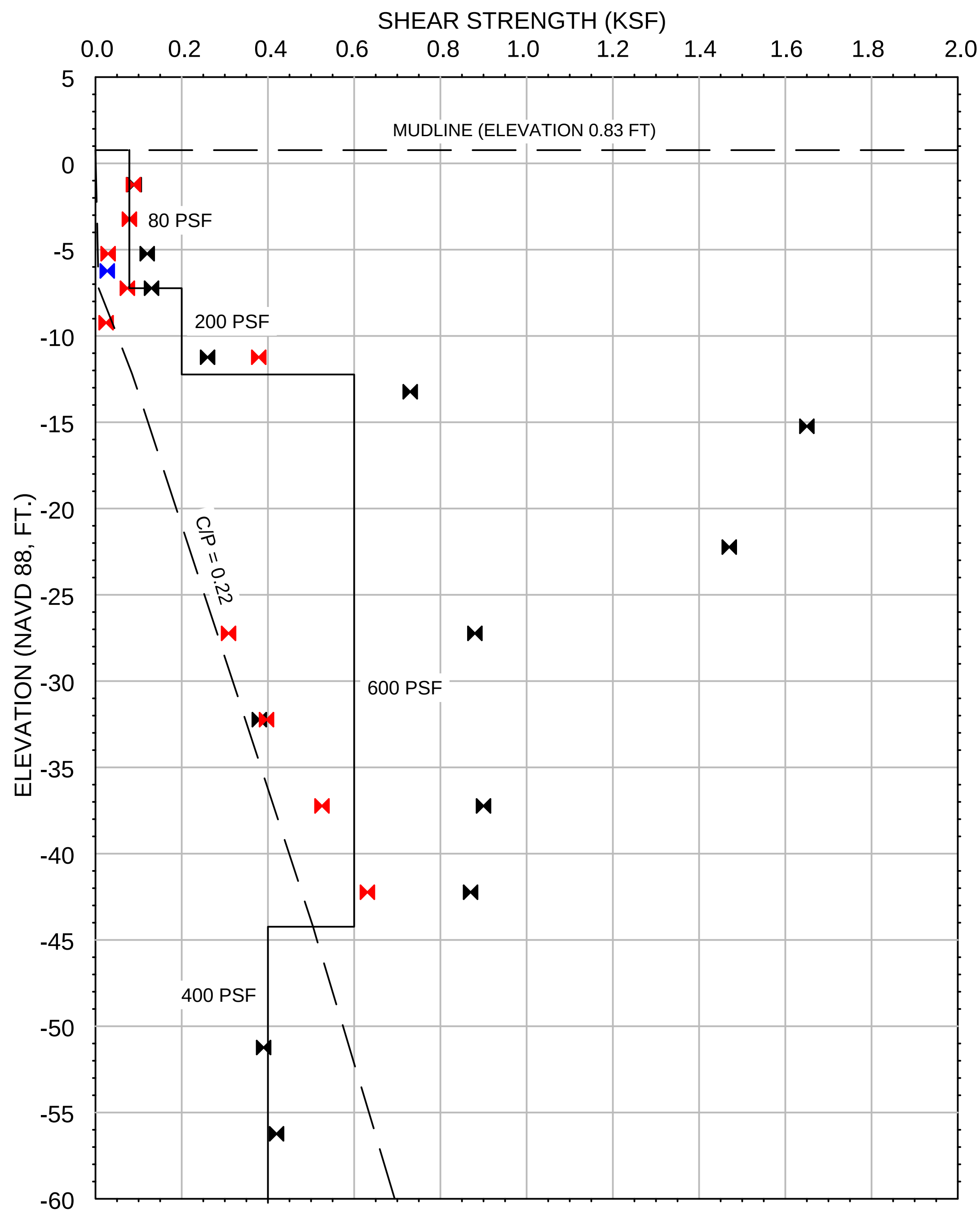
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-9□

JPV : KMC

P:\16\16715023\00\CAD\GRAPH-MC.dwg\TAB:Chart A-9c modified on Mar 21, 2012 - 2:40pm



LE□END

COMPRESSION TEST — B-9

MINIVANE — B-9

FIELD TEST — B-9

SHEAR STREN□TH VS ELEVATION
B-9

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-A-9d

APPENDIX II-B
Containment Dike Slope Stability

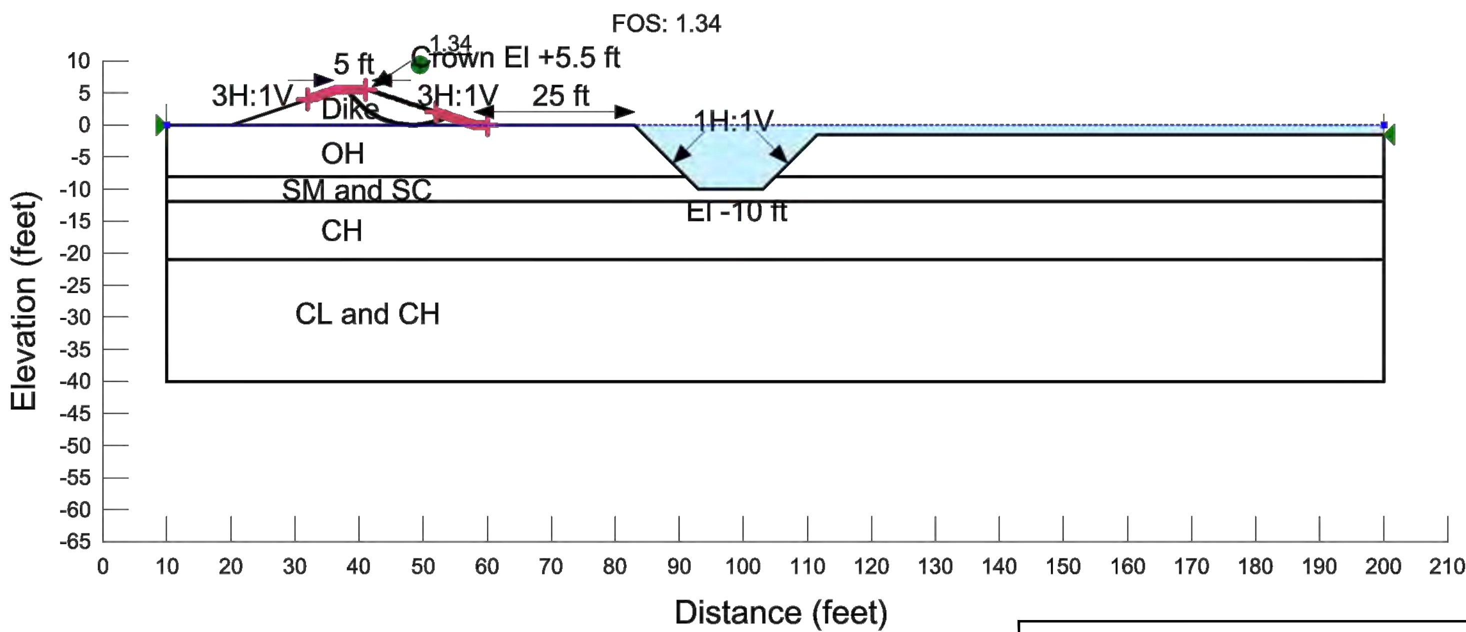
Slope Stability Calculation Approach for the Containment Dike
Bayou Bonfouca Marsh Creation (PO-104)

1. A total of 9 profiles were developed from the 9 soil borings after analyzing shear strength, unit weight, and moisture content profiles of each boring.
2. Three separate scenarios were assumed to evaluate containment dike sections. The first generally assumed a marsh fill elevation of +4.5 ft NAVD 88 before the dredge fill was placed. Stability into the containment dike borrow cut was analyzed. The second assumed hydraulically dredged fill was in place at the maximum elevation and stability away from the dredged fill was analyzed. The third scenario modifies the second scenario to take into account reductions to marsh fill elevations due to relatively low settlement in the marsh creation areas. All elevations are listed in reference to NAVD 88.
    a. For the unfilled marsh area scenario, earthen containment dike sections were developed and analyzed for overall stability. The details of the containment dike are given below:
        i. Containment dike constructed using soils excavated from the marsh creation area (fill unit weight assumed to be 80 pcf for all locations except B-5, which was assumed to be 100 pcf)
        ii. Crown elevation of +5.5 feet (includes 1 foot of freeboard). Exceptions include B-4, B-7, and B-8, where material limitations reduced the safe crown elevation to +5.0 feet for B-4, and +4.0 feet for B-7 and B-8 (though with geotextile reinforcement, B-8 crown elevation can increase to +4.5 feet)
        iii. Crown width of 5 feet. Exceptions include B-7 and B-8, where the crown width was reduced to minimize fill volume and increase stability
        iv. The side slopes of the containment dike are 3H:1V for dikes in the vicinity of borings B-1 through B-6, 2H:1V for dikes in the vicinity of B-7 (mainly for pond construction purposes), 4H:1V for geotextile reinforced dikes near B-8, 7H:1V for unreinforced dikes near B-8, and 5H:1V for dikes near B-9
        v. Assumed average foundation elevations are -1 feet in open water areas, except for at B-4, where the foundation elevation is -1.5 feet, and 0 feet on grassy/land areas
        vi. Water elevation assumed at 0 ft
        vii. Bottom of borrow excavation for containment dike is El. -10 feet
    b. For the filled marsh area scenario, earthen containment dike sections were developed and analyzed for overall stability. The details of the containment dike are given below.
        i. Containment dike constructed using soils excavated from the marsh creation area (fill unit weight assumed to be 80 pcf for all locations except B-5, which was assumed to be 100 pcf)
        ii. Crown elevation of +5.5 feet at most locations (includes 1 foot of freeboard); exceptions are B-4, B-7, and B-8, which had stable crown elevations of 5.0 ft (B-4), 4.5 feet (geotextile reinforced dikes near B-8), and 4.0 feet (B-7 and unreinforced dikes at B-8)
        iii. Crown width of 5 feet at locations near B-1 through B-6 and B-9. Stable crown width at B-7 is 2 ft; at B-8, stable crown width is 1 ft, or 2 ft if geotextile reinforcement is included
        iv. The side slopes of the containment dike are 3H:1V (Horizontal : Vertical) for locations near B-1 through B-6. At B-7, side slopes are 2H:1V; at B-8 side slopes are 7H:1V for unreinforced dikes and 4H:1V for geotextile reinforced dikes; and at B-9, side slopes are 5H:1V
        v. Foundation, water, and borrow excavation elevations are the same as scenario one
    c. For the reduced marsh fill scenario, earthen containment dike sections were modified and analyzed for overall stability. The details of the containment dike are given below.
        i. Containment dike constructed using soils excavated from the marsh creation area (fill unit weight assumed to be 80 pcf for all locations except B-5, which was assumed to be 100 pcf)
        ii. Crown elevation of +4.0 feet at most locations (includes 1 foot of freeboard); exceptions are B-3 and B-4, which had stable crown elevations of 5.0 feet

iii. Crown width of 5 feet at locations near B-1 through B-6 and B-9. Stable crown width at B-7 is 2 feet, B-8 stable crown width for unreinforced dikes is 1 foot, and B-8 reinforced dike stable crown width is 2 feet
iv. The side slopes of the containment dike are 3H:1V (Horizontal : Vertical) for locations near B-1 through B-6. At B-7, stable side slopes are 2H:1V; at B-8, unreinforced stable side slopes are 7H:1V and reinforced stable side slopes are 4H:1V; and at B-9, side slopes are 5H:1V
v. Foundation, water, and borrow excavation elevations are the same as scenario one.

3. Results (refer to Appendix II-B for specific results)
   a. Scenario two (maximum marsh fill behind the containment dike) often had lower factors of safety than scenario one (no marsh fill).
   b. Crown and marsh fill elevation reductions improved the factors of safety against slope failure.

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 82 pcf Cohesion: 200 psf Phi: 0 °
Name: Silty and Clayey Sand Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 20
Name: Clay Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 1000 psf Phi: 0 °
Name: Silty Clay and Clay Model: Mohr-Coulomb Unit Weight: 114 pcf Cohesion: 1000 psf Phi: 0



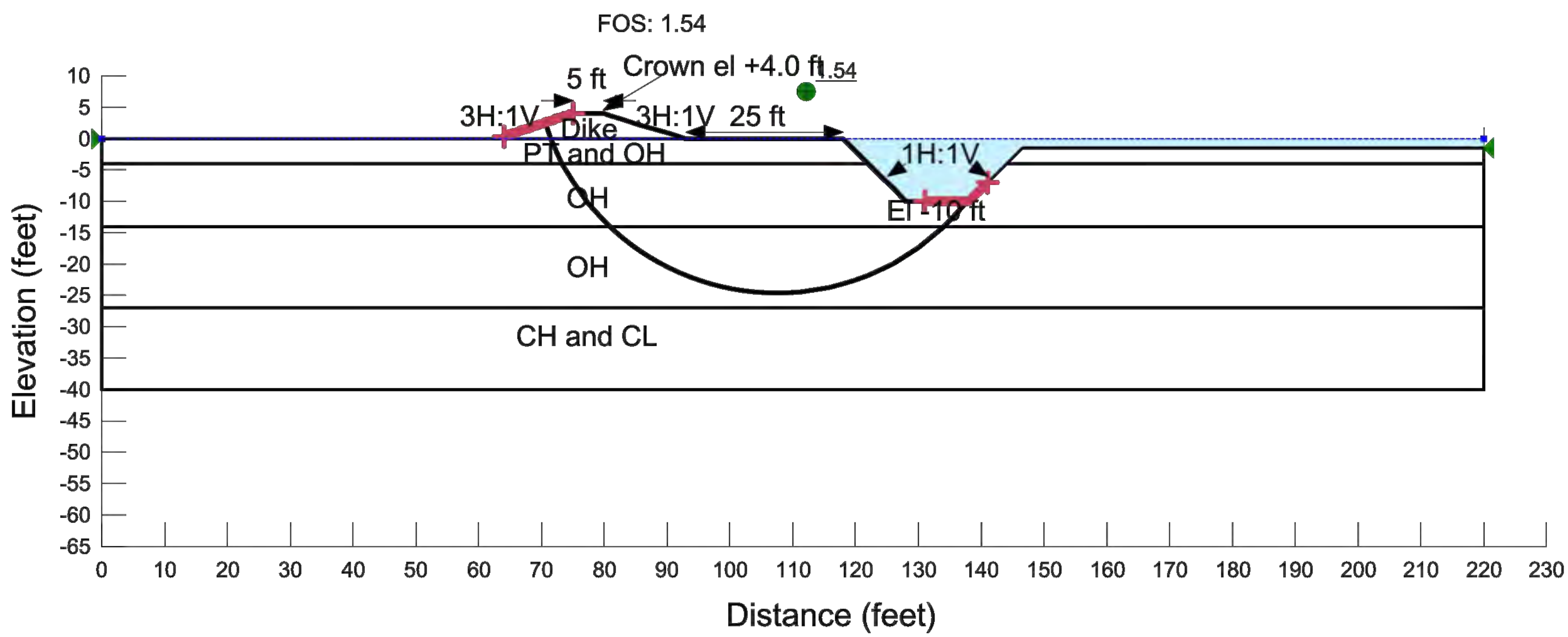
SLO□E STABILIT□ -
BORIN□ 1 □ITHO□T FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GeoEngineers

Figure II-B-1

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat and Organic Clay Model: Mohr-Coulomb Unit Weight: 67 pcf Cohesion: 110 psf Phi: 0 °
Name: Organic Clay - 1 Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 85 psf Phi: 0 °
Name: Organic Clay - 2 Model: Mohr-Coulomb Unit Weight: 104 pcf Cohesion: 85 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 106 pcf Cohesion: 150 psf Phi: 0 °



SLOPE STABILITY -
BORING 2 WITHOUT FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-2

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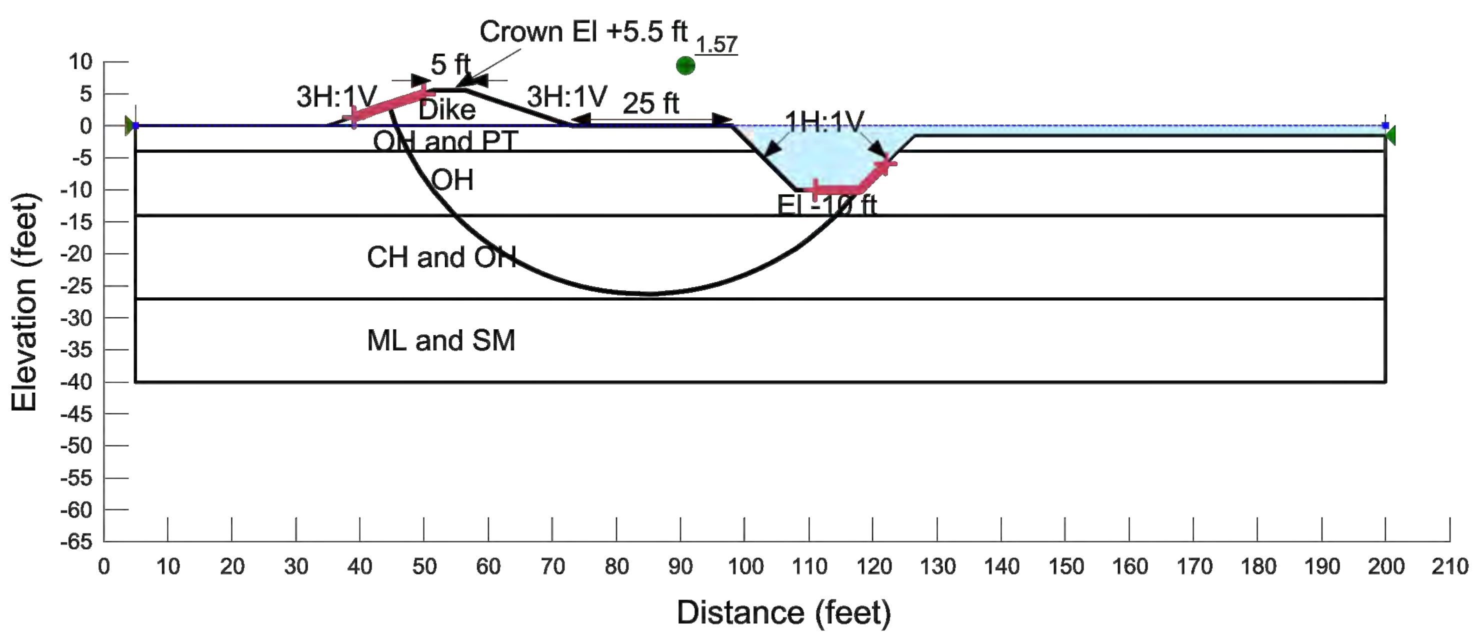
JMP : KMC

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 73 pcf Cohesion: 120 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 84 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Organic Clay Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 130 psf Phi: 0 °
Name: Silt and Sand Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 100 psf Phi: 10 °

FOS: 1.57



SLO□E STABILIT□ -
BORIN□ 3 □ITHO□T FILL

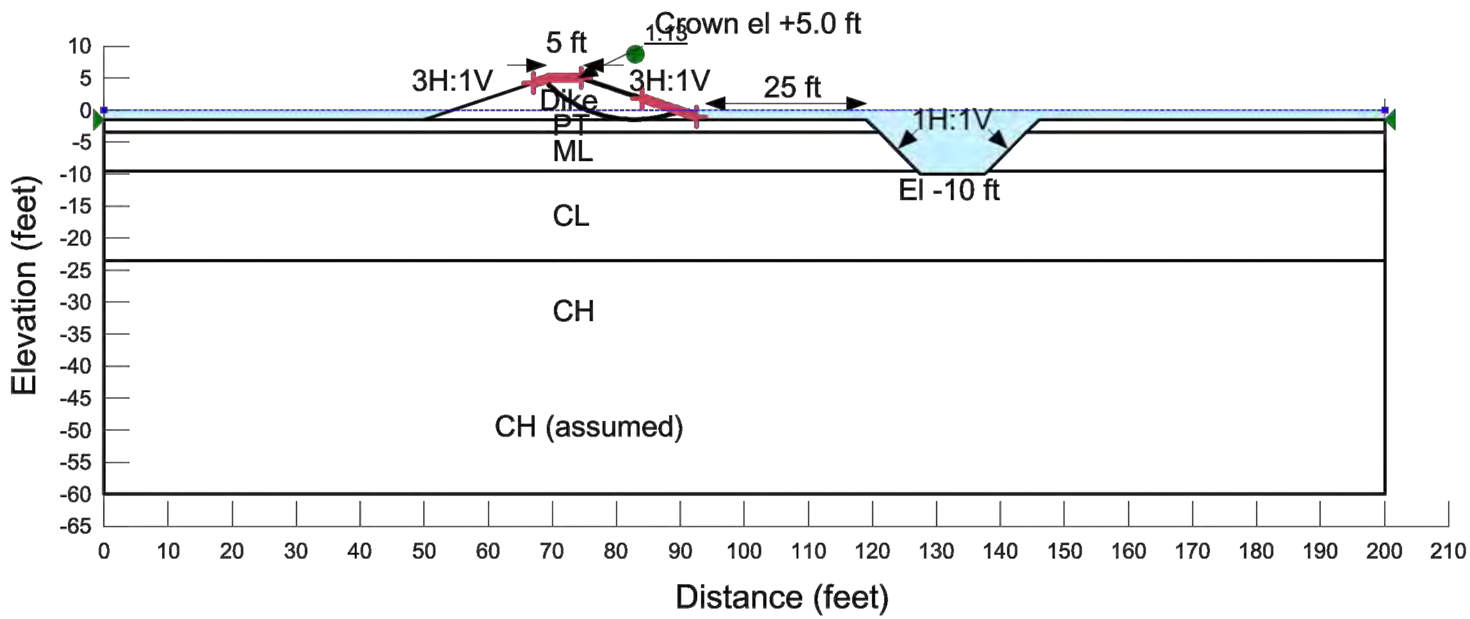
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-3

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 100 psf Phi: 0 °
Name: Silt Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 100 psf Phi: 10 °
Name: Silty Clay Model: Mohr-Coulomb Unit Weight: 128 pcf Cohesion: 930 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 114 pcf Cohesion: 930 psf Phi: 0 °

FOS: 1.13



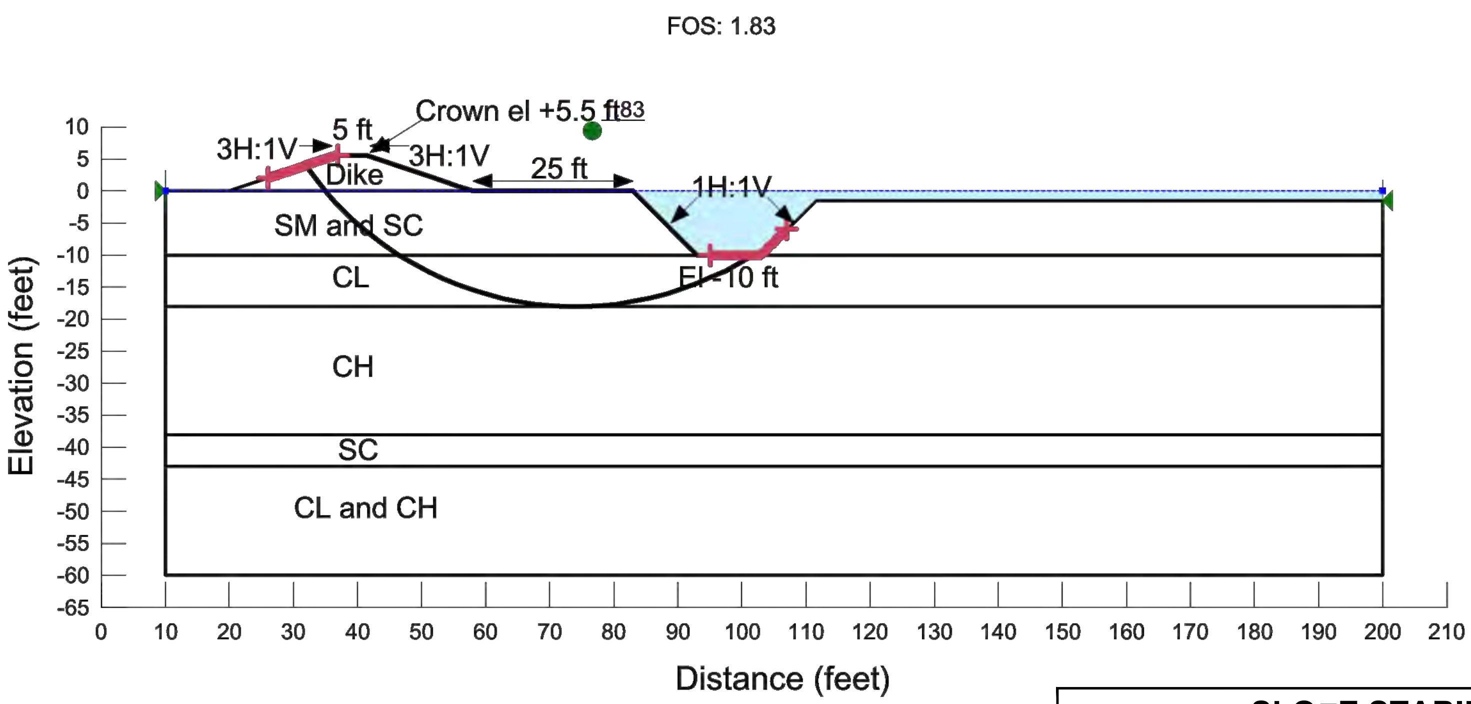
SLO□E STABILIT□ -
BORIN□ 4 □ITHO□T FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-4

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 100 psf Phi: 0 °
Name: Silty and Clayey Sand Model: Mohr-Coulomb Unit Weight: 127 pcf Cohesion: 200 psf Phi: 0 °
Name: Sandy Clay Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 300 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1170 psf Phi: 0 °
Name: Clayey Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 20 °
Name: Silty Clay and Clay Model: Mohr-Coulomb Unit Weight: 113 pcf Cohesion: 650 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 5 □ITHO□T FILL

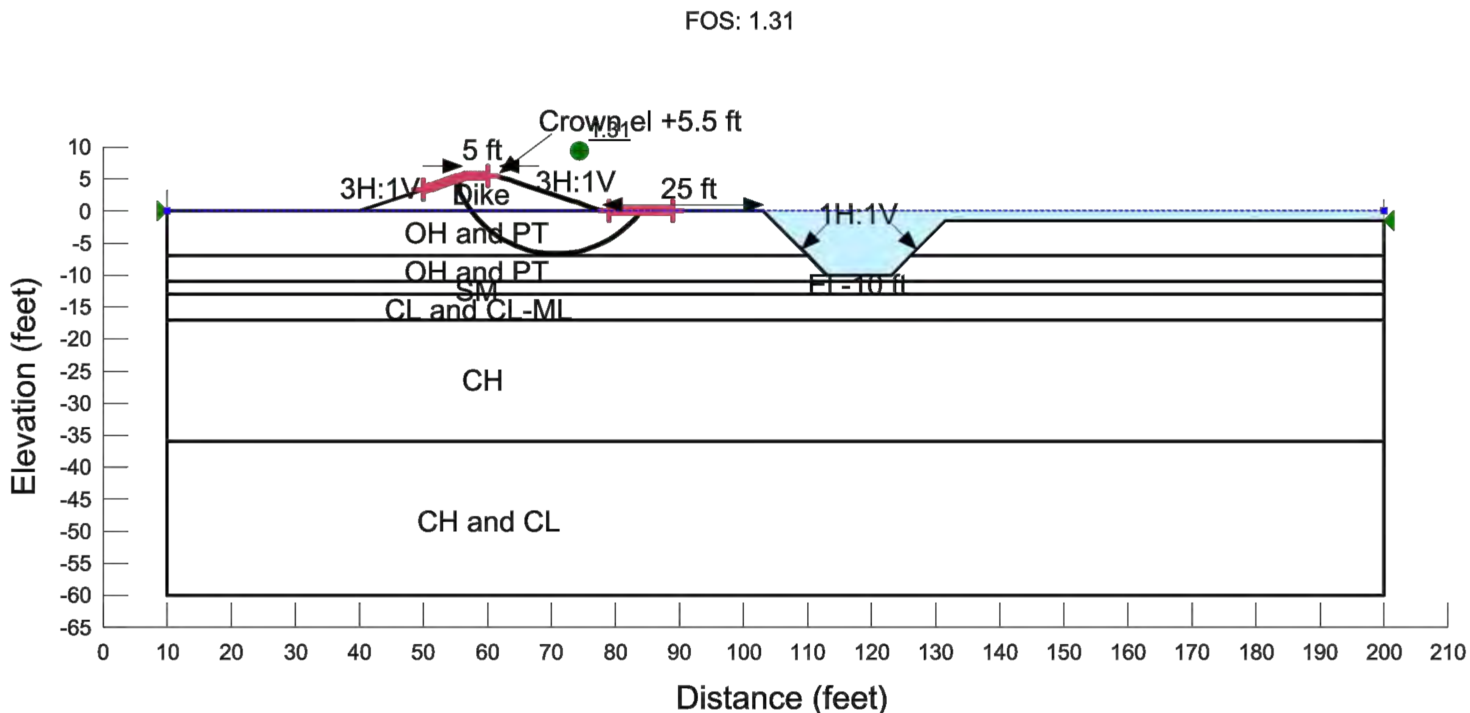
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-5

P:\16\16715023\00\CAD\Slope Stability.dwg\TAB:B-6 modified on Mar 21, 2012 - 4:22pm JMP : KMC

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat- 1 Model: Mohr-Coulomb Unit Weight: 82 pcf Cohesion: 100 psf Phi: 0 °
Name: Organic Clay and Peat - 2 Model: Mohr-Coulomb Unit Weight: 75 pcf Cohesion: 170 psf Phi: 0 °
Name: Silty Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 20 °
Name: Silty Clay and Clayey Silt Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 300 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 116 pcf Cohesion: 950 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 650 psf Phi: 0 °



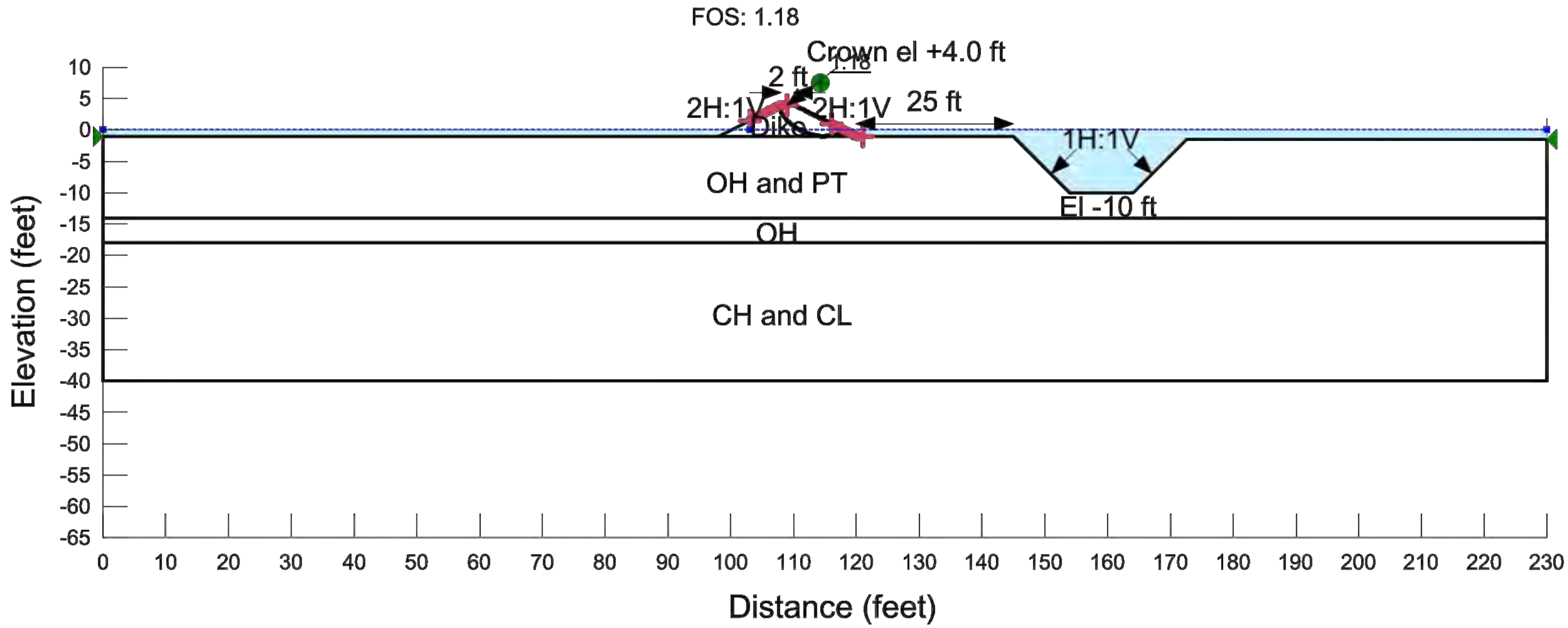
SLO□E STABILIT□ - BORIN□ 6 □ITHO□T FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-6

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 90 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 106 pcf Cohesion: 90 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1000 psf Phi: 0 °



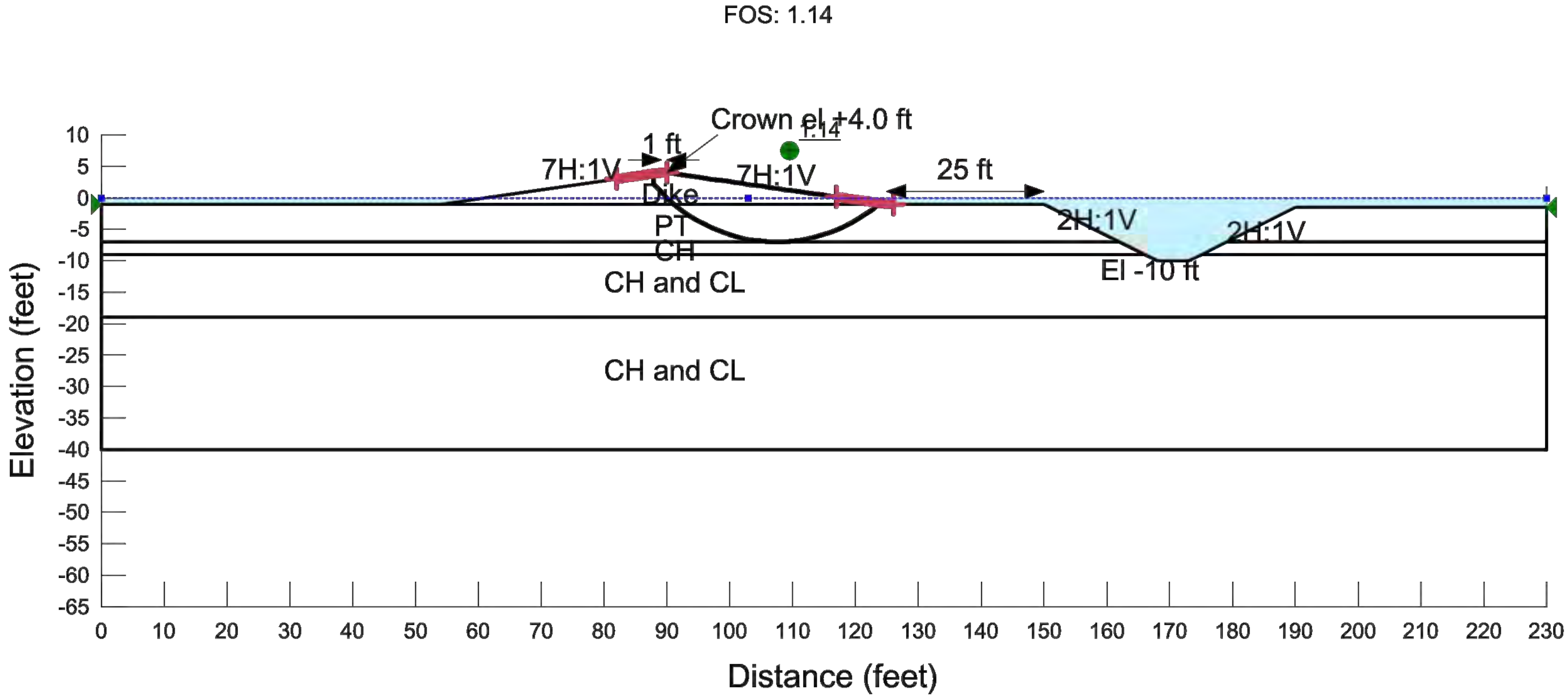
SLO□E STABILIT□ - BORIN□ 7 □ITHO□T FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-7

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °



SLO□E STABILIT□ - BORIN□ 8 □ITHO□T FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

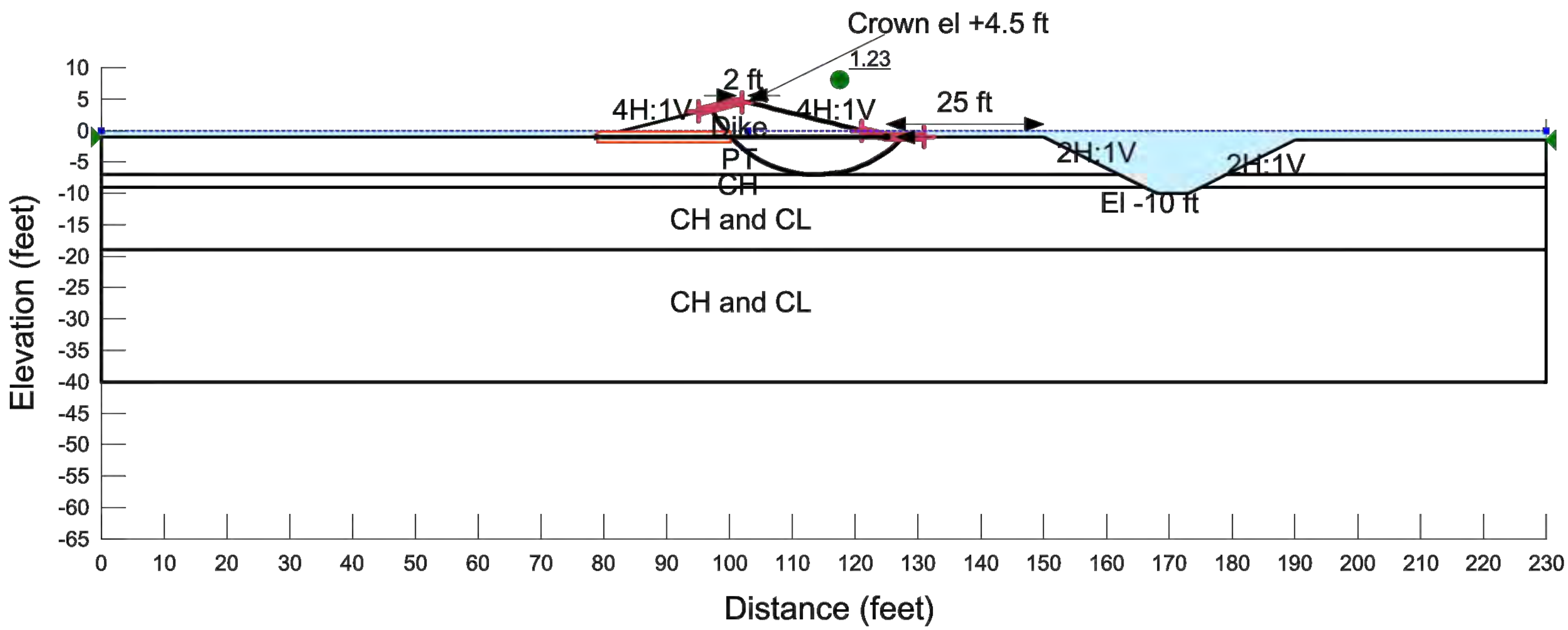
GEOENGINEERS

Figure II-B-8

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °

Type: Fabric Contact Cohesion: 50 psf Fabric Capacity: 4800 lbs

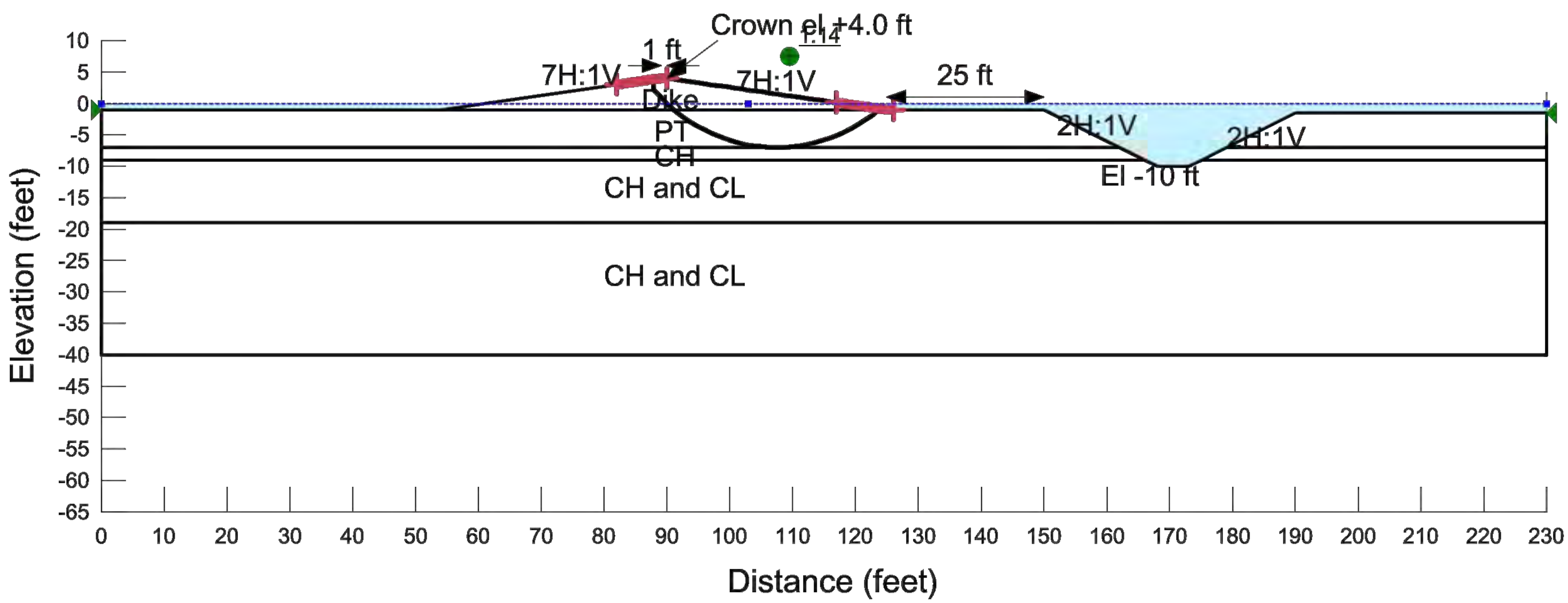
FOS: 1.23



SLO□E STABILIT□ - BORIN□ 8 □ITH FABRI□ □ITHO□T FILL	
Bayou Bonfouca Marsh Creation Project (PO-104) St. Tammany Parish, Louisiana	
GeoEngineers	Figure II-B-9

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °

FOS: 1.14



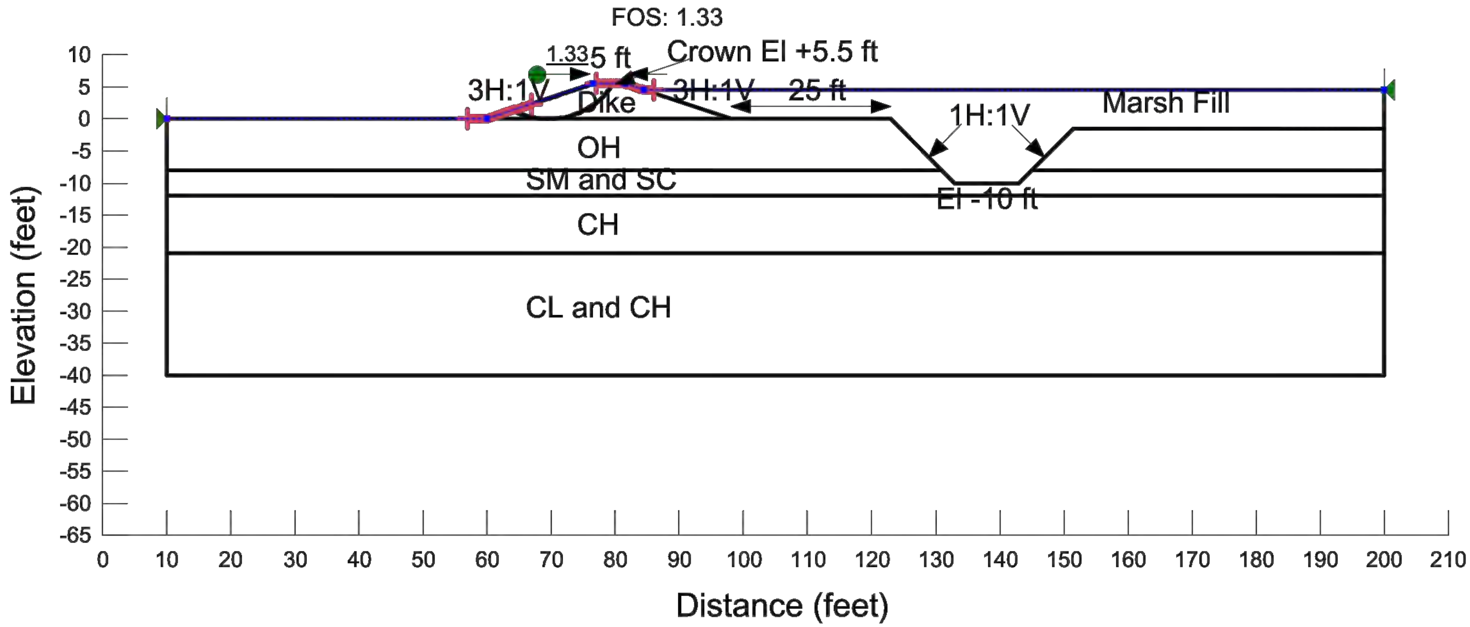
SLO□E STABILIT□ -
BORIN□ 9 □ITHO□T FILL

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GeoEngineers

Figure II-B-1□

Name: Containment Dike Fill   Model: Mohr-Coulomb   Unit Weight: 80 pcf   Cohesion: 60 psf   Phi:
Name: Organic Clay   Model: Mohr-Coulomb   Unit Weight: 82 pcf   Cohesion: 200 psf   Phi: 0 °
Name: Silty and Clayey Sand   Model: Mohr-Coulomb   Unit Weight: 124 pcf   Cohesion: 0 psf   Phi:
Name: Clay   Model: Mohr-Coulomb   Unit Weight: 124 pcf   Cohesion: 1000 psf   Phi: 0 °
Name: Silty Clay and Clay   Model: Mohr-Coulomb   Unit Weight: 114 pcf   Cohesion: 1000 psf   Phi
Name: Marsh Fill   Model: Mohr-Coulomb   Unit Weight: 96 pcf   Cohesion: 1 psf   Phi: 0 °



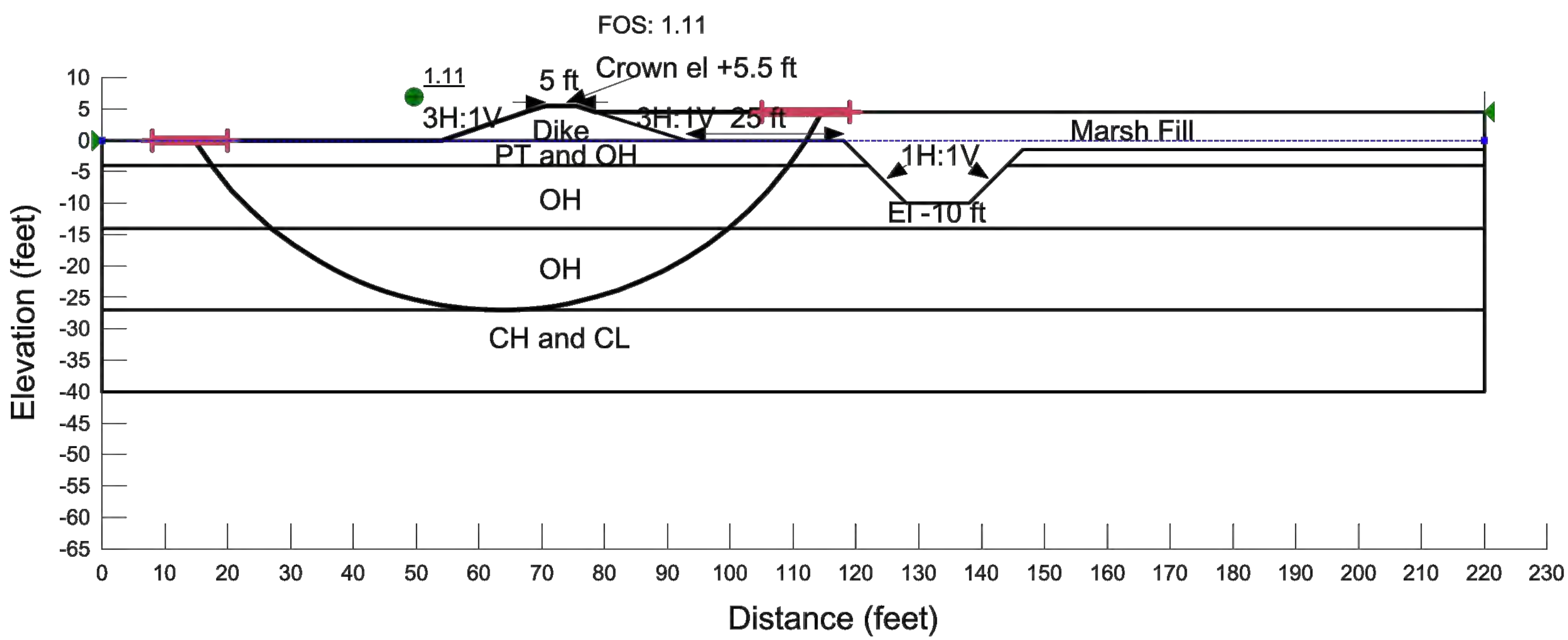
SLO□E STABILIT□ -
BORIN□ 1 □ITH FILL □ 4.5 FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-1□

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat and Organic Clay Model: Mohr-Coulomb Unit Weight: 67 pcf Cohesion: 110 psf Phi: 0 °
Name: Organic Clay - 1 Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 85 psf Phi: 0 °
Name: Organic Clay - 2 Model: Mohr-Coulomb Unit Weight: 104 pcf Cohesion: 85 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 106 pcf Cohesion: 150 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 2 □ITH FILL □ 4.5 FEET

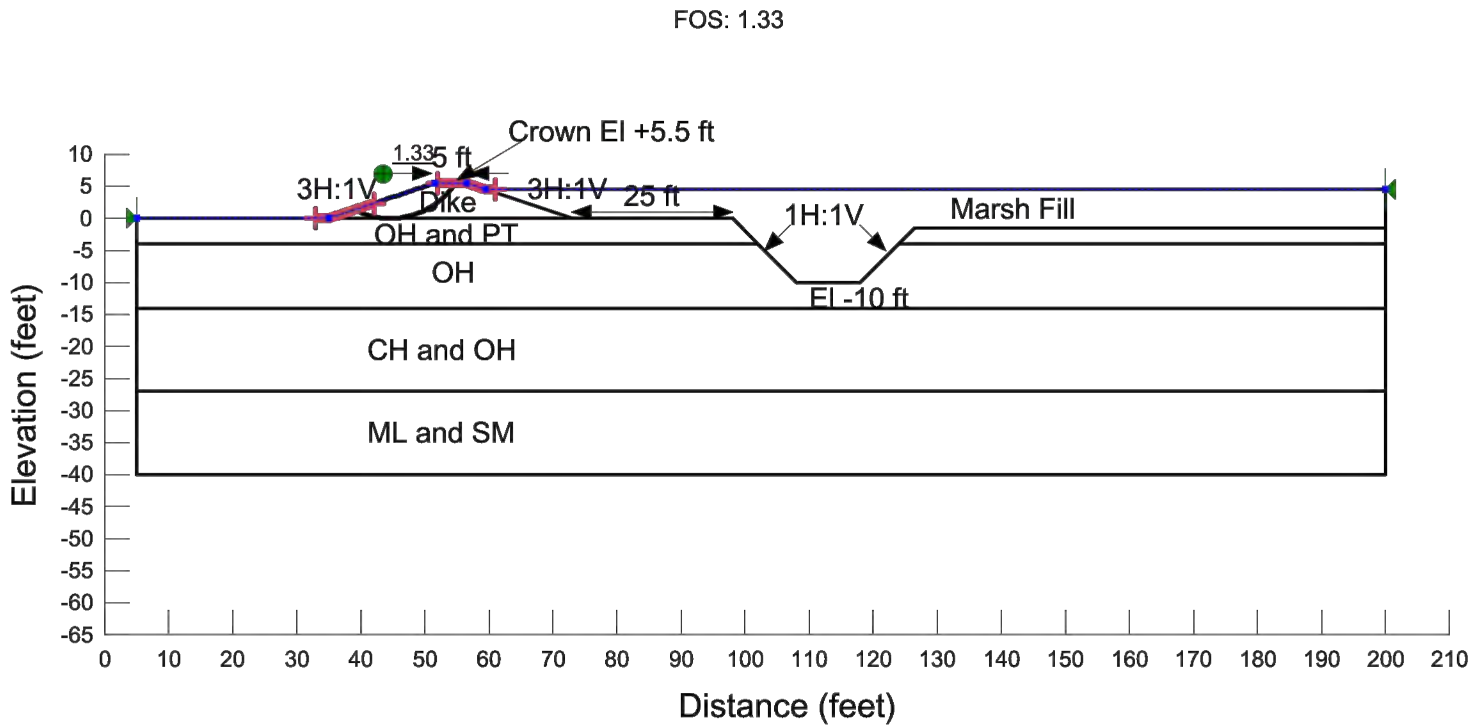
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GeoEngineers

Figure II-B-11

P:\16\16715023\00\CAD\Slope Stability.dwg\TAB:B-13 modified on Mar 21, 2012 - 4:22pm JMP : KMC

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 73 pcf Cohesion: 120 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 84 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Organic Clay Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 130 psf Phi: 0 °
Name: Silt and Sand Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 100 psf Phi: 10 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



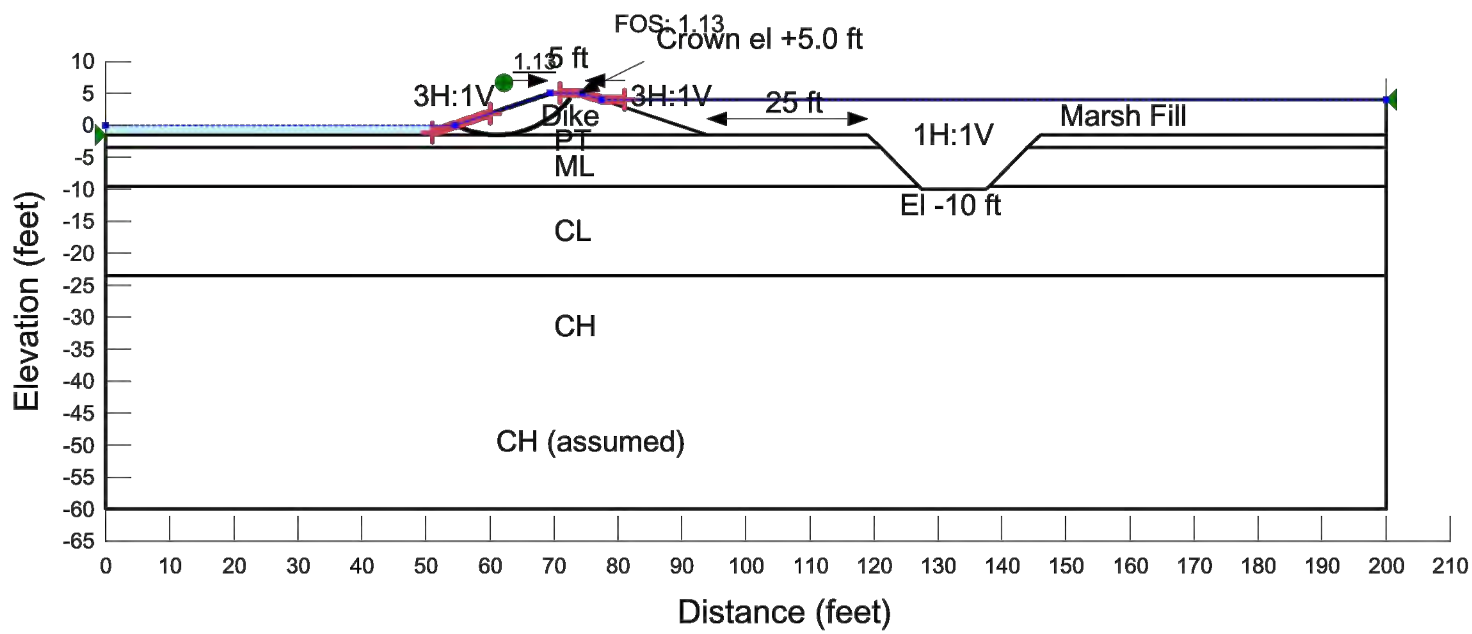
SLO□E STABILIT□ -
BORIN□ 3 □ITH FILL □ 4.5 FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-13

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 100 psf Phi: 0 °
Name: Silt Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 100 psf Phi: 10 °
Name: Silty Clay Model: Mohr-Coulomb Unit Weight: 128 pcf Cohesion: 930 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 114 pcf Cohesion: 930 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



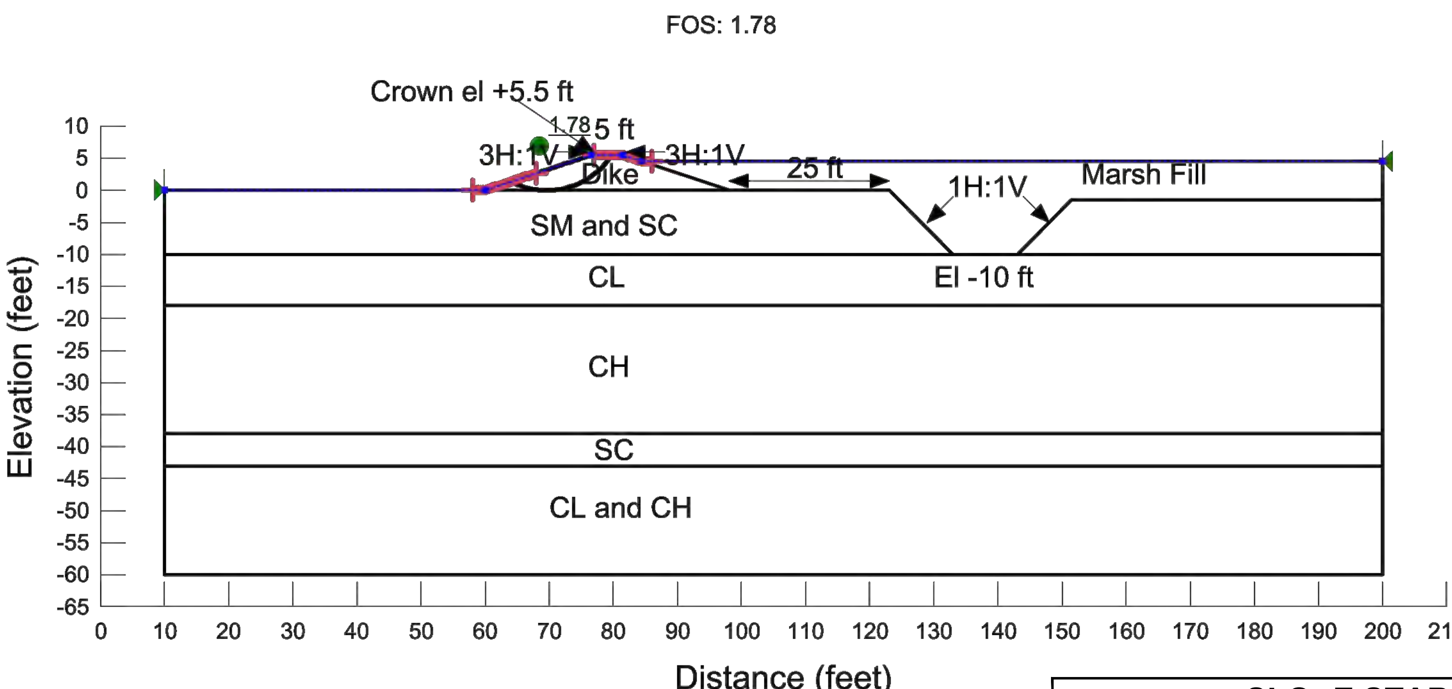
SLO□E STABILIT□ -
BORIN□ 4 □ITH FILL □ 4.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-14

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 100 psf Phi: 0 °
Name: Silty and Clayey Sand Model: Mohr-Coulomb Unit Weight: 127 pcf Cohesion: 200 psf Phi: 0 °
Name: Sandy Clay Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 300 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1170 psf Phi: 0 °
Name: Clayey Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 20 °
Name: Silty Clay and Clay Model: Mohr-Coulomb Unit Weight: 113 pcf Cohesion: 650 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ - BORIN□ 5 □ITH FILL □ 4.5 FEET

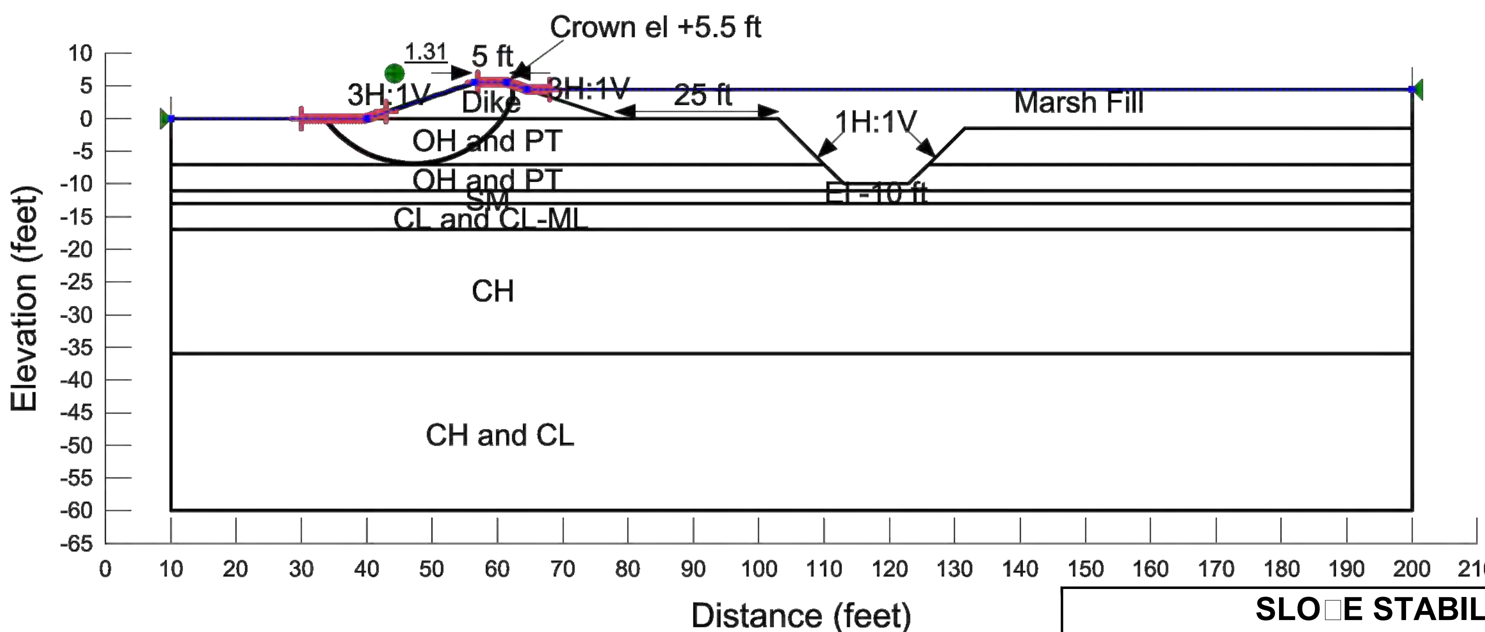
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-15

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat- 1 Model: Mohr-Coulomb Unit Weight: 82 pcf Cohesion: 100 psf Phi: 0 °
Name: Organic Clay and Peat - 2 Model: Mohr-Coulomb Unit Weight: 75 pcf Cohesion: 170 psf Phi: 0 °
Name: Silty Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 20 °
Name: Silty Clay and Clayey Silt Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 300 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 116 pcf Cohesion: 950 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 650 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °

FOS: 1.31



SLO□E STABILIT□ -
BORIN□ 6 □ITH FILL □ 4.5 FEET

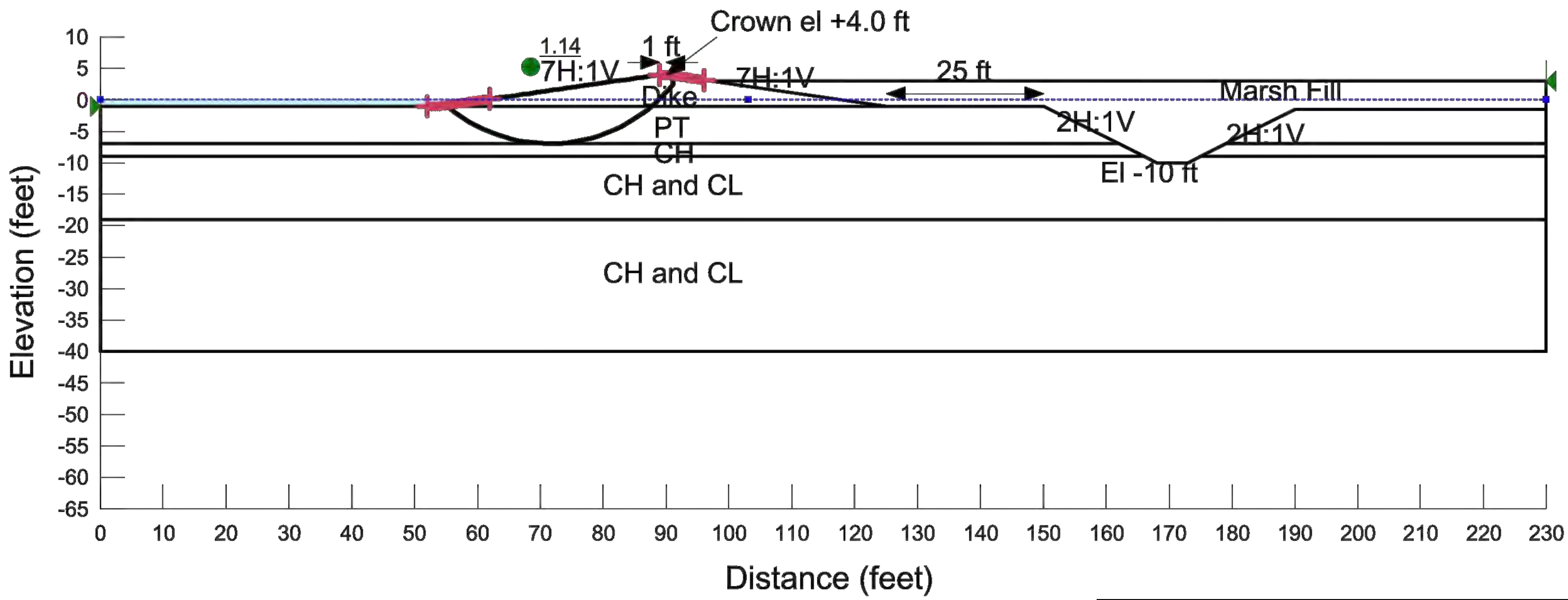
Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-16

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °

FOS: 1.14



SLO□E STABILIT□ -
BORIN□ 8 □ITH FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

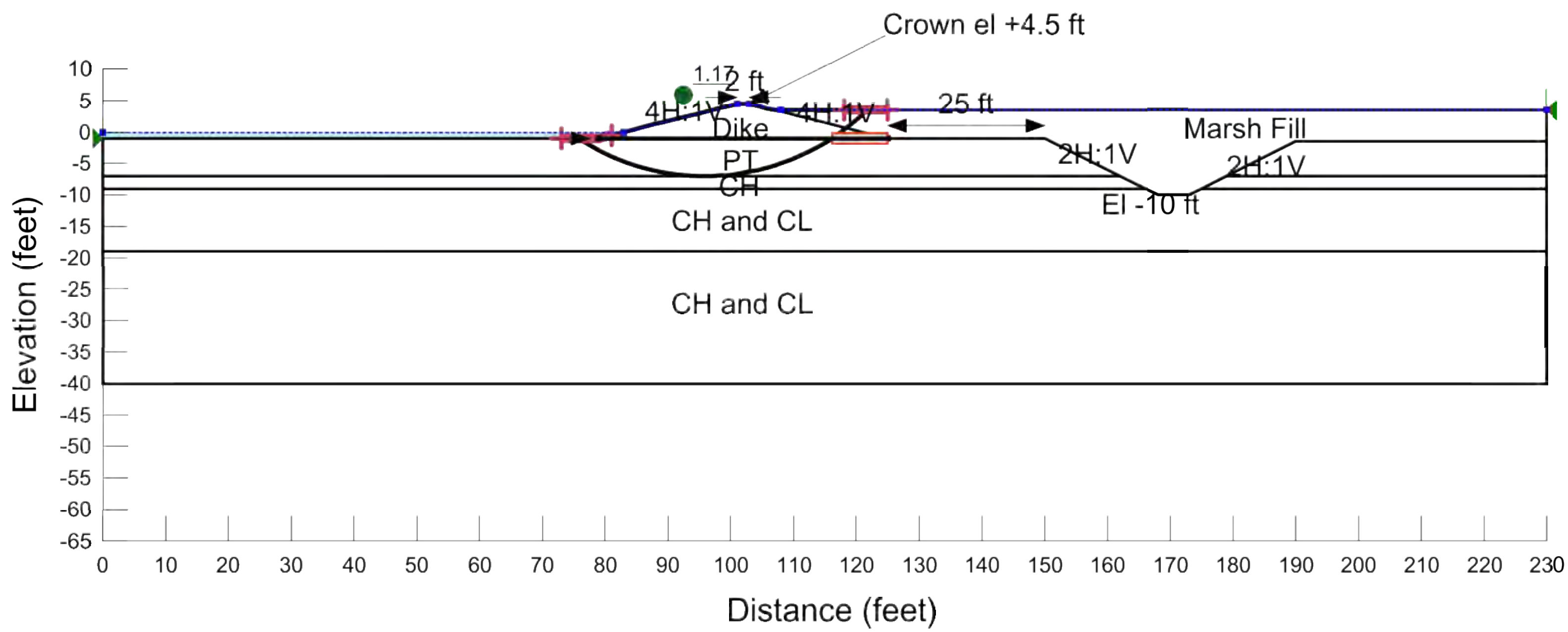
GEOENGINEERS

Figure II-B-17

Name: Containment Dike Fill   Model: Mohr-Coulomb   Unit Weight: 80 pcf   Cohesion: 60 psf   Phi: 0 °
Name: Peat   Model: Mohr-Coulomb   Unit Weight: 70 pcf   Cohesion: 50 psf   Phi: 0 °
Name: Clay   Model: Mohr-Coulomb   Unit Weight: 78 pcf   Cohesion: 130 psf   Phi: 0 °
Name: Clay and Silty Clay   Model: Mohr-Coulomb   Unit Weight: 129 pcf   Cohesion: 450 psf   Phi: 0 °
Name: Clay and Silty Clay (2)   Model: Mohr-Coulomb   Unit Weight: 118 pcf   Cohesion: 1000 psf   Phi: 0 °
Name: Marsh Fill   Model: Mohr-Coulomb   Unit Weight: 96 pcf   Cohesion: 1 psf   Phi: 0 °

Type: Fabric Contact Cohesion: 50 psf Fabric Capacity: 4800 lbs

FOS: 1.17



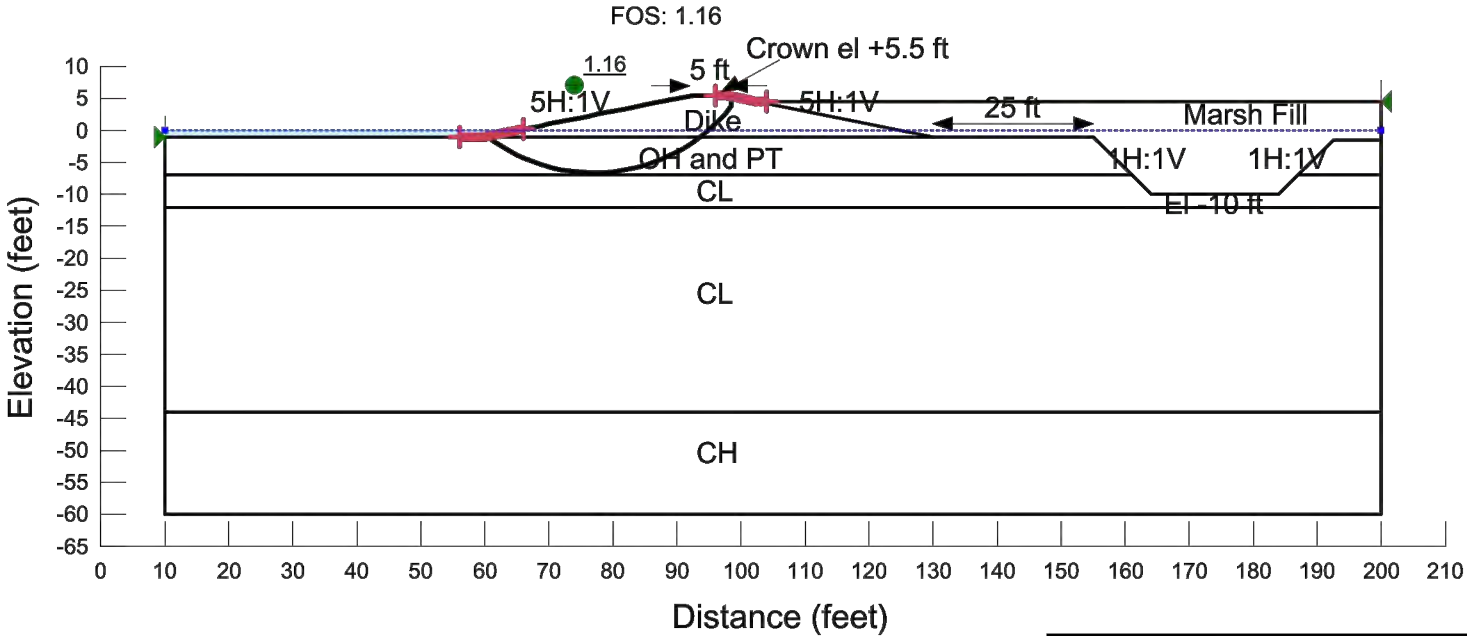
SLOPE STABILITY -
BORING 8 WITH FABRIC AND FILL @ 3.5 FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-B-18

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 69 pcf Cohesion: 80 psf Phi: 0 °
Name: Silty Clay - 1 Model: Mohr-Coulomb Unit Weight: 123 pcf Cohesion: 200 psf Phi: 0 °
Name: Silty Clay - 2 Model: Mohr-Coulomb Unit Weight: 123 pcf Cohesion: 600 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 116 pcf Cohesion: 400 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 9 □ITH FILL □ 4.5 FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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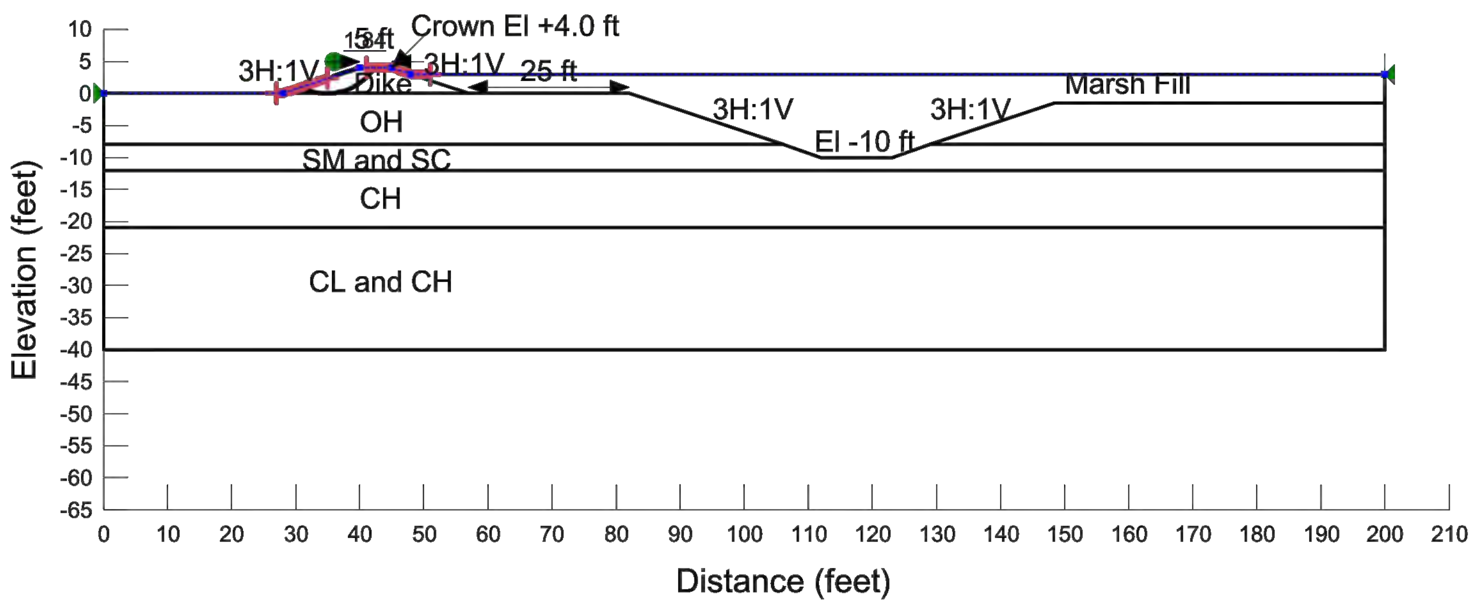
Figure II-B-19

P:\16\16715023\00\CAD\Slope Stability.dwg\TAB:B-20 modified on Mar 21, 2012 - 4:22pm JMP : KMC

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 82 pcf Cohesion: 200 psf Phi: 0 °
Name: Silty and Clayey Sand Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 20 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 1000 psf Phi: 0 °
Name: Silty Clay and Clay Model: Mohr-Coulomb Unit Weight: 114 pcf Cohesion: 1000 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °

FOS: 1.84



SLO□E STABILIT□ -
BORIN□ 1 □ITH FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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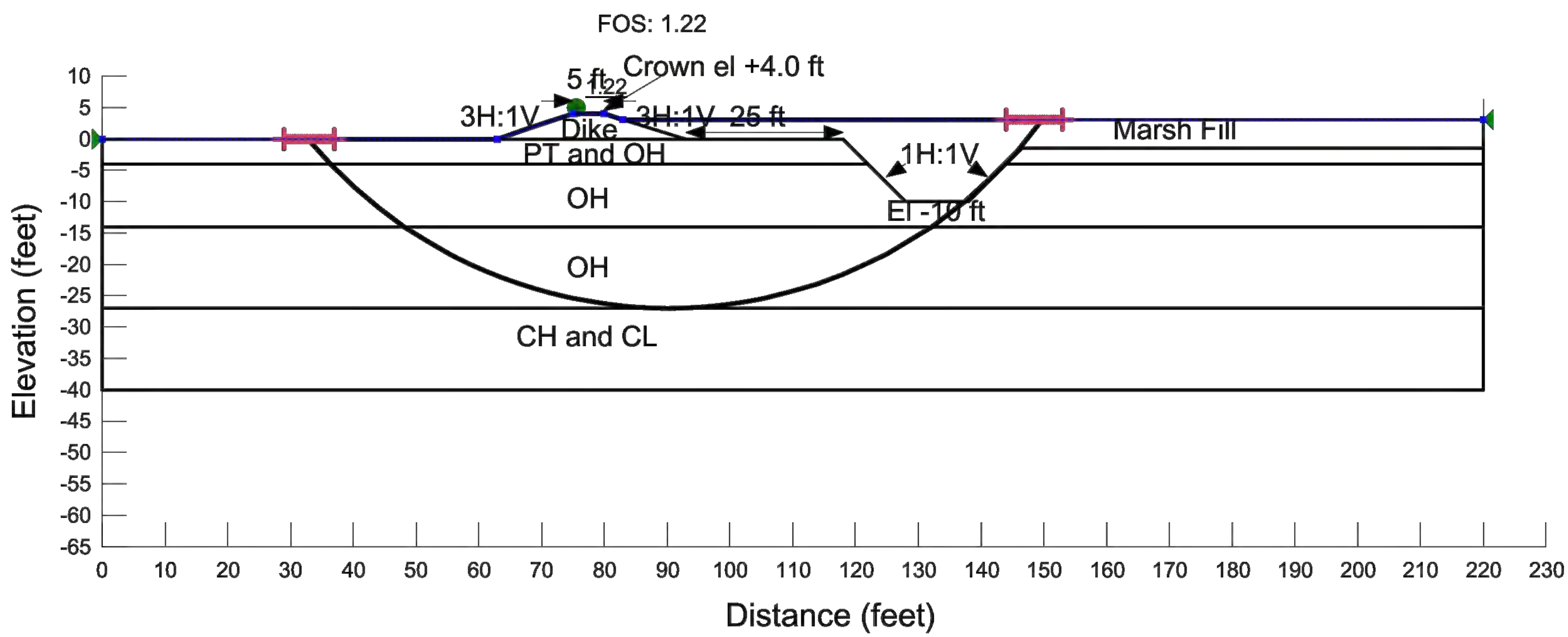
Figure II-B-2□

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat and Organic Clay Model: Mohr-Coulomb Unit Weight: 67 pcf Cohesion: 110 psf Phi: 0 °
Name: Organic Clay - 1 Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 85 psf Phi: 0 °
Name: Organic Clay - 2 Model: Mohr-Coulomb Unit Weight: 104 pcf Cohesion: 85 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 106 pcf Cohesion: 150 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 2 □ITH FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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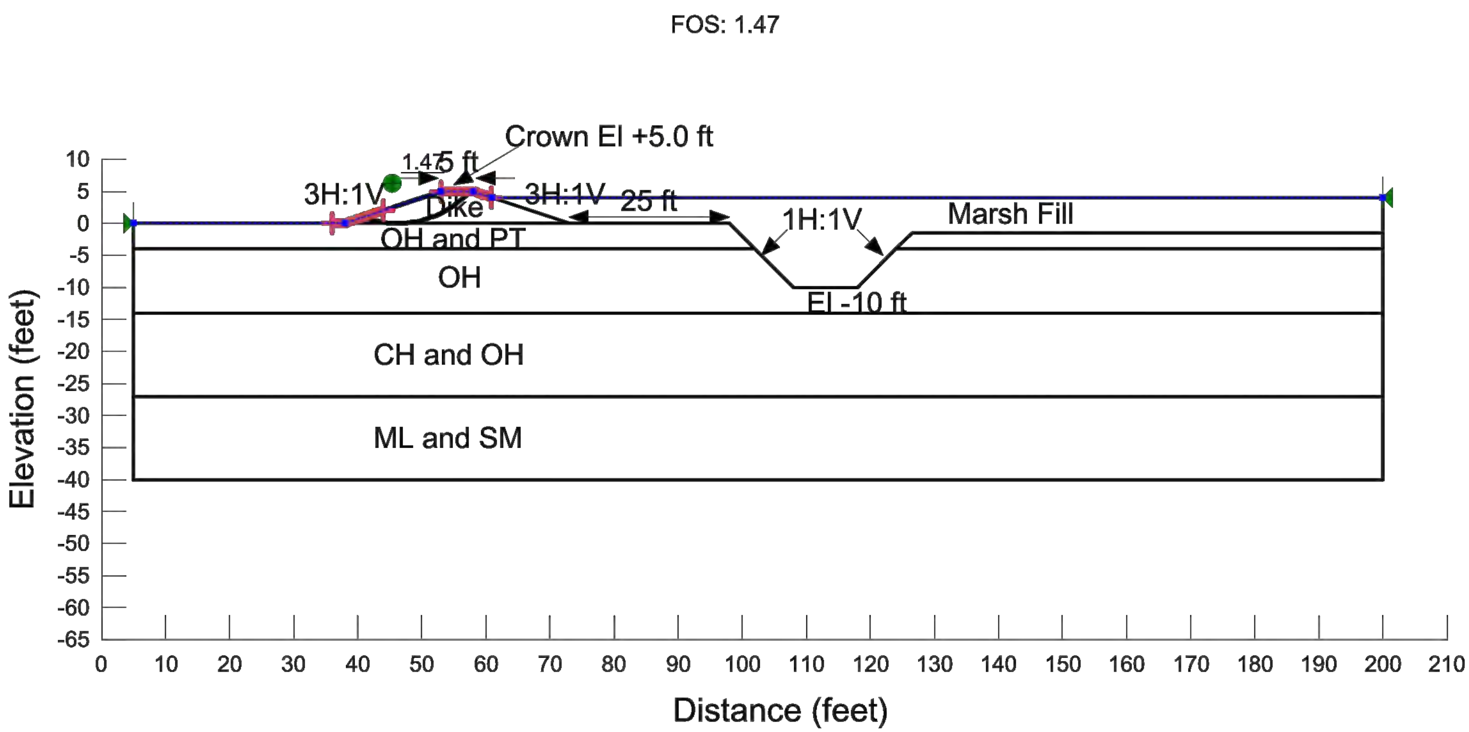
Figure II-B-21

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 73 pcf Cohesion: 120 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 84 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Organic Clay Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 130 psf Phi: 0 °
Name: Silt and Sand Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 100 psf Phi: 10 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 3 □ITH FILL □ 4.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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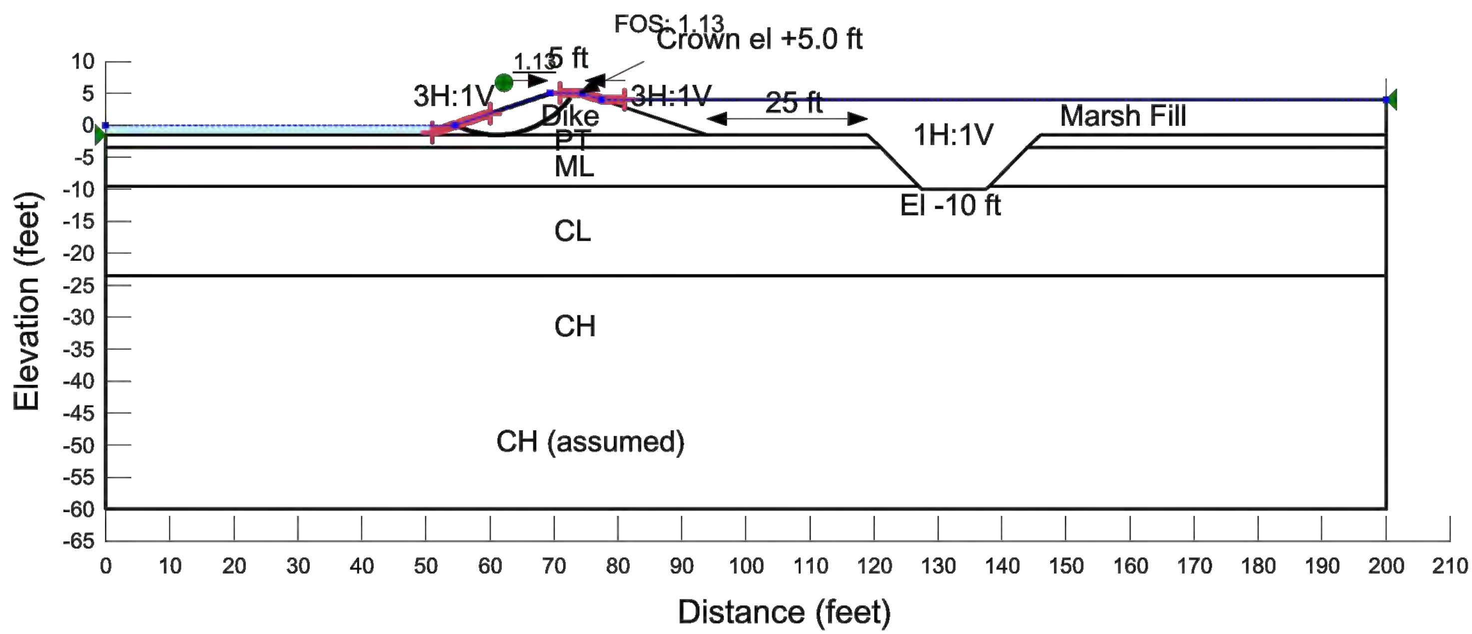
Figure II-B-22

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 100 psf Phi: 0 °
Name: Silt Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 100 psf Phi: 10 °
Name: Silty Clay Model: Mohr-Coulomb Unit Weight: 128 pcf Cohesion: 930 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 114 pcf Cohesion: 930 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLOPE STABILITY - BORING 4 WITH FILL @ 4.0 FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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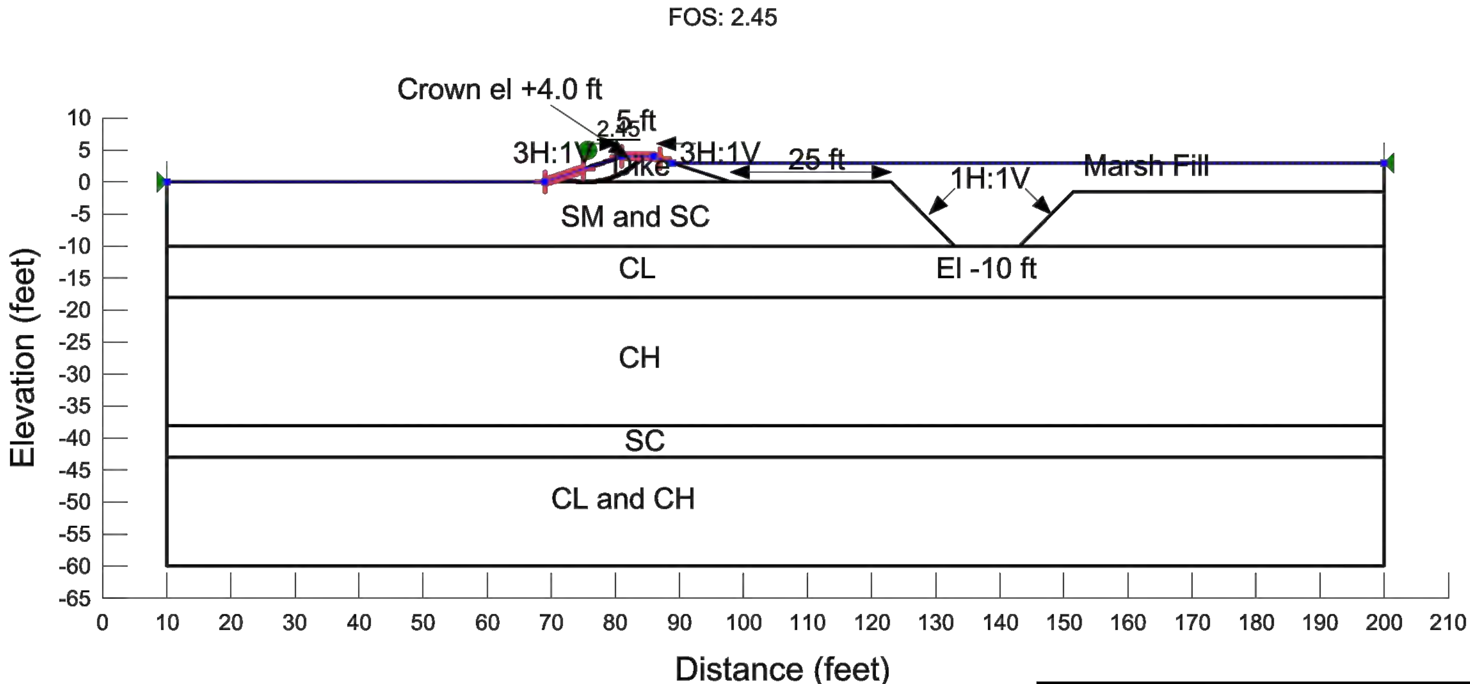
Figure II-B-23

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 100 psf Phi: 0 °
Name: Silty and Clayey Sand Model: Mohr-Coulomb Unit Weight: 127 pcf Cohesion: 200 psf Phi: 0 °
Name: Sandy Clay Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 300 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1170 psf Phi: 0 °
Name: Clayey Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 20 °
Name: Silty Clay and Clay Model: Mohr-Coulomb Unit Weight: 113 pcf Cohesion: 650 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



**SLO□E STABILIT□ -
BORIN□ 5 □ITH FILL □ 3.□FEET**

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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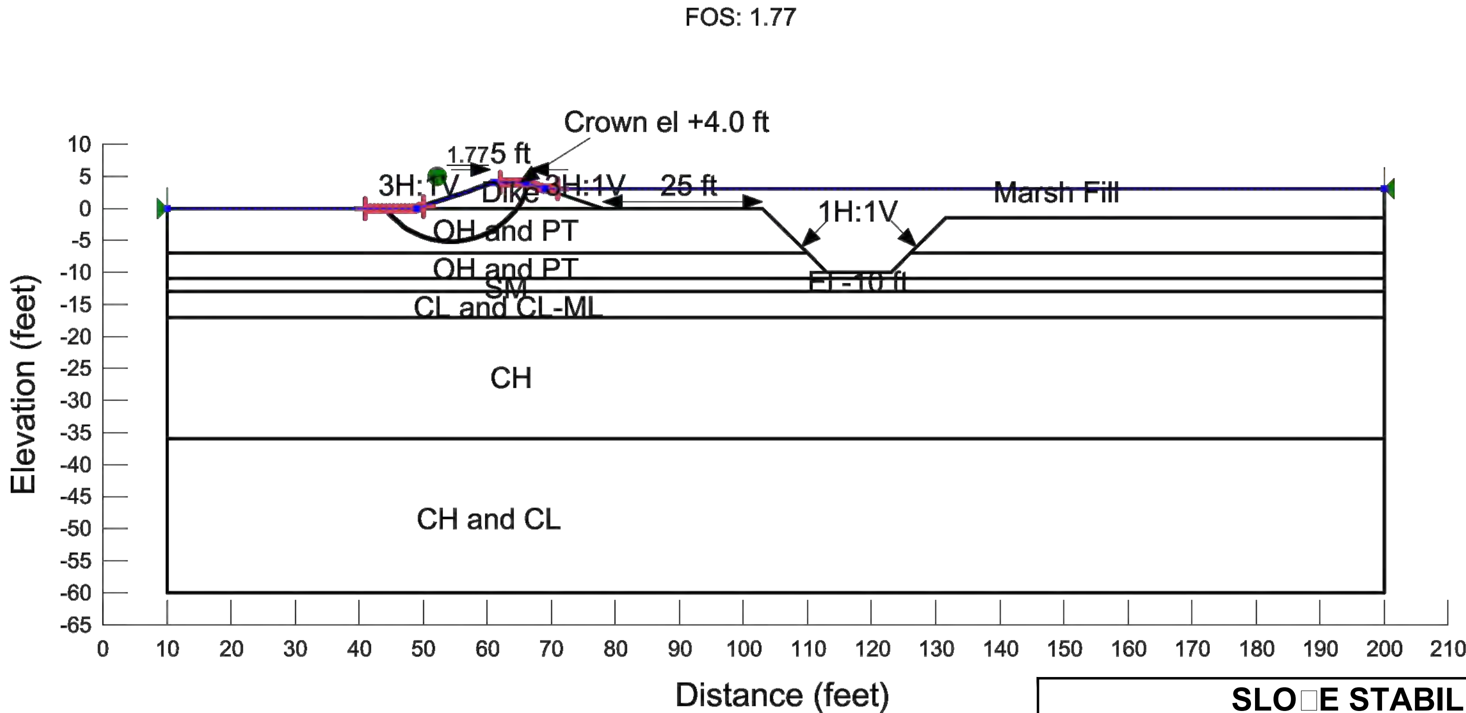
Figure II-B-24

Name: Containment Dike Fill	Model: Mohr-Coulomb	Unit Weight: 80 pcf	Cohesion: 60 psf	Phi: 0 °
Name: Organic Clay and Peat- 1	Model: Mohr-Coulomb	Unit Weight: 82 pcf	Cohesion: 100 psf	Phi: 0 °
Name: Organic Clay and Peat - 2	Model: Mohr-Coulomb	Unit Weight: 75 pcf	Cohesion: 170 psf	Phi: 0 °
Name: Silty Sand	Model: Mohr-Coulomb	Unit Weight: 120 pcf	Cohesion: 0 psf	Phi: 20 °
Name: Silty Clay and Clayey Silt	Model: Mohr-Coulomb	Unit Weight: 129 pcf	Cohesion: 300 psf	Phi: 0 °
Name: Clay	Model: Mohr-Coulomb	Unit Weight: 116 pcf	Cohesion: 950 psf	Phi: 0 °
Name: Clay and Silty Clay	Model: Mohr-Coulomb	Unit Weight: 115 pcf	Cohesion: 650 psf	Phi: 0 °
Name: Marsh Fill	Model: Mohr-Coulomb	Unit Weight: 96 pcf	Cohesion: 1 psf	Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 6 □ITH FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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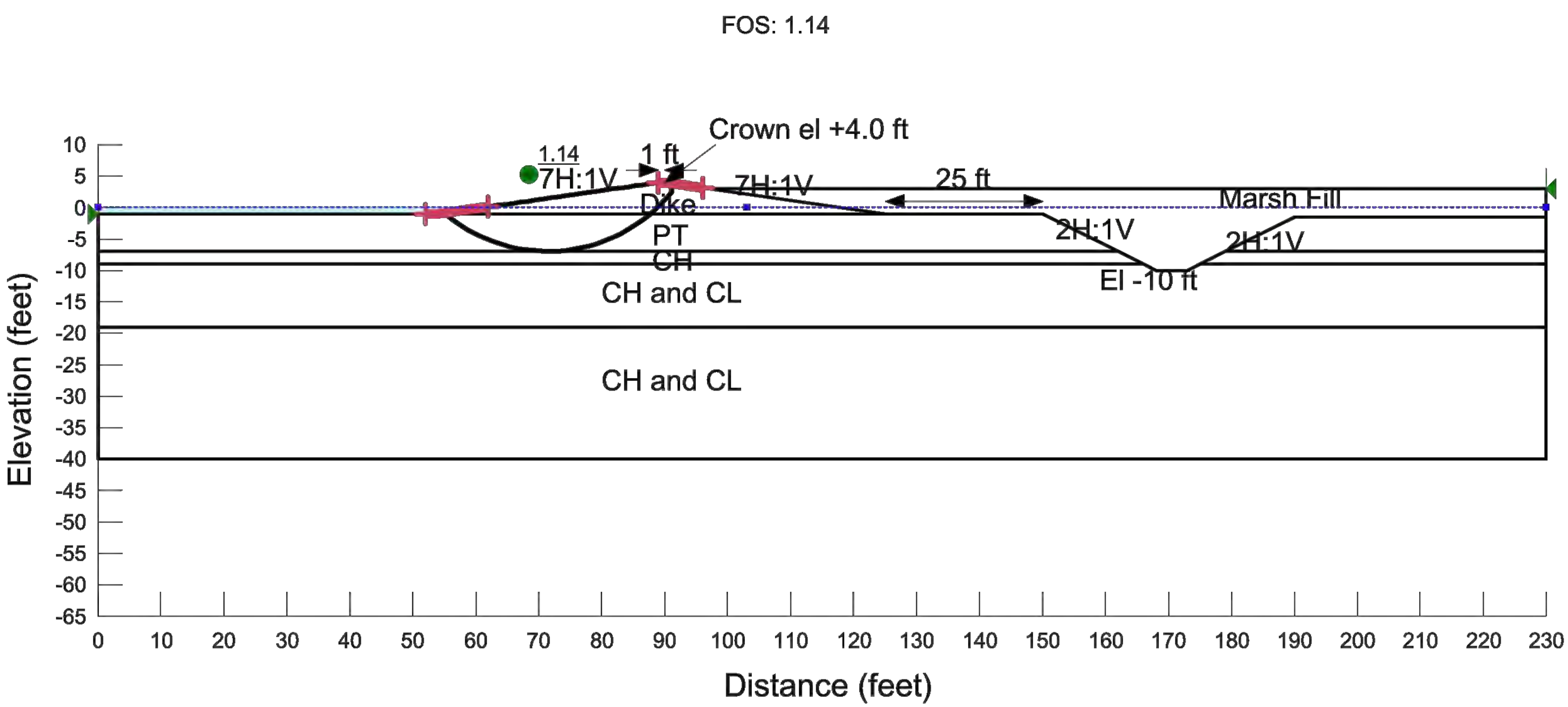
Figure II-B-25

Name: Containment Dike Fill   Model: Mohr-Coulomb   Unit Weight: 80 pcf   Cohesion: 60 psf   Phi: 0 °
Name: Peat   Model: Mohr-Coulomb   Unit Weight: 70 pcf   Cohesion: 50 psf   Phi: 0 °
Name: Clay   Model: Mohr-Coulomb   Unit Weight: 78 pcf   Cohesion: 130 psf   Phi: 0 °
Name: Clay and Silty Clay   Model: Mohr-Coulomb   Unit Weight: 129 pcf   Cohesion: 450 psf   Phi: 0 °
Name: Clay and Silty Clay (2)   Model: Mohr-Coulomb   Unit Weight: 118 pcf   Cohesion: 1000 psf   Phi: 0 °
Name: Marsh Fill   Model: Mohr-Coulomb   Unit Weight: 96 pcf   Cohesion: 1 psf   Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 8 □ITH FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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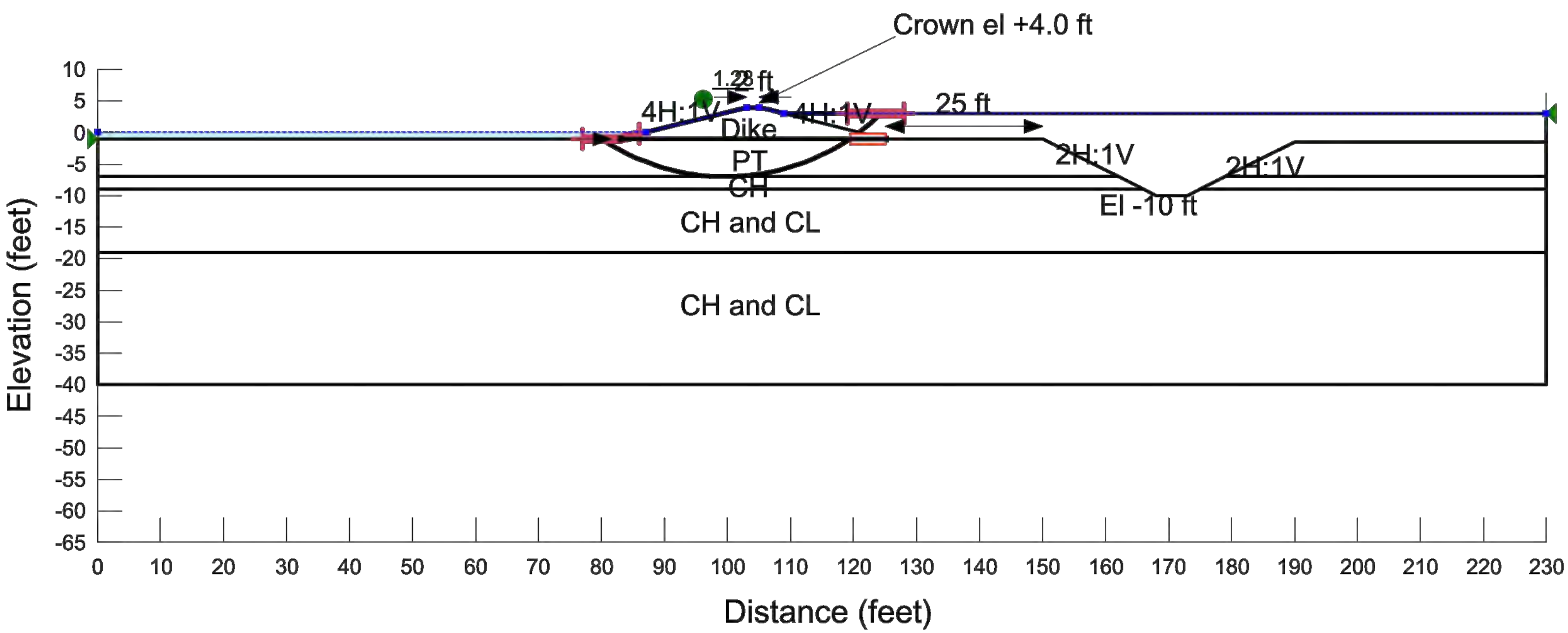
Figure II-B-26

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °

Type: Fabric Contact Cohesion: 50 psf Fabric Capacity: 4800 lbs

FOS: 1.28



SLO□E STABILIT□ -
BORIN□ 8 □ITH FABRI□ AND FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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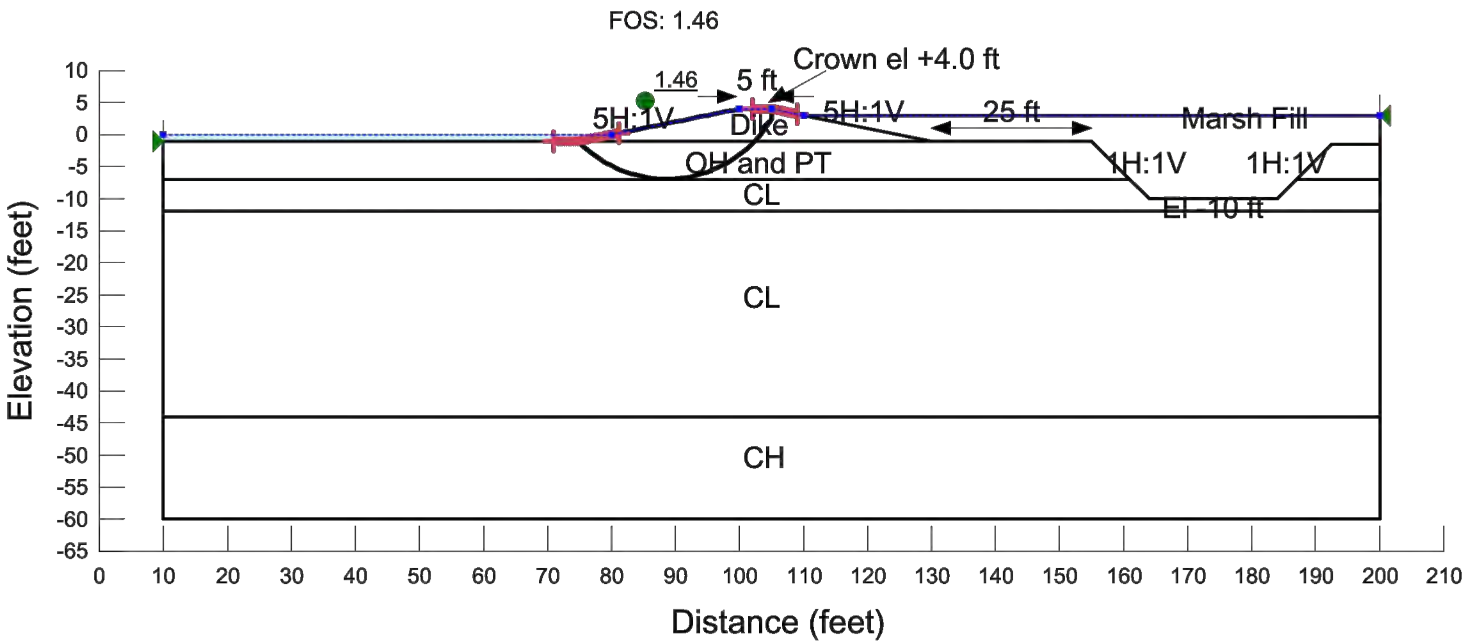
Figure II-B-27

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 69 pcf Cohesion: 80 psf Phi: 0 °
Name: Silty Clay - 1 Model: Mohr-Coulomb Unit Weight: 123 pcf Cohesion: 200 psf Phi: 0 °
Name: Silty Clay - 2 Model: Mohr-Coulomb Unit Weight: 123 pcf Cohesion: 600 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 116 pcf Cohesion: 400 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 9 □ITH FILL □ 3.□FEET

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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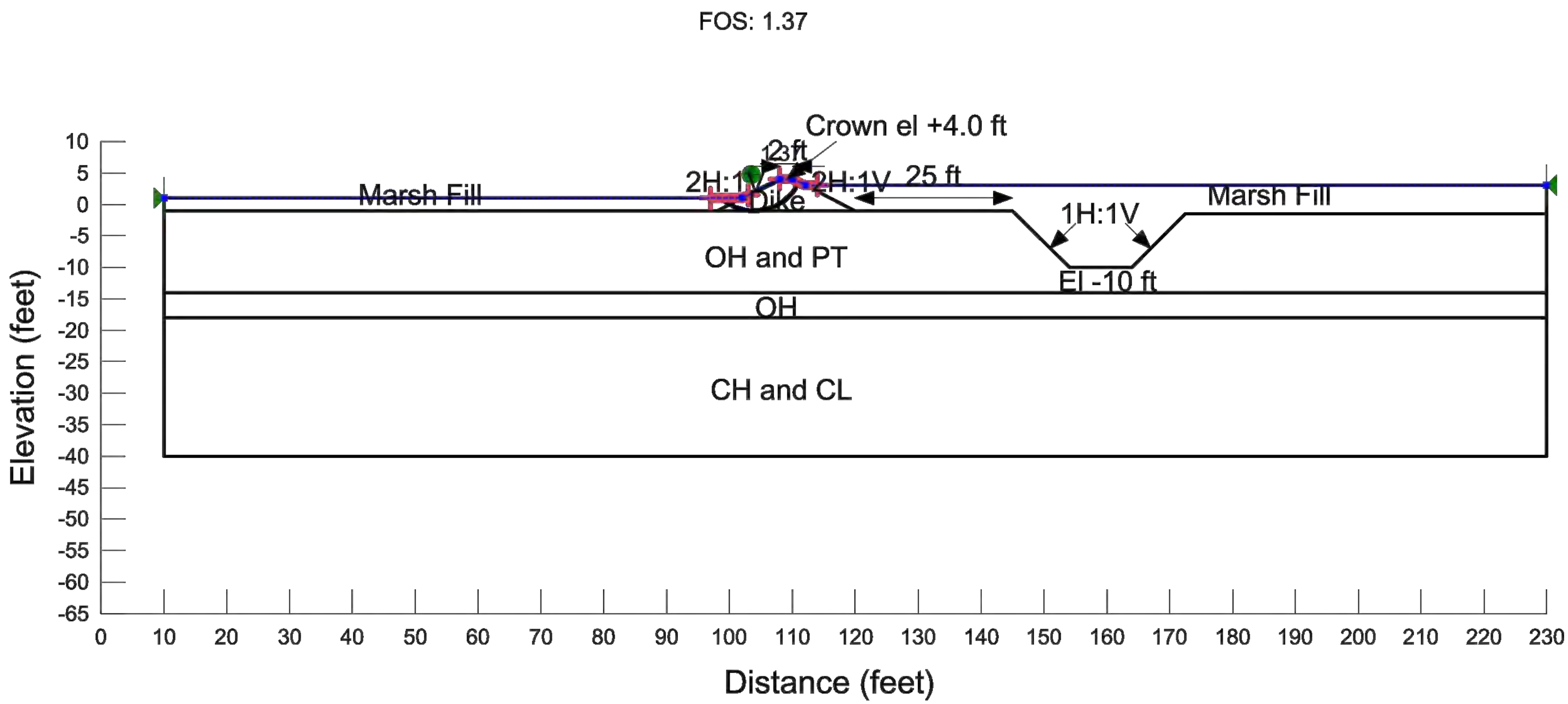
Figure II-B-28

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 90 psf Phi: 0 °
Name: Organic Clay Model: Mohr-Coulomb Unit Weight: 106 pcf Cohesion: 90 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1000 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLO□E STABILIT□ -
BORIN□ 7 □ITH FILL □ 3.□FEET IN MARSH AND 1.□FOOT IN □OND

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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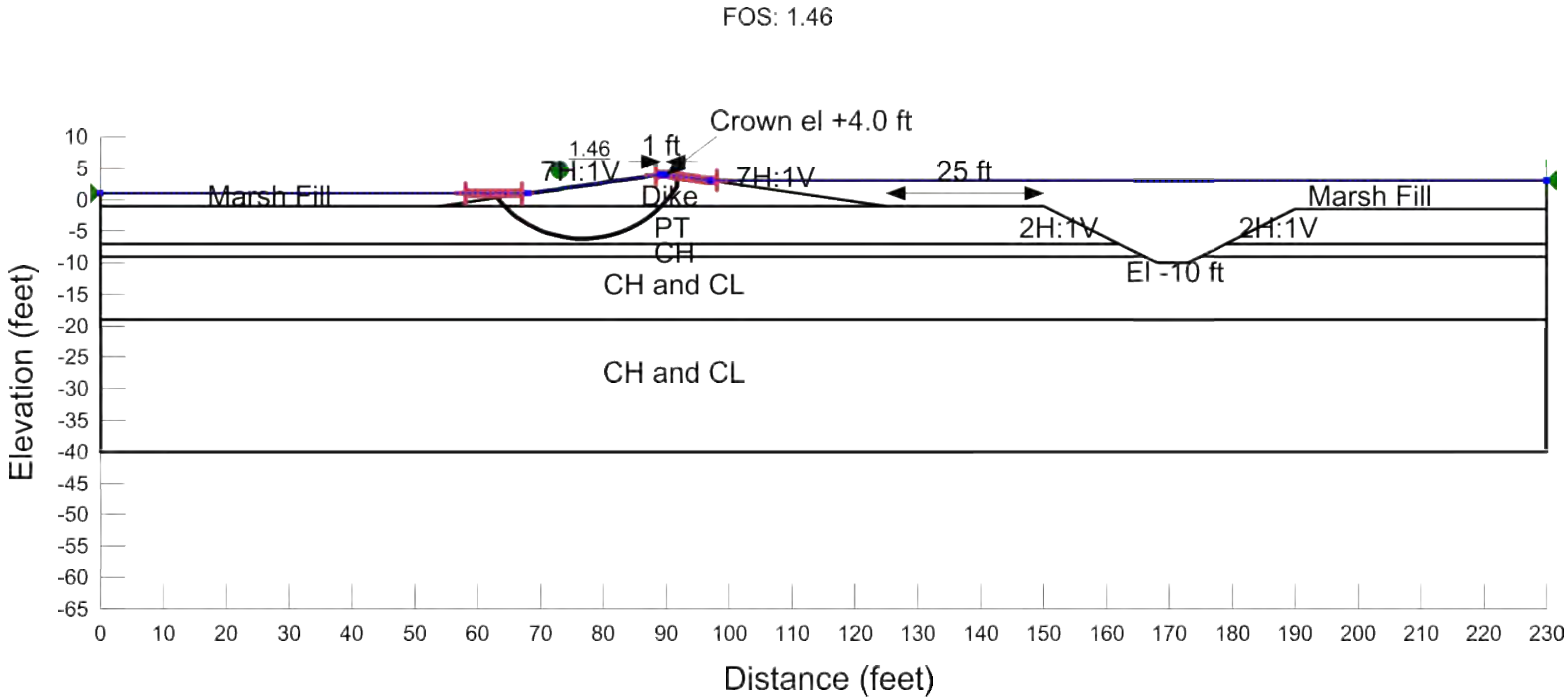
Figure II-B-29

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLOPE STABILITY -
BORING 8 WITH FILL @ 3.0 FEET IN MARSH AND 1.0 FOOT IN POND

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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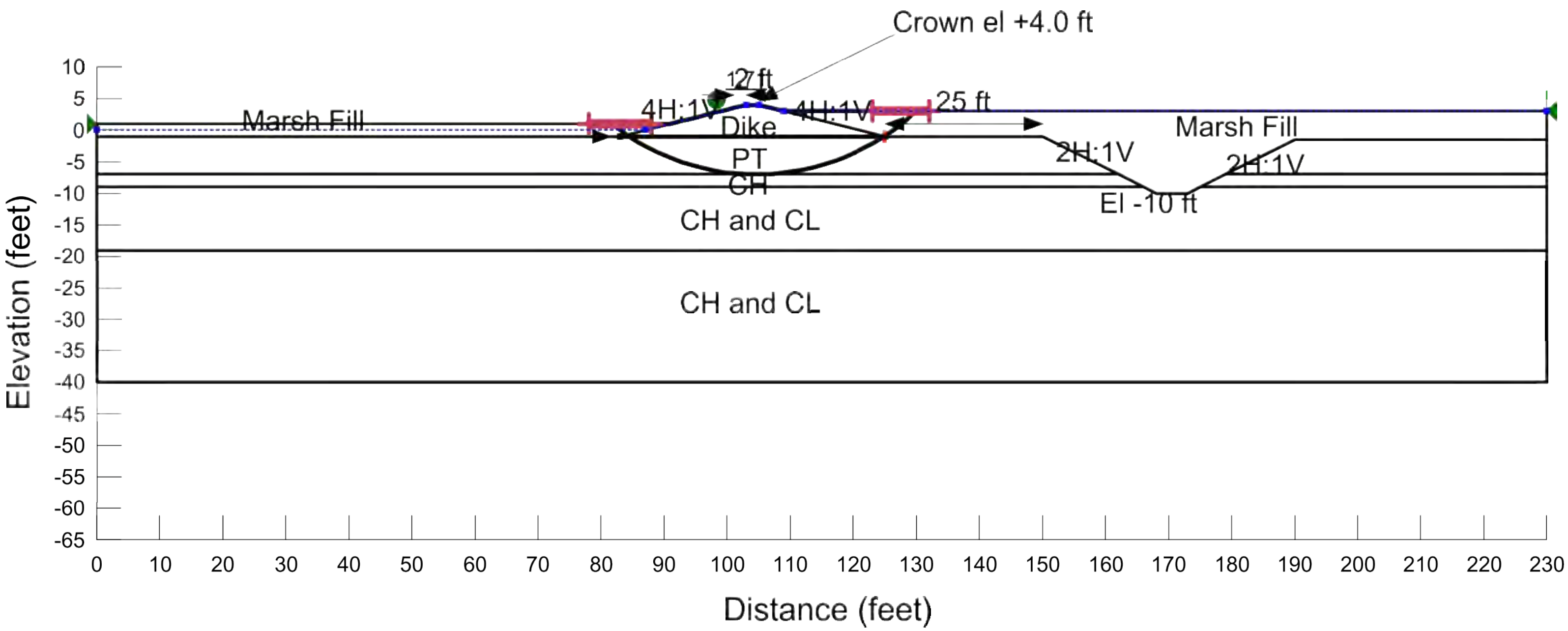
Figure II-B-30

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Peat Model: Mohr-Coulomb Unit Weight: 70 pcf Cohesion: 50 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 78 pcf Cohesion: 130 psf Phi: 0 °
Name: Clay and Silty Clay Model: Mohr-Coulomb Unit Weight: 129 pcf Cohesion: 450 psf Phi: 0 °
Name: Clay and Silty Clay (2) Model: Mohr-Coulomb Unit Weight: 118 pcf Cohesion: 1000 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °

Type: Fabric Contact Cohesion: 50 psf Fabric Capacity: 4800 lbs

FOS: 1.71



SLOPE STABILITY -
BORING 8 WITH FABRIC AND FILL @ 3.0 FEET IN MARSH AND 1.0 FOOT IN POND

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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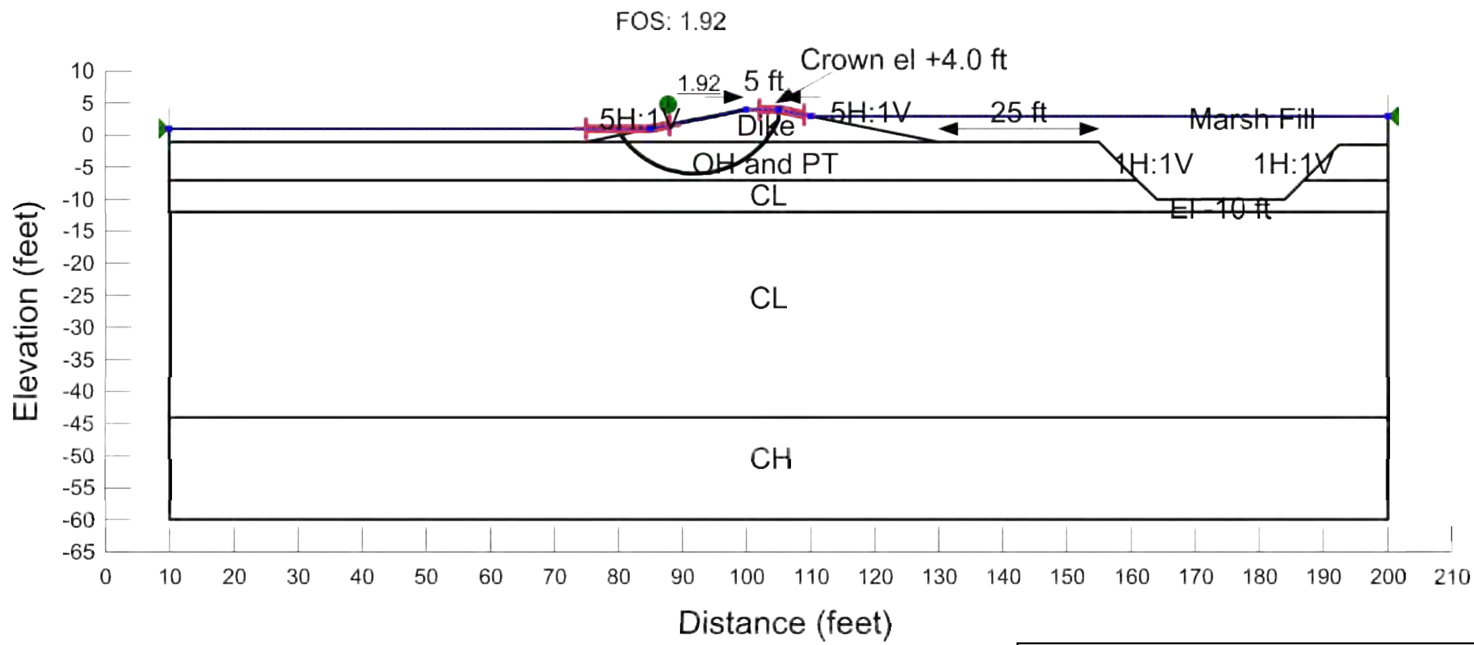
Figure II-B-31

Name: Containment Dike Fill Model: Mohr-Coulomb Unit Weight: 80 pcf Cohesion: 60 psf Phi: 0 °
Name: Organic Clay and Peat Model: Mohr-Coulomb Unit Weight: 69 pcf Cohesion: 80 psf Phi: 0 °
Name: Silty Clay - 1 Model: Mohr-Coulomb Unit Weight: 123 pcf Cohesion: 200 psf Phi: 0 °
Name: Silty Clay - 2 Model: Mohr-Coulomb Unit Weight: 123 pcf Cohesion: 600 psf Phi: 0 °
Name: Clay Model: Mohr-Coulomb Unit Weight: 116 pcf Cohesion: 400 psf Phi: 0 °
Name: Marsh Fill Model: Mohr-Coulomb Unit Weight: 96 pcf Cohesion: 1 psf Phi: 0 °



SLOPE STABILITY - BORING 9 WITH FILL @ 3.0 FEET IN MARSH AND 1.0 FOOT IN POND

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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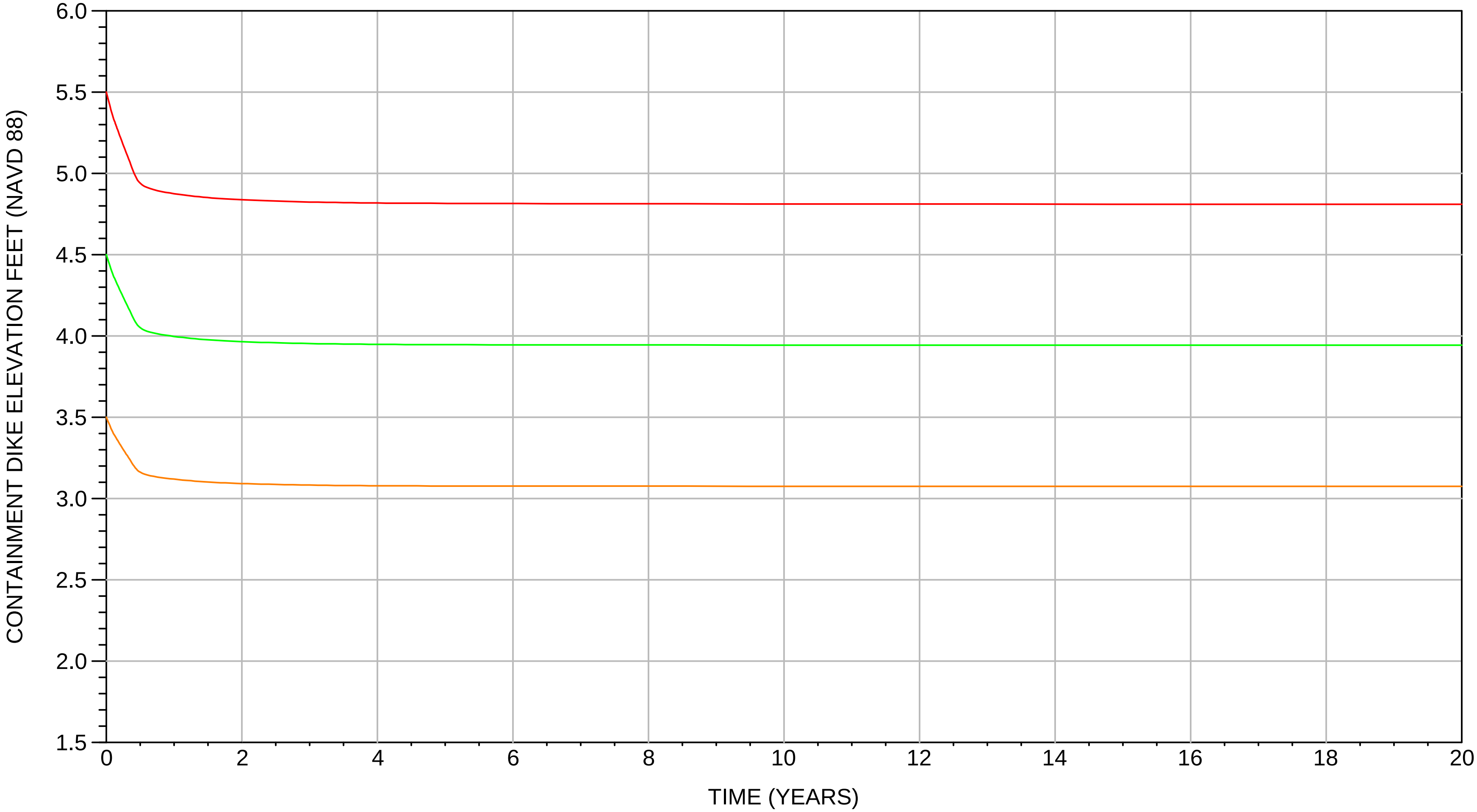
Figure II-B-32

APPENDIX II-C
Containment Dike Settlement

Calculation Approach for Settlement and Time Rate of Settlement for Earthen Containment Levees Bayou Bonfouca Marsh Creation (PO-104)

1. Settlement parameters were developed for each soil boring as shown in the attached spreadsheets. The following description explains how the parameters were developed.
    a. One consolidation test was completed for each boring. Samples for each consolidation test were selected from varying depths and materials.
    b. A total of 9 consolidation test results were analyzed and graphs were reconstructed to determine compression (C_c), recompression (C_r), and vertical consolidation (C_v) coefficients, initial void ratios (e_0), and maximum past pressures (P_c).
    c. Correlations presented in equations 1 through 3 (shown in the spreadsheets in Appendix III-D) were used to calculate e_0, C_c, and C_r for all soil layers.
    d. GeoEngineers developed different correlations based on the analyses of the consolidation test results as follows:
        i. e_0 was computed using correlations established from the results of laboratory consolidation testing for this project.
        ii. w vs. C_c: C_c=0.0054*((w*S.G.)-35) was found to provide sufficient accuracy based on the test data for this and other projects for all compressible soil types. C_c for each of the soil layers was determined based on the moisture contents estimated during soil profile development.
        iii. C_r was taken to be 10 percent of C_c for all compressible soil types based on consolidation test results from this project.
        iv. C_v values were estimated using a graphical correlation established by GeoEngineers based on this and other coastal protection and restoration projects.
    e. For soil layers without a representative consolidation test, the above mentioned correlations/calculation methods were used to estimate C_c, C_r, and C_v.
    f. Maximum past pressure (P_c) was obtained from the consolidation test curves for the soil layers with a representative consolidation test. For other soil layers, the overconsolidation ratio (OCR) was estimated from the equation $OCR = (c/(P_0' * 0.22))^{(1/0.8)}$. This equation was taken from Figure 7.1 of "Recommended Practice for soft ground site characterization," by Charles Ladd and Don DeGroot. P_c was estimated by multiplying the effective overburden pressure (P_0') by OCR.
    g. In cases where P_0' was greater than P_c, P_0' was used as the maximum past pressure under the assumption that the soil is normally consolidated.
2. In this area, clay shear strength for a normally consolidated soil profile will be approximately 22% of the effective overburden pressure. This relationship is shown as the C/P line on the shear strength profiles. Based on this relationship, it generally appears that the soils are overconsolidated, with the exception of some deeper soil layers in certain locations (e.g., soil borings B-2 and B-3). This affects the settlement parameters in these zones.
3. Both vertical and horizontal drainage were considered. Vertical drainage to the phreatic surface or to the nearest granular soil layer has been considered. The presence of small sand and silt layers within clay was considered in the vertical drainage path evaluation. In some of the soil profiles, the preferential drainage path in the deeper soil layers is horizontal. For these cases, the horizontal drainage coefficient, C_h, was assumed to be twice the magnitude of C_v.
4. Consolidation of foundation soils was modeled using a one-dimensional consolidation program.
5. Time rate of settlement was computed using spreadsheet calculations based on Terzaghi's one-dimensional consolidation theory.



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	4.9	4.9	4.8	4.8	4.8	4.8	4.8
4.5	4.0	4.0	4.0	3.9	3.9	3.9	3.9
3.5	3.1	3.1	3.1	3.1	3.1	3.1	3.1

CONSTRUCTION SETTLEMENT
0.044 FT.
0.038 FT.
0.031 FT.

□ONTAINMENT DI□E ELEVATION VS. TIME (B-1)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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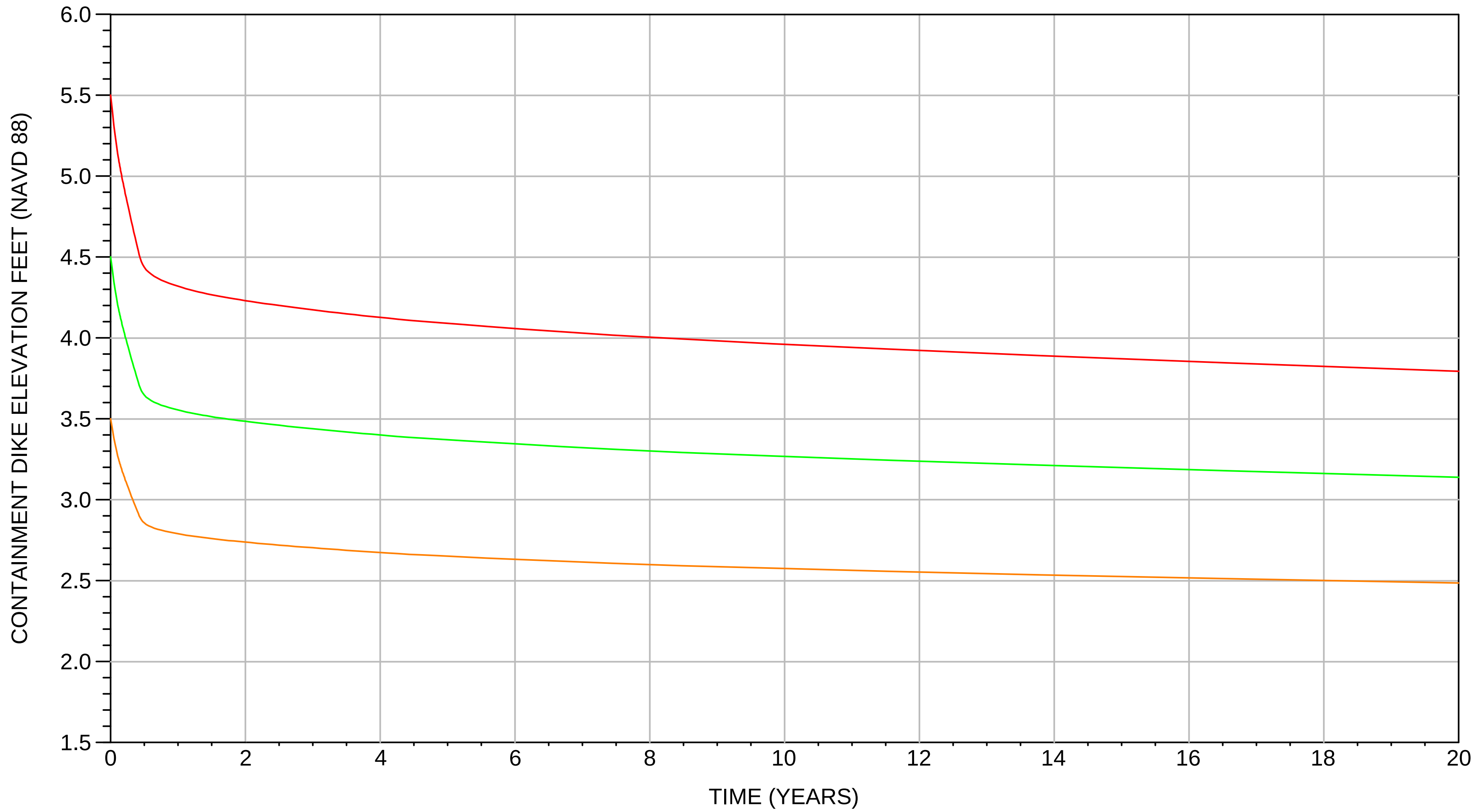
Figure II-□-1



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	4.4	4.3	4.2	4.1	3.9	3.8	3.7
4.5	3.6	3.6	3.4	3.4	3.3	3.1	3.1
3.5	2.8	2.8	2.7	2.6	2.6	2.5	2.5

CONSTRUCTION SETTLEMENT
0.221 FT.
0.175 FT.
0.129 FT.

□ONTAINMENT DI□E
ELEVATION VS. TIME (B-2)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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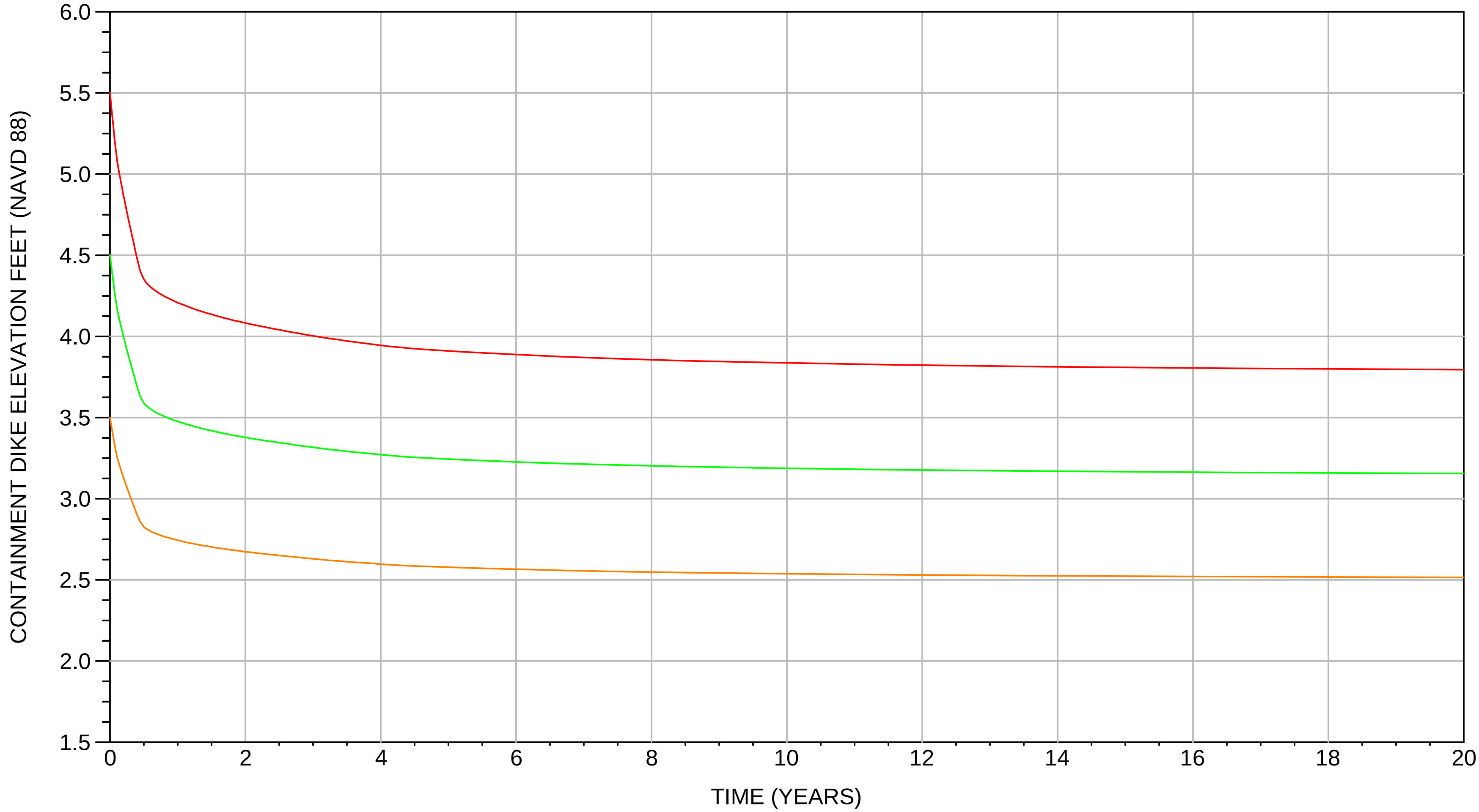
Figure
II-□-2



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	4.3	4.2	4.0	3.9	3.9	3.8	3.8
4.5	3.6	3.5	3.3	3.2	3.2	3.2	3.2
3.5	2.8	2.7	2.6	2.6	2.5	2.5	2.5

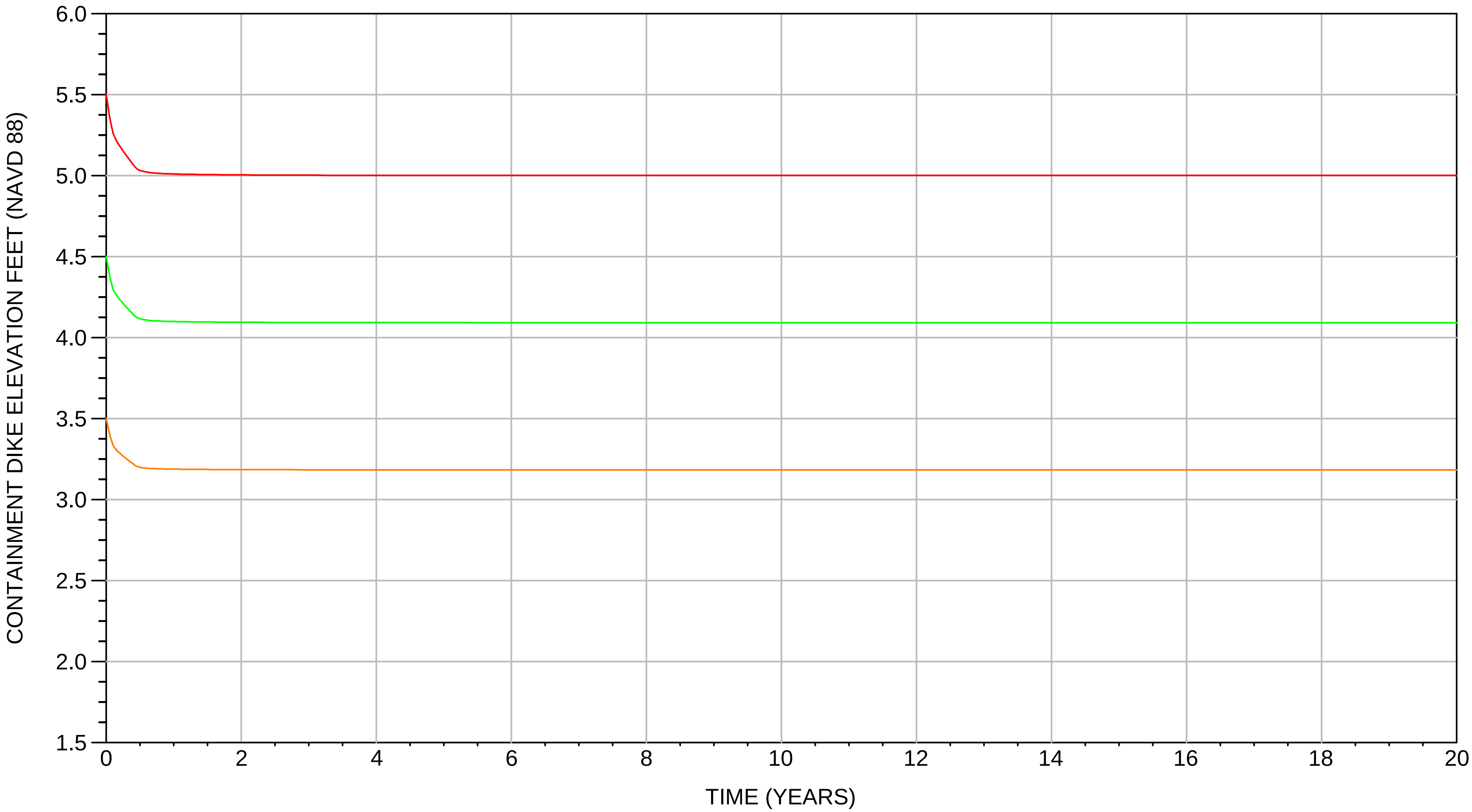
CONSTRUCTION SETTLEMENT
0.221 FT.
0.158 FT.
0.116 FT.

□ONTAINMENT DI□E ELEVATION VS. TIME (B-3)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-□-3



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
4.5	4.1	4.1	4.1	4.1	4.1	4.1	4.1
3.5	3.2	3.2	3.2	3.2	3.2	3.2	3.2

CONSTRUCTION SETTLEMENT
0.053 FT.
0.044 FT.
0.036 FT.

□ONTAINMENT DI□E ELEVATION VS. TIME (B-4)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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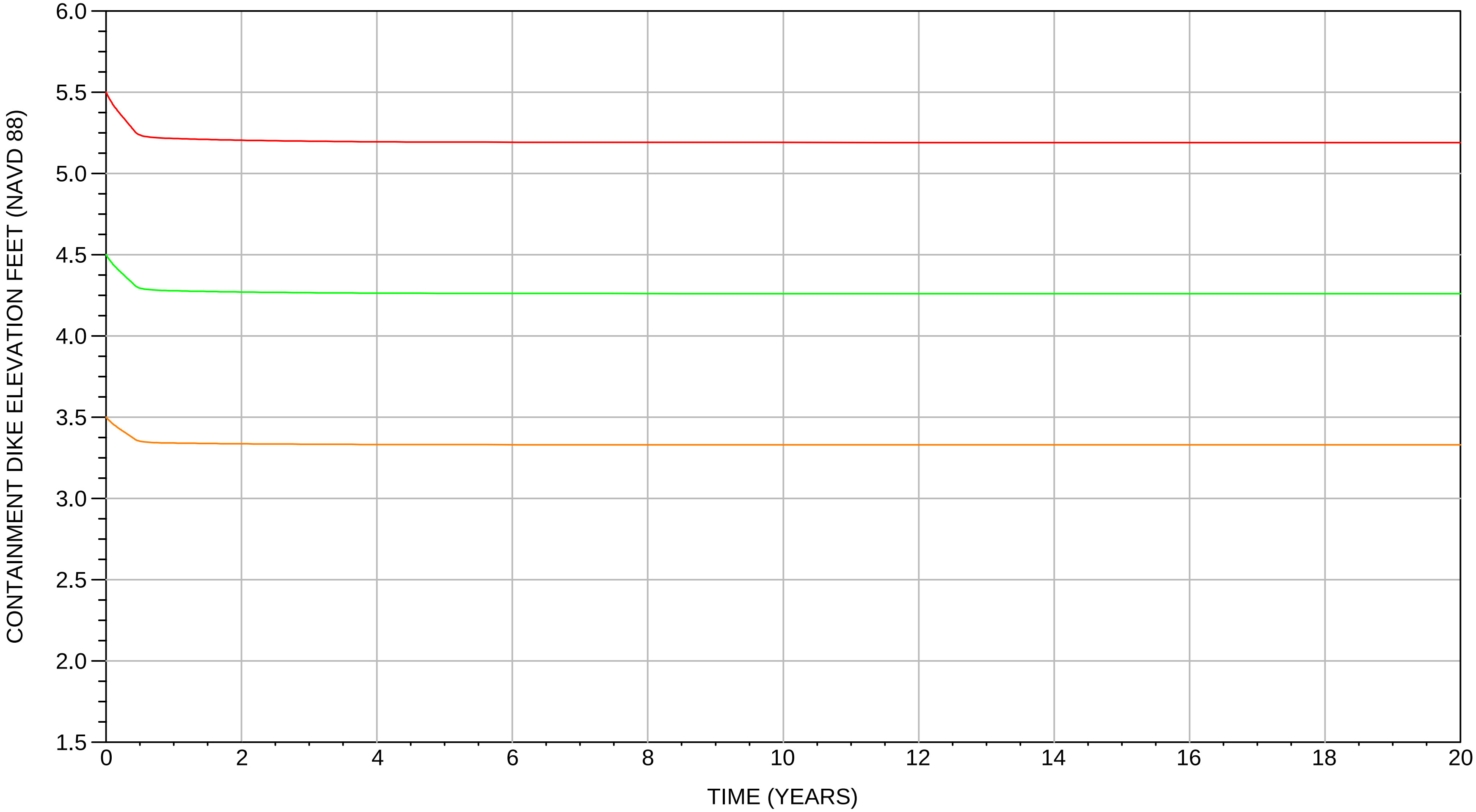
Figure II-□-4



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	5.2	5.2	5.2	5.2	5.2	5.2	5.2
4.5	4.3	4.3	4.3	4.3	4.3	4.3	4.3
3.5	3.3	3.3	3.3	3.3	3.3	3.3	3.3

CONSTRUCTION SETTLEMENT
0.044 FT.
0.034 FT.
0.024 FT.

□ONTAINMENT DI□E ELEVATION VS. TIME (B-5)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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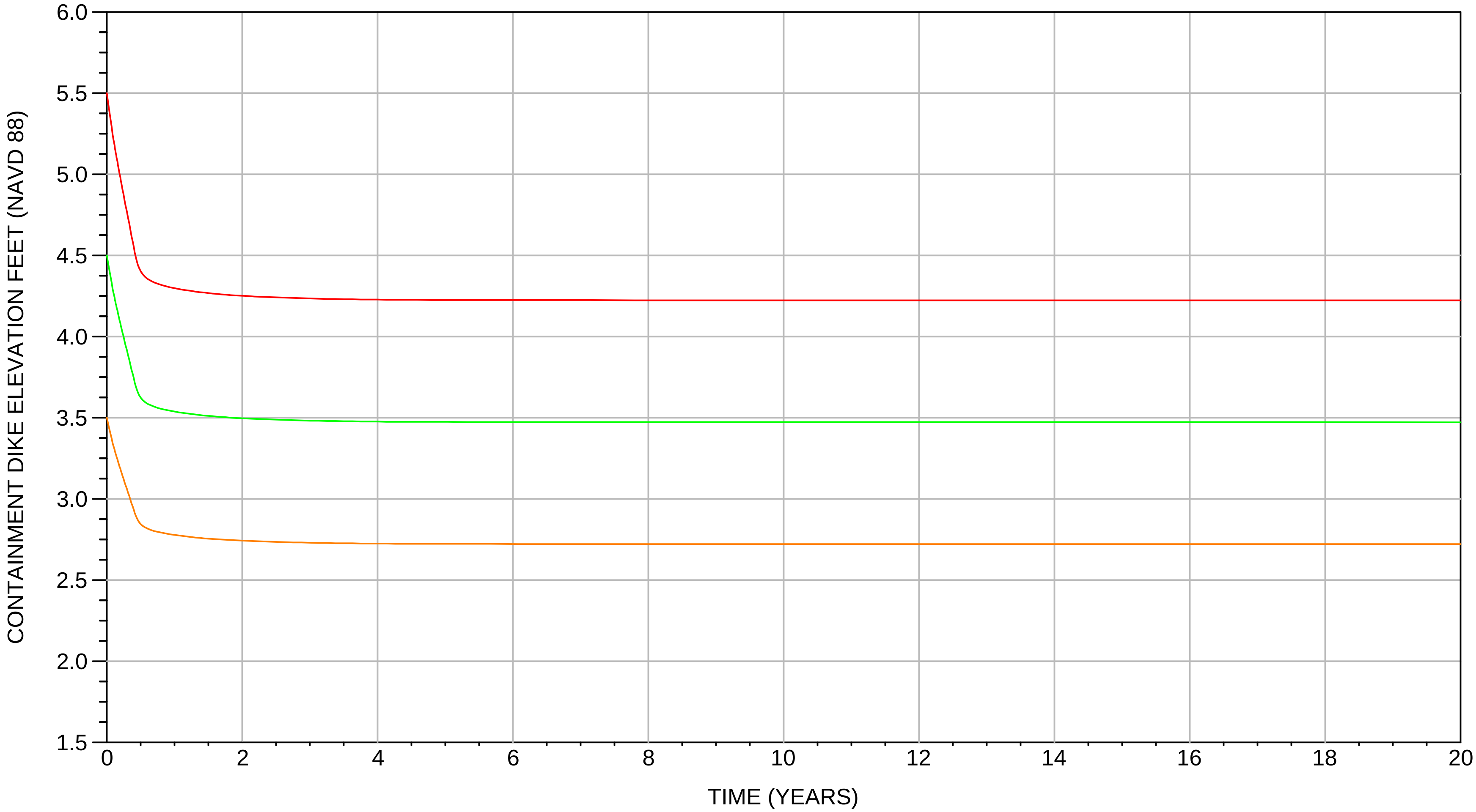
Figure II-□-5



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	4.3	4.3	4.3	4.2	4.2	4.2	4.2
4.5	3.6	3.5	3.5	3.5	3.5	3.5	3.5
3.5	2.8	2.8	2.7	2.7	2.7	2.7	2.7

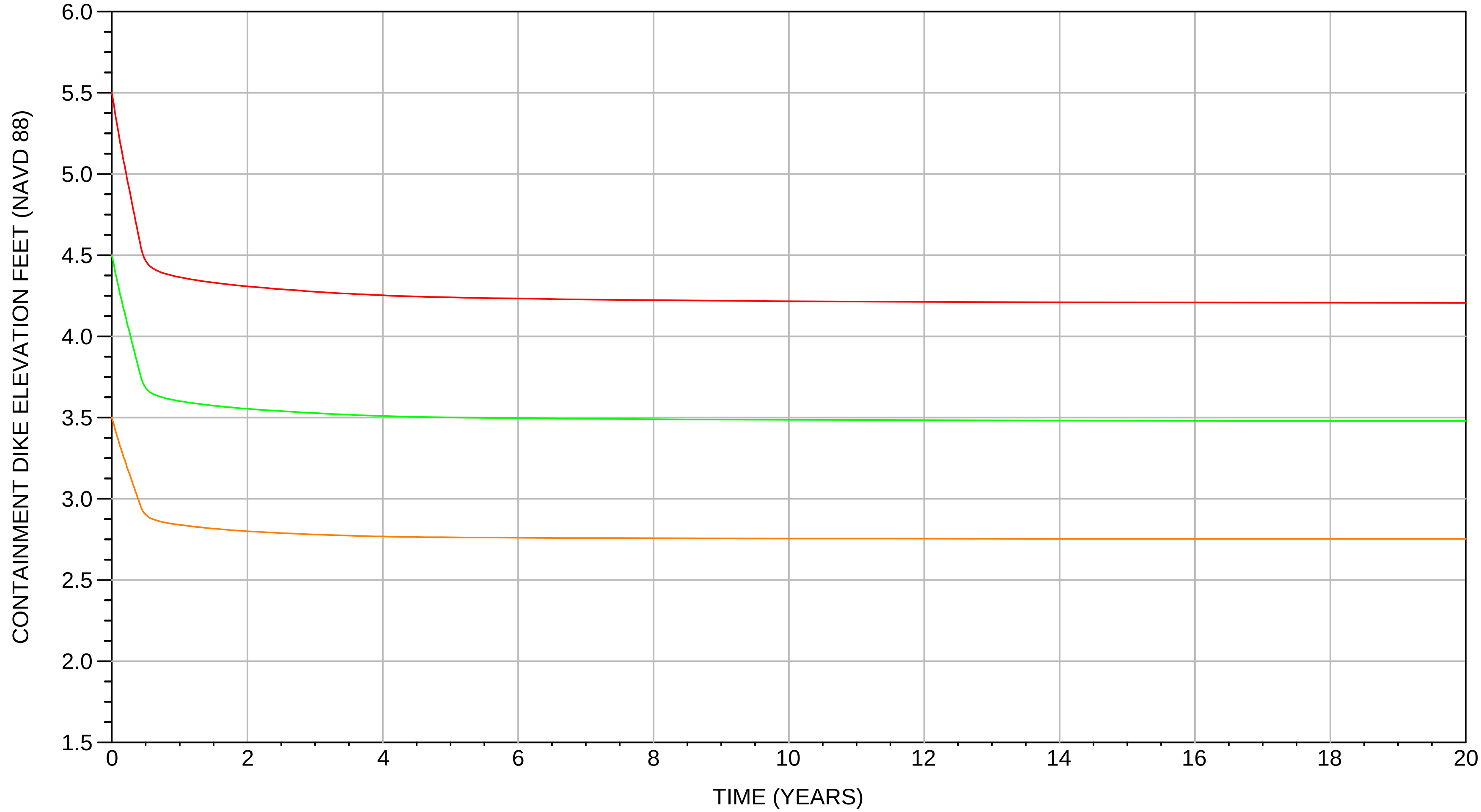
CONSTRUCTION SETTLEMENT
0.067 FT.
0.057 FT.
0.048 FT.

CONTAINMENT DIKE ELEVATION VS. TIME (B-6)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-C-6



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	4.4	4.4	4.3	4.2	4.2	4.2	4.2
4.5	3.6	3.6	3.5	3.5	3.5	3.5	3.5
3.5	2.9	2.8	2.8	2.8	2.8	2.8	2.8

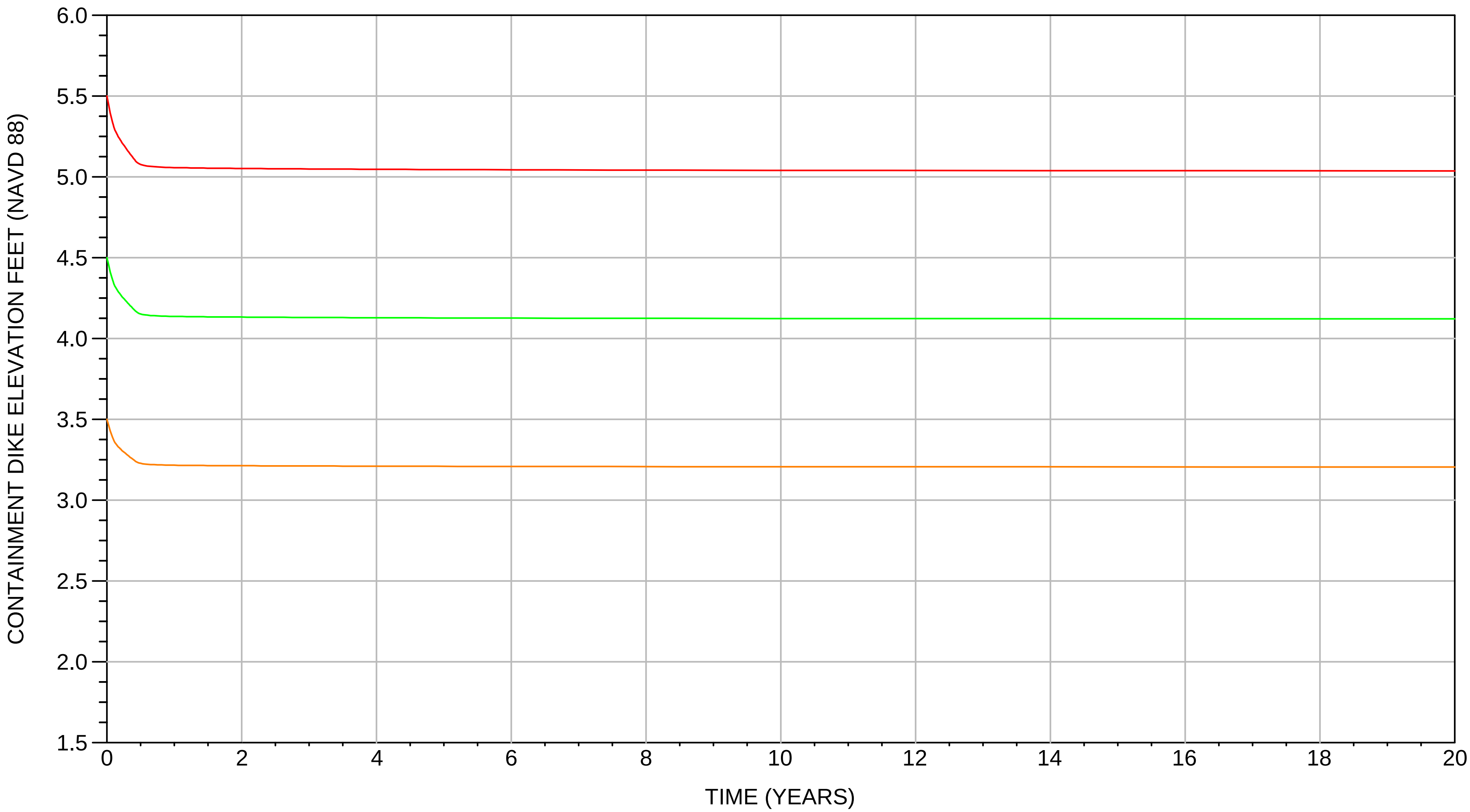
CONSTRUCTION SETTLEMENT
0.071 FT.
0.056 FT.
0.041 FT.

□ONTAINMENT DI□E ELEVATION VS. TIME (B-7)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-□-7



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	5.1	5.1	5.0	5.0	5.0	5.0	5.0
4.5	4.1	4.1	4.1	4.1	4.1	4.1	4.1
3.5	3.2	3.2	3.2	3.2	3.2	3.2	3.2

CONSTRUCTION SETTLEMENT
0.046 FT.
0.039 FT.
0.032 FT.

CONTAINMENT DIKE ELEVATION VS. TIME (B-8)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-□-8

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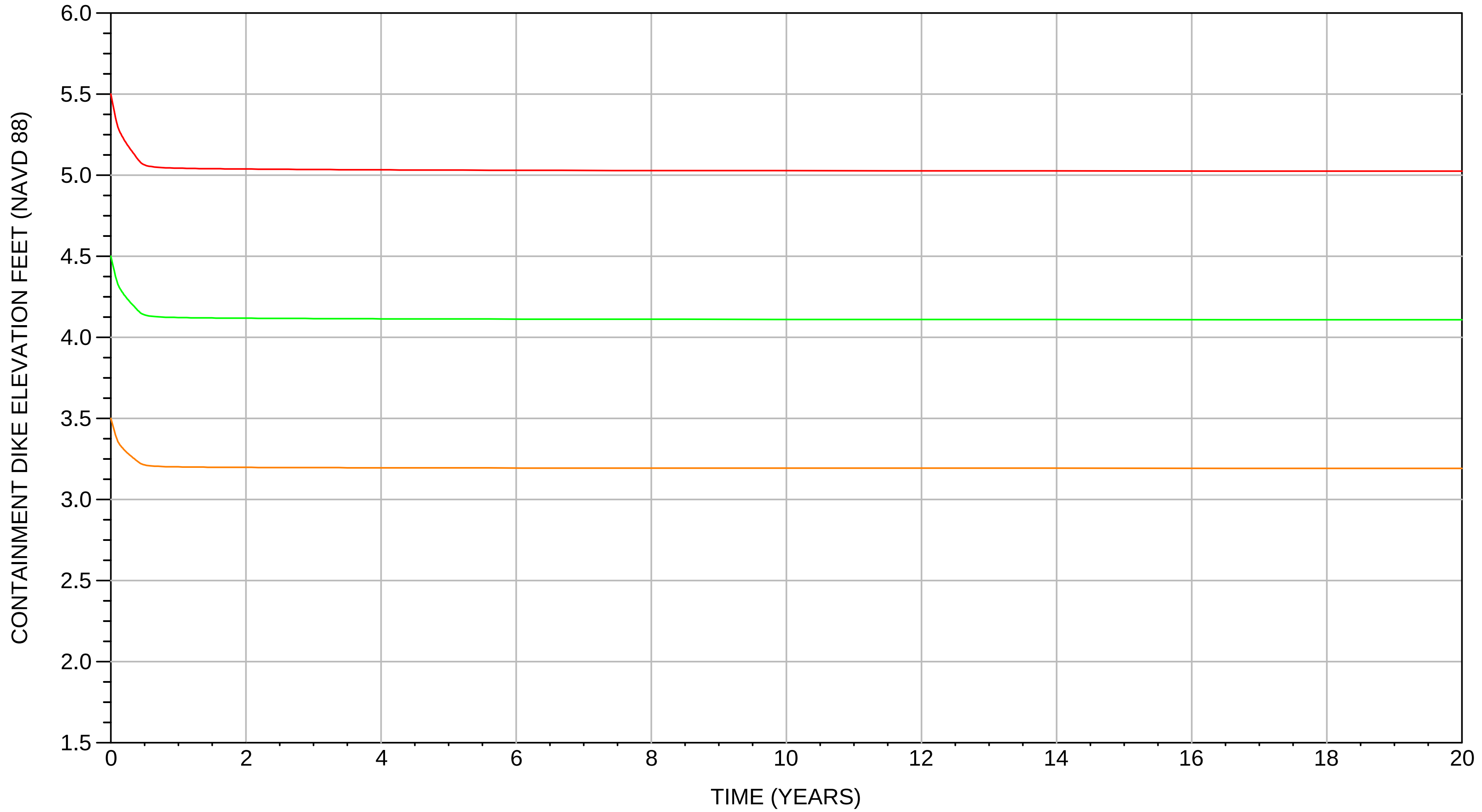

CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
4.5	4.1	4.1	4.1	4.1	4.1	4.1	4.1
3.5	3.2	3.2	3.2	3.2	3.2	3.2	3.2

CONSTRUCTION SETTLEMENT
0.048 FT.
0.041 FT.
0.035 FT.

□ONTAINMENT DI□E
ELEVATION VS. TIME (B-8F)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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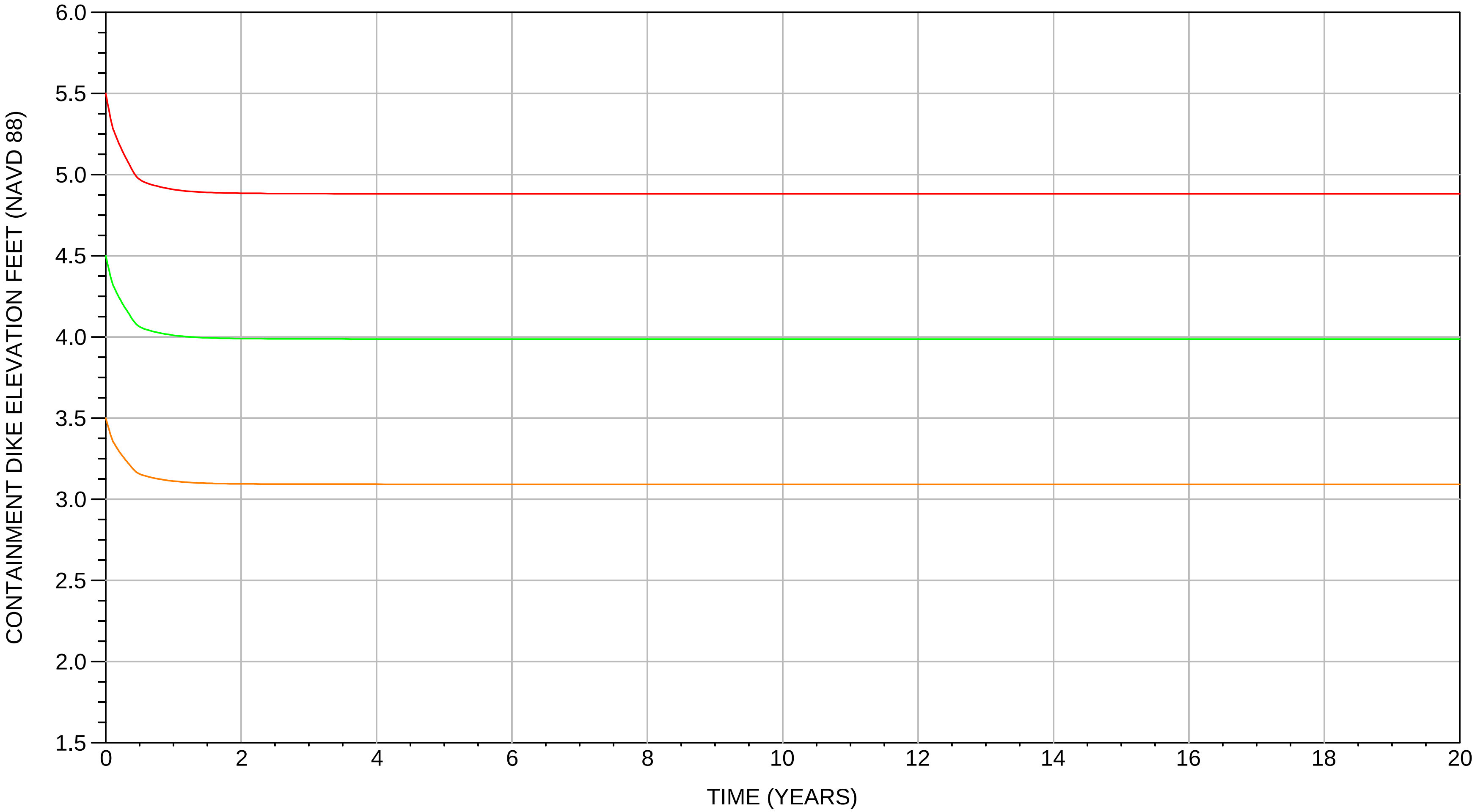
Figure II-□-9



CONTAINMENT DIKE ELEVATION (FEET)							
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	20 YEARS	LONG TERM
5.5	5.0	4.9	4.9	4.9	4.9	4.9	4.9
4.5	4.1	4.0	4.0	4.0	4.0	4.0	4.0
3.5	3.1	3.1	3.1	3.1	3.1	3.1	3.1

CONSTRUCTION SETTLEMENT
0.077 FT.
0.066 FT.
0.055 FT.

□ONTAINMENT DI□E
ELEVATION VS. TIME (B-9)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GeoEngineers

Figure
II-□-1□

APPENDIX II-D
Marsh Fill and Foundation Settlement

Settlement Calculation Approach for the Dredged Fill Marsh Creation Area
Bayou Bonfouca Marsh Creation (PO-104)

1. Settlement parameters were developed for each soil layer for all borings as shown in the parameter spreadsheets provided in this Appendix. Settlement parameters for Borings B-1 through B-5 and B-7 through B-9 were used for settlement estimates for the marsh creation area. Settlement parameters were developed as follows.
    - (a) One consolidation test was done for each of the above mentioned soil borings and the samples for the consolidation tests were selected from varying depths and materials.
    - (b) Consolidation test results were analyzed and graphs were reconstructed to determine compression (C_c), recompression (C_r), and vertical consolidation (C_v) coefficients, initial void ratios (e_0) and maximum past pressures (P_c).
    - (c) Correlations presented in equations 1 through 3 (shown in the spreadsheets in Appendix III-E) were used to calculate e_0 and C_c for all the soil layers.
    - (d) GeoEngineers developed different correlations based on the analyses of the consolidation test results as follows:
        - (i) Void Ratio (e_o) was estimated based on water content test results for various samples and the best fit curve drawn through plotted points from consolidation test results.
        - (ii) Moisture Content (w) Vs. C_v: A best fit curve was drawn through the plotted points from this and other coastal projects and C_v for the soil layers were obtained depending upon the moisture content.
        - (iii) w Vs. C_c: C_c=0.0054*((w*S.G.)-35) was found to provide sufficient accuracy based on the test data for this and other projects for all compressible soil types; C_c was obtained for the soil layers based on the moisture content.
        - (iv) C_r was taken to be 10% of C_c for all cohesive and semi-cohesive soils.
    - (e) For the soil layers without a representative consolidation test, the above mentioned correlations were used to estimate C_c, C_r, C_v, and e_0.
    - (f) Past previous pressure (P_c) were obtained from the consolidation test curves for the soil layers with a representative consolidation test. For other soil layers, the overconsolidation ratio (OCR) was estimated from the equation OCR = (c/(P_0' * 0.22))^(1/0.8). This equation was taken from Figure 7.1 of "Recommended practice for soft ground site characterization," by Charles Ladd and Don DeGroot. P_c was estimated by multiplying the overburden pressure (P_0) by OCR.
    - (g) In cases where P'_0 was greater than P_c, P_0' was used as the maximum past pressure under the assumption that the soil is normally consolidated.
2. In this area, clay shear strength for a normally consolidated soil profile will be approximately 22% of the effective overburden pressure. This relationship is shown as the C/P line on the shear strength profiles. Based on this relationship, it appears that the top 20 feet of the soil profile is over-consolidated throughout the design profiles. For all but two of the borings (B-2 and B-3), the top 40 feet are overconsolidated. Beyond 40 feet depth, some of the layers are still overconsolidated. This affects the settlement parameters selected for design.
3. Due to the broad fill area, the drainage is vertical for all the soil layers. Drainage to the phreatic surface or to the nearest granular soil layer has been considered for these soil layers. The presence of small sand and silt layers within clay was considered in the drainage path evaluation.

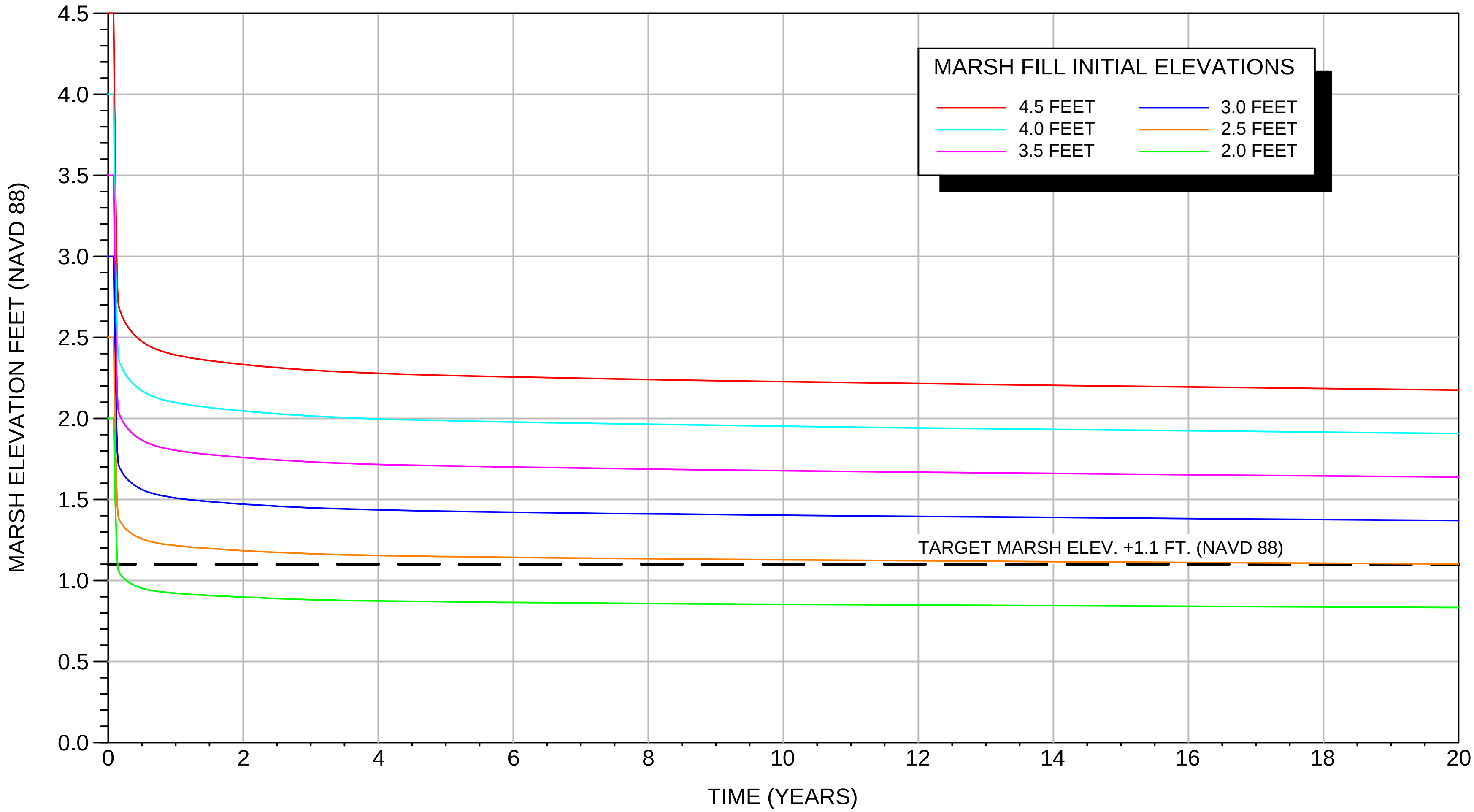
Settlement of the marsh creation area consists primarily of two separate processes: consolidation of the dredged fill and consolidation of the foundation soils. Consolidation of the dredged fill was modeled using PSDDF (Primary Consolidation, Secondary Compression, and Desiccation of Dredged Fill), a program created for the United States Army Corps of Engineers to simulate finite strain consolidation in dredged fill materials. Consolidation of the foundations soils was modeled iteratively using a one-dimensional consolidation program.

To account for the effects of progressive dredged fill densification and submergence below the waterline caused by foundation soil settlement, we re-computed effective vertical stress and corresponding settlement at various time intervals after fill placement. The typical steps at some time = t were as follows:

1. Calculate settlement for soil beneath the fill based on the elapsed time and the effective stress calculated for the application of a single lift of fill and determine the new mudline elevation.
2. From PSDDF determine the change in thickness of the dredged fill to calculate the fill density and the new fill surface elevation. The new fill surface elevation is influenced by both the foundation settlement and the change in fill thickness computed by PSDDF.
3. Re-compute the effective vertical stress based on the new elevations of the fill surface and mudline, and a constant water elevation of 0.8 feet NAVD 88.
4. Use the new lower effective stress to re-compute settlement.

This was repeated at days 45, 60, 90, 180, 365, 1095 (3 years), 1825 (5 years), 3650 (10 years), and 7300 (20 years). Day 1 of the PSDDF calculation was taken as 30 days after the start of filling, allowing 30 days to complete placement of the hydraulic fill. Therefore, day 30 for foundation soil settlement calculations is day 1 for PSDDF calculations.

The sum of the dredged fill settlement and the underlying soil settlement was used to determine the total settlement at the surface of the dredge fill area after filling is complete. Settlement of dredged fill evaluations were performed for a single lift scenario with fill placed in a range of elevations from +2.0 to +4.5 feet. Results were plotted at 0.5-foot intervals (based on initial constructed fill elevation) alongside a line representing the marsh target elevation (+1.1 ft) to establish the best estimate for initial fill elevation.



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.9	0.9	0.9	0.9	0.9	0.8
2.5	1.2	1.2	1.2	1.1	1.1	1.1
3.0	1.6	1.5	1.4	1.4	1.4	1.4
3.5	1.9	1.8	1.7	1.7	1.7	1.6
4.0	2.2	2.1	2.0	2.0	1.9	1.9
4.5	2.5	2.4	2.3	2.3	2.2	2.2

MARSH ELEVATION VS. TIME (B-1)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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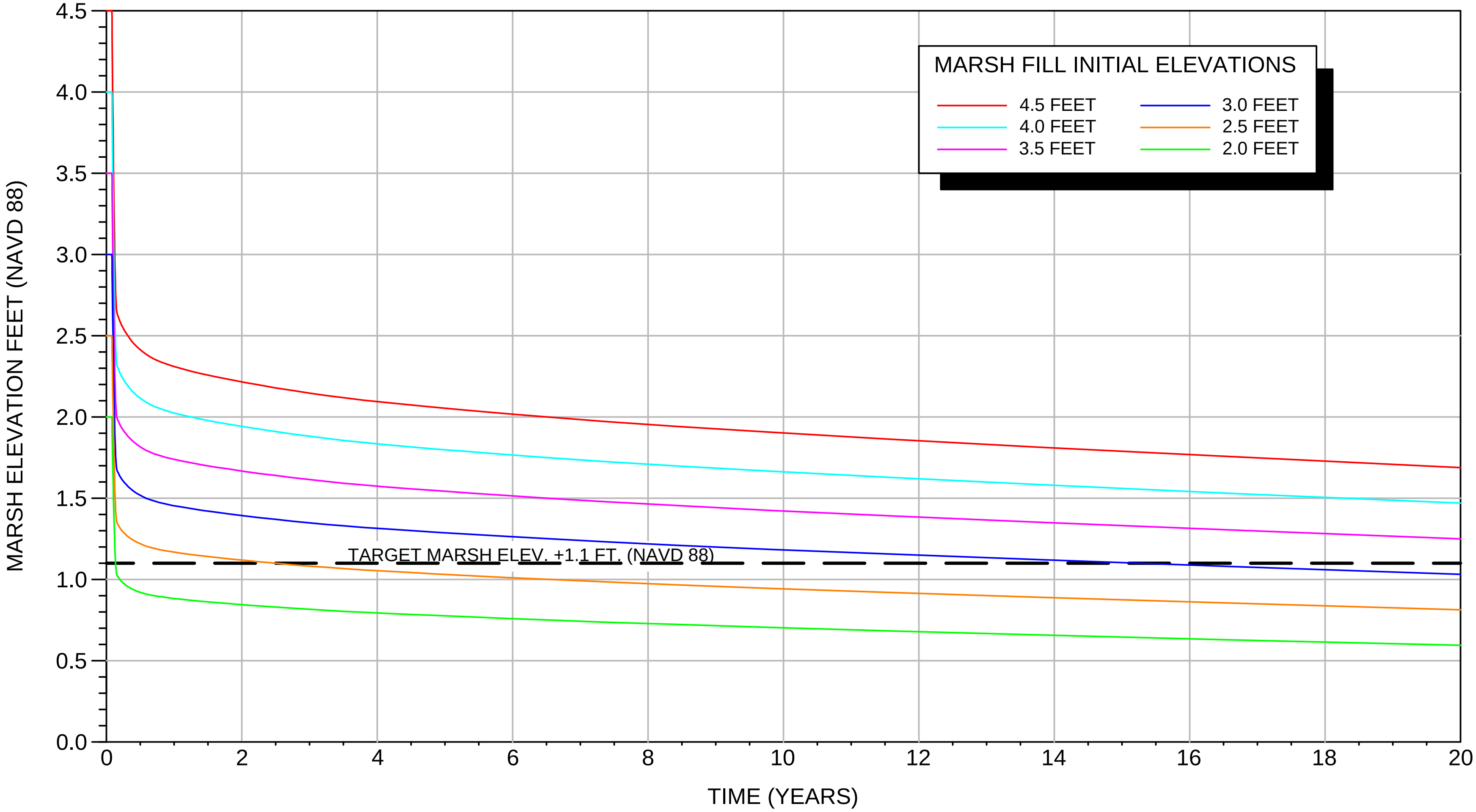
Figure II-D-1



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.9	0.9	0.8	0.8	0.7	0.6
2.5	1.2	1.2	1.1	1.0	0.9	0.8
3.0	1.5	1.4	1.3	1.3	1.2	1.0
3.5	1.8	1.7	1.6	1.5	1.4	1.3
4.0	2.1	2.0	1.9	1.8	1.6	1.5
4.5	2.4	2.3	2.1	2.0	1.9	1.7

MARSH ELEVATION VS. TIME (B-2)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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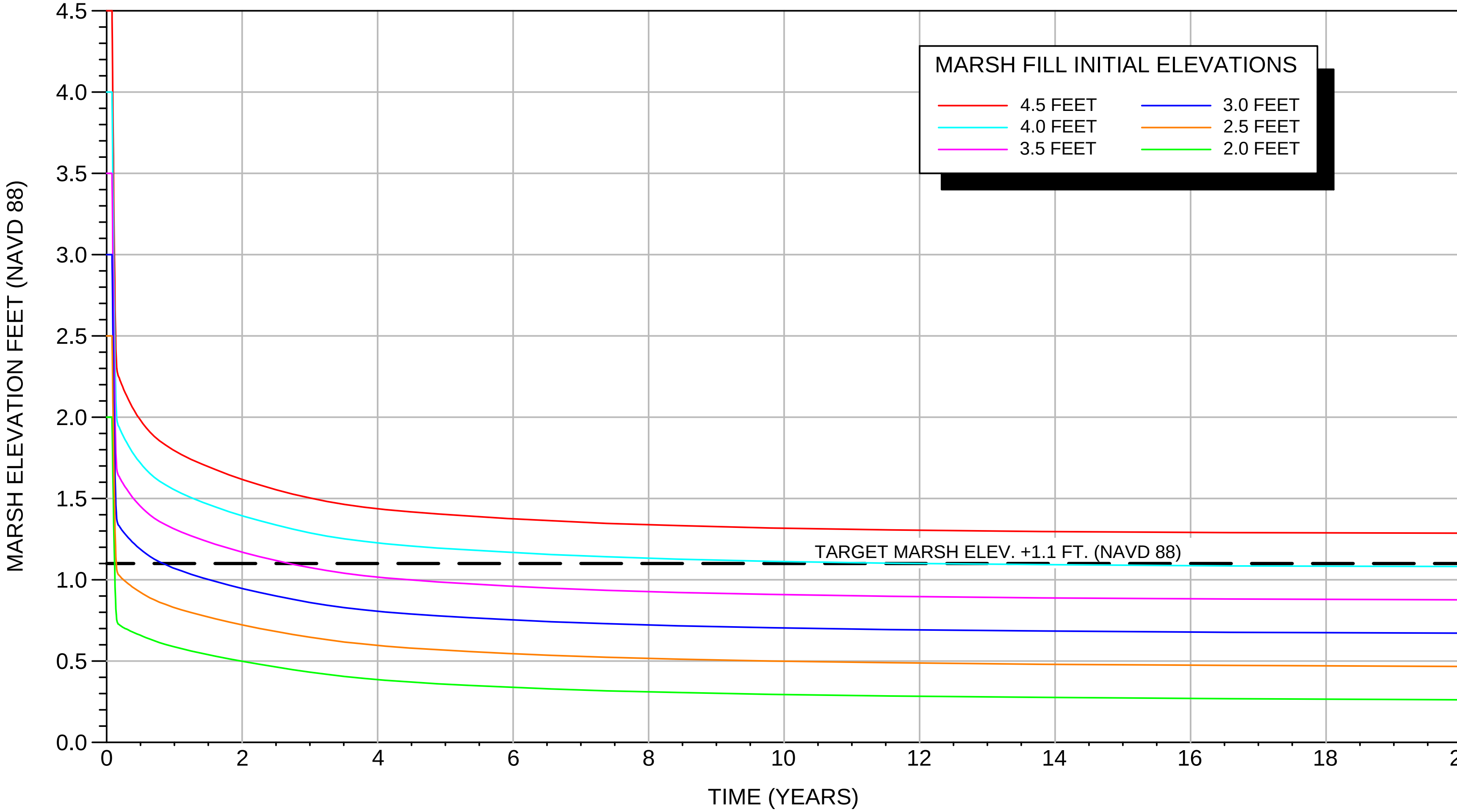
Figure II-D-2



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.7	0.6	0.4	0.3	0.3	0.3
2.5	0.9	0.8	0.6	0.6	0.5	0.5
3.0	1.2	1.0	0.8	0.8	0.7	0.7
3.5	1.4	1.3	1.0	1.0	0.9	0.9
4.0	1.7	1.5	1.3	1.2	1.1	1.1
4.5	2.0	1.8	1.5	1.4	1.3	1.3

MARSH ELEVATION VS. TIME (B-3)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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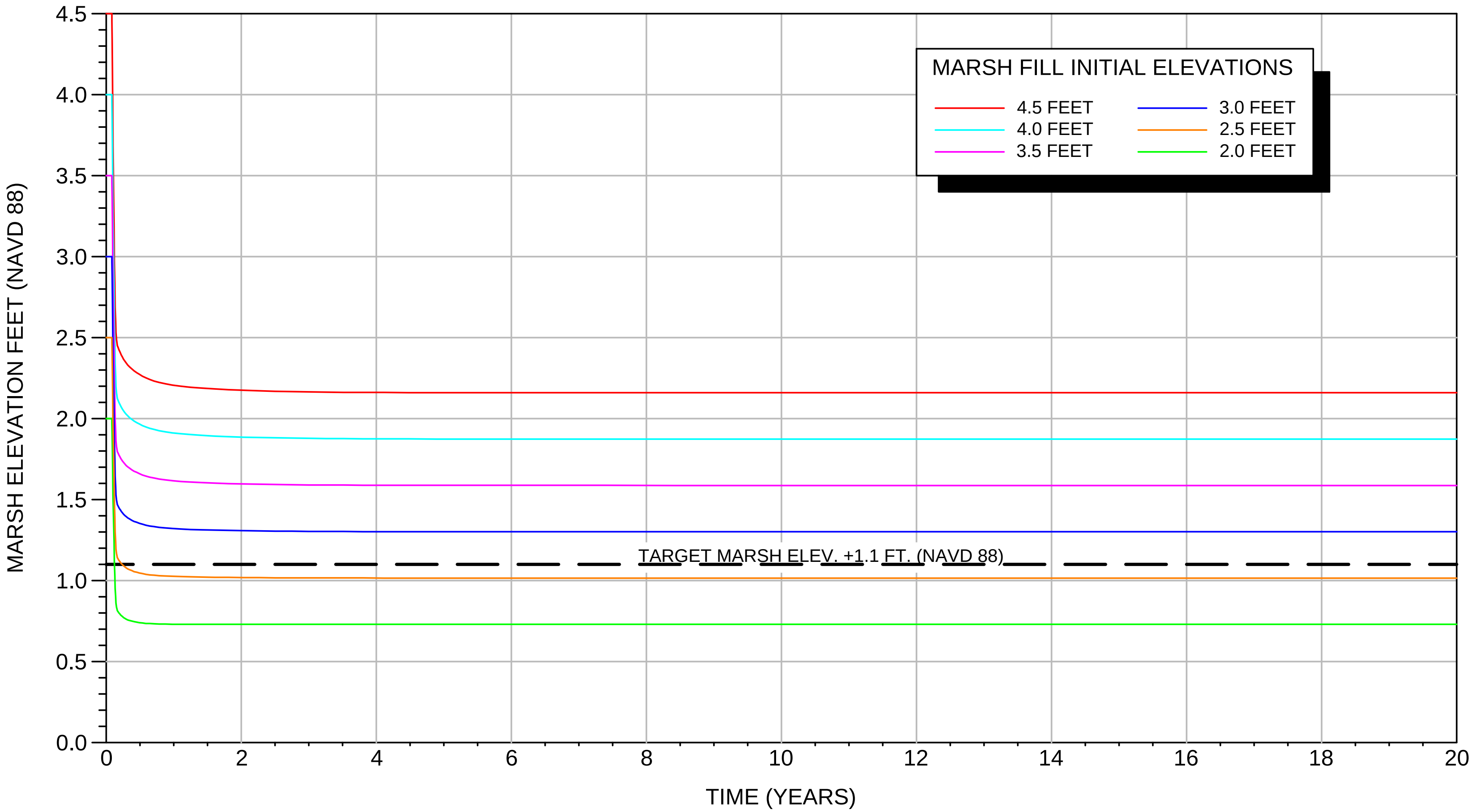
Figure II-D-3



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.7	0.7	0.7	0.7	0.7	0.7
2.5	1.0	1.0	1.0	1.0	1.0	1.0
3.0	1.3	1.3	1.3	1.3	1.3	1.3
3.5	1.6	1.6	1.6	1.6	1.6	1.6
4.0	2.0	1.9	1.9	1.9	1.9	1.9
4.5	2.3	2.2	2.2	2.2	2.2	2.2

MARSH ELEVATION VS. TIME (B-4)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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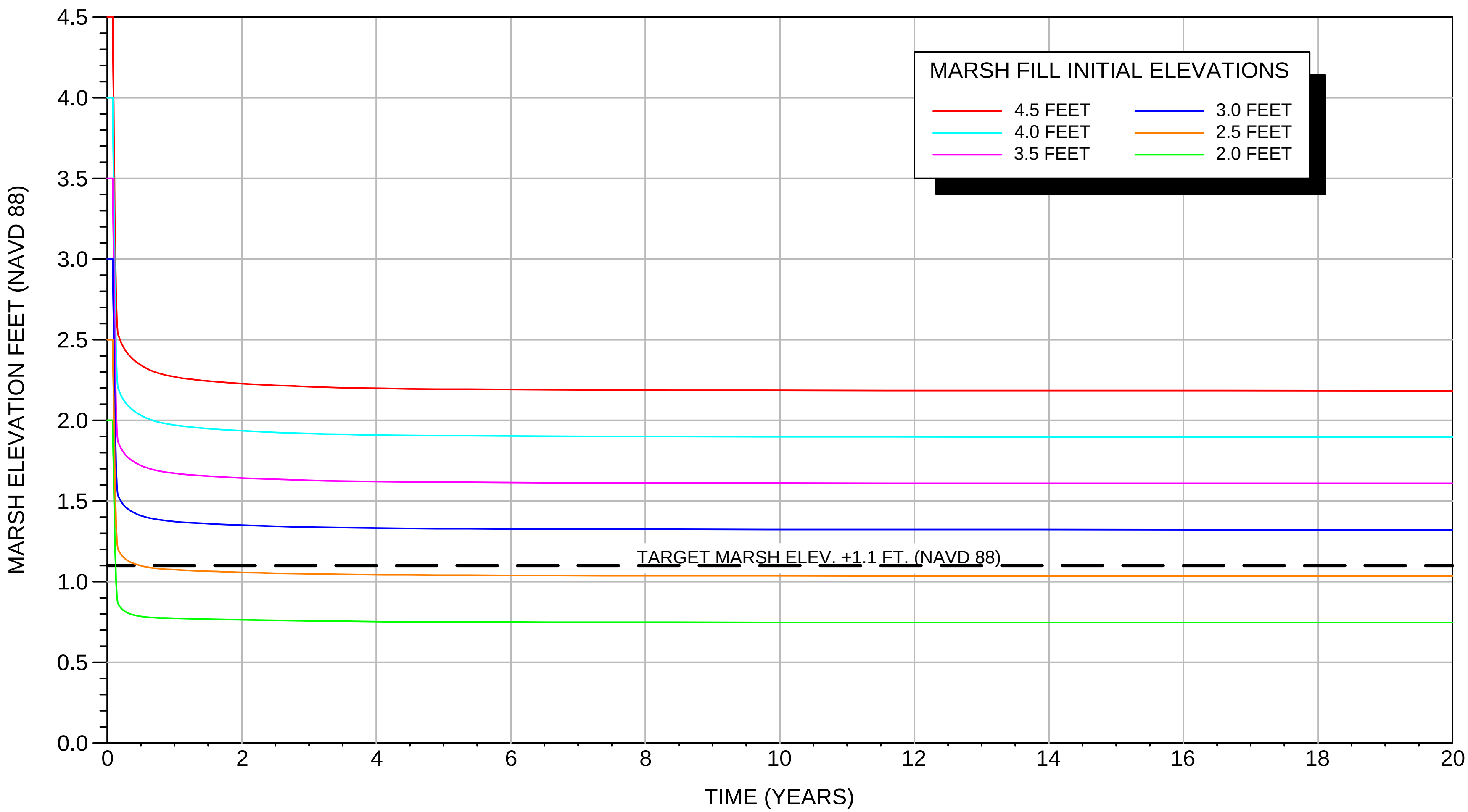
Figure II-D-4



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.8	0.8	0.8	0.7	0.7	0.7
2.5	1.1	1.1	1.0	1.0	1.0	1.0
3.0	1.4	1.4	1.3	1.3	1.3	1.3
3.5	1.7	1.7	1.6	1.6	1.6	1.6
4.0	2.0	2.0	1.9	1.9	1.9	1.9
4.5	2.3	2.2	2.2	2.2	2.2	2.2

MARSH ELEVATION VS. TIME (B-5)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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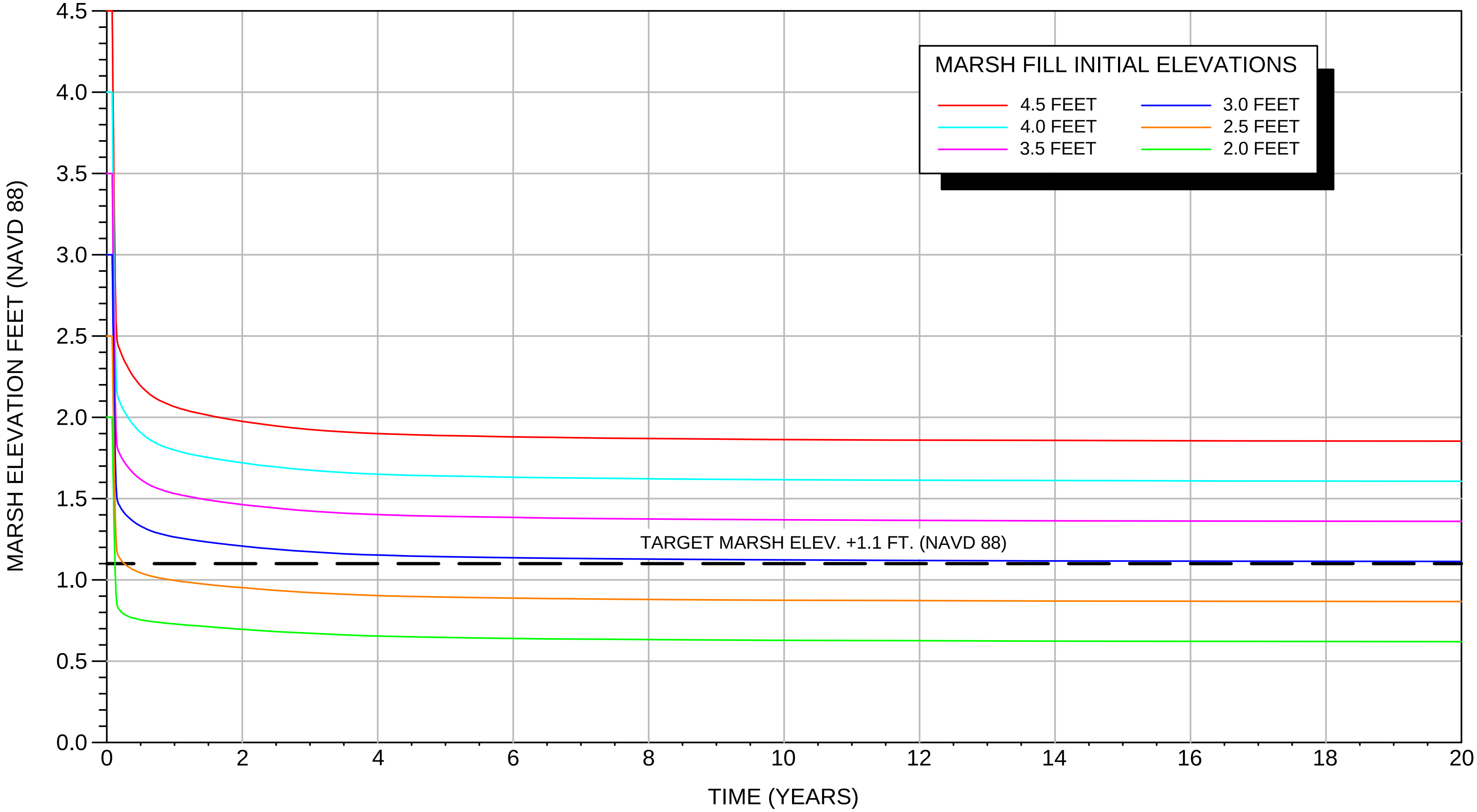
Figure II-D-5



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.8	0.7	0.7	0.6	0.6	0.6
2.5	1.0	1.0	0.9	0.9	0.9	0.9
3.0	1.3	1.2	1.2	1.1	1.1	1.1
3.5	1.6	1.5	1.4	1.4	1.4	1.4
4.0	1.9	1.8	1.7	1.6	1.6	1.6
4.5	2.2	2.0	1.9	1.9	1.9	1.9

MARSH ELEVATION VS. TIME (B-7)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

GEOENGINEERS

Figure II-D-6

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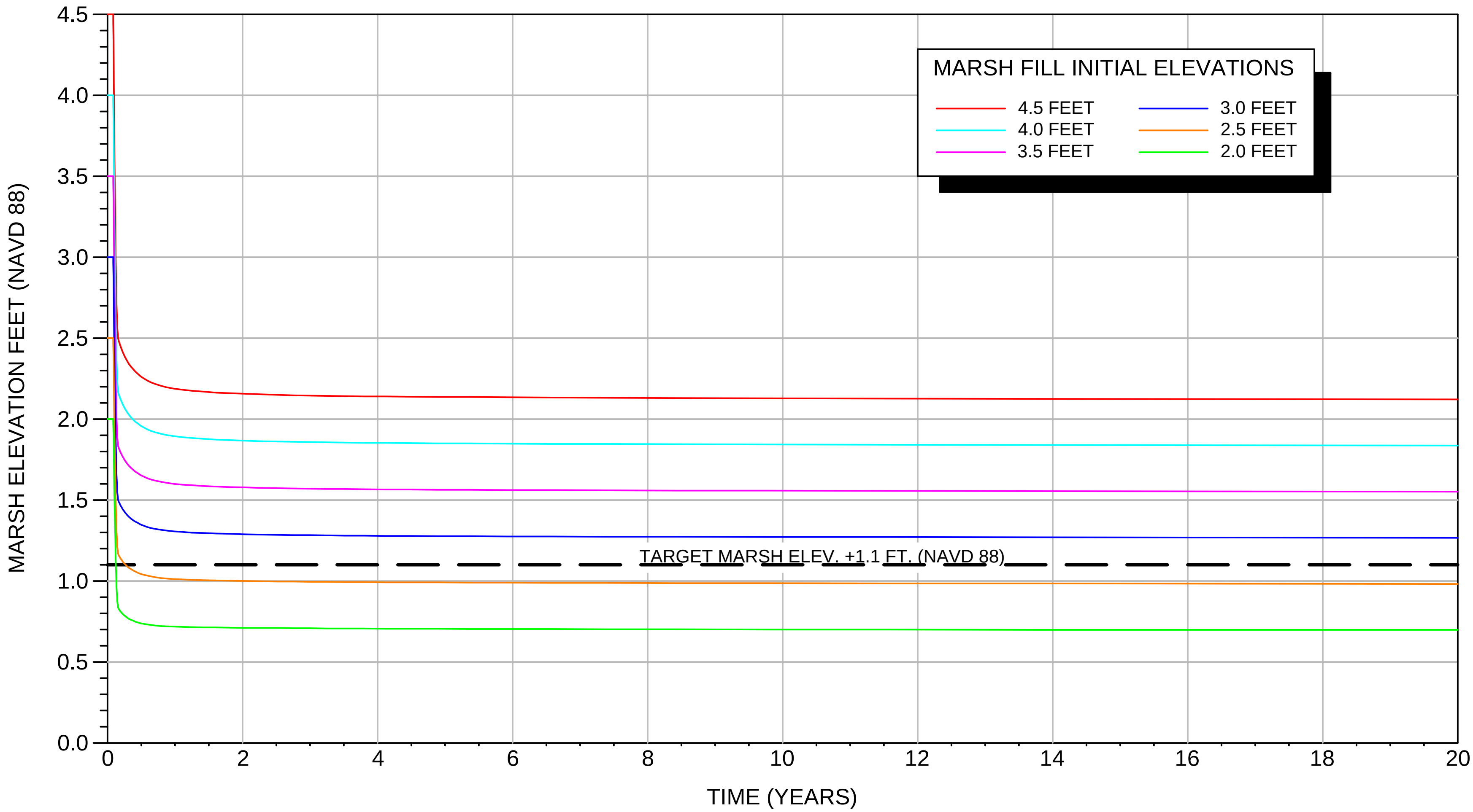

MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.7	0.7	0.7	0.7	0.7	0.7
2.5	1.0	1.0	1.0	1.0	1.0	1.0
3.0	1.3	1.3	1.3	1.3	1.3	1.3
3.5	1.6	1.6	1.6	1.6	1.6	1.6
4.0	1.9	1.9	1.9	1.8	1.8	1.8
4.5	2.2	2.2	2.1	2.1	2.1	2.1

MARSH ELEVATION VS. TIME (B-8)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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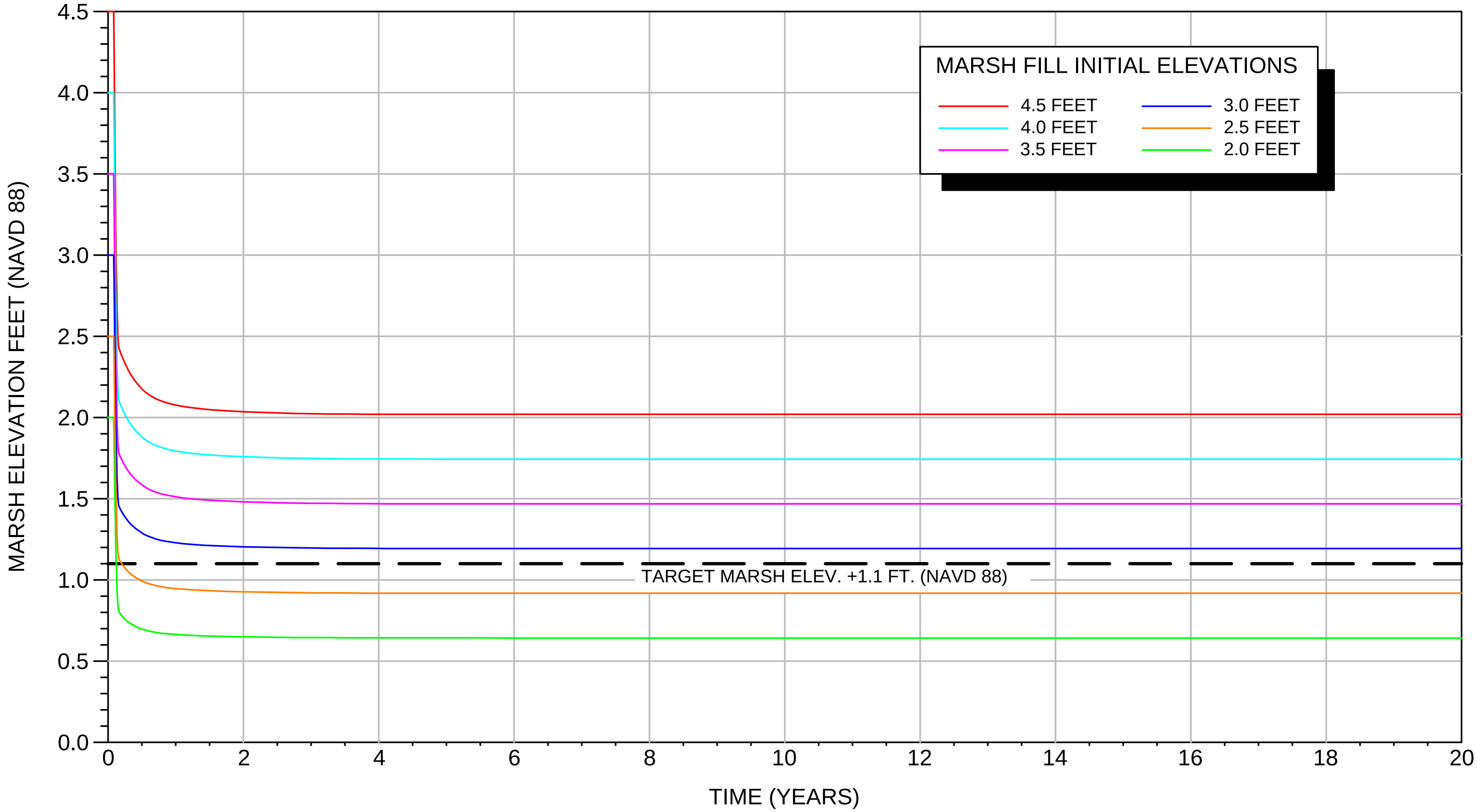
Figure II-D-7



MARSH ELEVATION (FEET)						
0 DAYS	6 MONTHS	1 YEAR	3 YEARS	5 YEARS	10 YEARS	LONG TERM
2.0	0.7	0.7	0.6	0.6	0.6	0.6
2.5	1.0	0.9	0.9	0.9	0.9	0.9
3.0	1.3	1.2	1.2	1.2	1.2	1.2
3.5	1.6	1.5	1.5	1.5	1.5	1.5
4.0	1.9	1.8	1.7	1.7	1.7	1.7
4.5	2.2	2.0	2.0	2.0	2.0	2.0

MARSH ELEVATION VS. TIME (B-9)

Bayou Bonfouca Marsh Creation Project (PO-104)
St. Tammany Parish, Louisiana

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Figure II-D-8

APPENDIX II-E
Report Limitations and Guidelines for Use

REPORT LIMITATIONS AND GUIDELINES FOR USE

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for State of Louisiana – Office of Coastal Protection and Restoration and their authorized agents and regulatory agencies. The information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. No party other than State of Louisiana – Office of Coastal Protection and Restoration may rely on the product of our services unless we agree to such reliance in advance and in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. Use of this report is not recommended for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Bayou Bonfouca Marsh Creation Project (PO-104) in St. Tammy Parish, Louisiana. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, we recommend that GeoEngineers be given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an informed opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

The construction recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers is unable to assume responsibility for the recommendations in this report without performing construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help prevent costly problems associated with unanticipated subsurface conditions, we recommend giving contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report's accuracy is limited. In addition, encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) are less exact than other engineering and natural science disciplines. Without this understanding, there may be expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

Have we delivered World Class Client Service?

Please let us know by visiting **www. geoengineers.com/feedback**.

GeoEngineers