REPORT OF

GEOTECHNICAL INVESTIGATION
BARATARIA BARRIER ISLAND
RESTORATION COMPLEX
PROJECT BA-38
CHALAND AND PELICAN HEADLANDS
PLAQUEMINES PARISH, LOUISIANA

FOR

LOUISIANA DEPARTMENT OF
NATURAL RESOURCES
BATON ROUGE, LOUISIANA

AND

C-K ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Geotechnical, Environmental & Materials Consultants

Baton Rouge, LA • Lake Charles, LA • New Orleans, LA

STE
Soil Testing Engineers, Inc.
316 HIGHLANDIA DRIVE (70810) • P.O. BOX 83710 (70884) • BATON ROUGE, LOUISIANA
PHONE (225) 752-4790 • FAX (225) 752-4878 • www.steofla.com

GORDON P. BOUTWELL, JR., Ph.D.
CHING N. TSAI, Ph.D.
CHAD M. POCHE, MS
CHARLES S. HEDGES, MS
KENNETH A. FLUKER, MS
STEVE M. MEUNIER
KELLIE T. MCNAMARA
BEYONG SEOCK LIM, Ph.D.
REGISTERED PROFESSIONAL ENGINEERS

October 30, 2003

Louisiana Department of Natural Resources
c/o C-K Associates, Inc.
17170 Perkins Road
Baton Rouge, Louisiana 70810

Attn: Mr. Brant Richard, P.E.

Re: Geotechnical Services
DNR Contract No. 2503-02-29
Engineering Assistance for Coastal Restoration Projects
Barataria Barrier Island Restoration Complex
Chaland and Pelican Headlands
Project BA-38
Plaquemines Parish, Louisiana
STE File: 03-1114

Gentlemen:

Soil Testing Engineers, Inc. (STE) has completed the geotechnical investigation for this project and is pleased to submit the findings of the investigation together with the resulting evaluations and recommendations. Details are presented in the attached report.

Should you have any questions concerning this report, please contact this office. We appreciate the opportunity to serve you on this project, and look forward to working with you again in the future.

Sincerely,
Soil Testing Engineers, Inc.

Dr. Gordon P. Boutwell, P.E.
Senior Consultant

Ching Nien Tsai, Ph.D., P.E.
Chief Engineer

STATE OF LOUISIANA
CHING-NIEN TSAI
REG. No. 23092
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

GPB/CNT/lf

GEOTECHNICAL, ENVIRONMENTAL & MATERIALS CONSULTANTS
LAKE CHARLES, LOUISIANA • (337) 474-1340 METAIRIE, LOUISIANA • (504) 835-2593

STE
Soil Testing Engineers, Inc.

REPORT OF GEOTECHNICAL INVESTIGATION BARATARIA BARRIER ISLAND RESTORATION COMPLEX PROJECT BA-38 PLAQUEMINES PARISH, LOUISIANA

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REPORT OF GEOTECHNICAL INVESTIGATION BARATARIA BARRIER ISLAND RESTORATION COMPLEX PROJECT BA-38 PLAQUEMINES PARISH, LOUISIANA

EXECUTIVE SUMMARY

The principal findings of this investigation are summarized below for convenience. Details are contained in the main body of this report, plus its Appendix.

A - CHALAND HEADLAND

A.1 **Project.** The Chaland Headland portion of the project will raise some 590 acres by providing an encircling levee totaling some 6 miles in length, then filling the encircled area. The south (gulf) side levee location has not yet been fixed.

A.2 **Scope of Work.** This consisted of drilling 10 borings in the construction area plus two more in the borrow area, plus laboratory testing, and engineering analyses to determine stability of slopes, settlement amounts and rates, sedimentation times for the area fill, and cut/fill ratios.

A.3 **Subsurface Conditions.** All of the soils mentioned are of Holocene (Recent) origin. In the construction area, about 3% of the soils to -25 feet NAVD are PT or OH, 63% are the more granular SM, SC, and ML, and 34% the cohesive CH and CL types. Below that level, about half is granular and half cohesive. The cohesive soils are relatively weak and compressible.

A.4 **Slope Stability.** Side slopes of 1(V):4(H) can be used for levees having up to 3 feet of freeboard, and side slopes of 1(V):6(H) can be used for those having up to 6 feet of freeboard. These slopes maintain a safety factor of at least 1.3 against failure.

A.5 **Levee Settlements.** Settlements of the levee are composed of weight-induced consolidation on the foundation soils, self-weight or internal settlement (negligible), and geologic subsidence. The amounts of movement depend on the levee freeboard and water depth. However, the net long-term settlements without geologic subsidence are on the order of 10% of the total levee height (freeboard plus water). Geologic subsidence adds about 6 inches over the 20-year project life.

A.6 **Dewatering Time.** About 2/3 of the hydraulically placed area fill will settle out of suspension in a few days. The majority of the remainder should settle out in 1 to 2 months.

A.7 **Deposition Area Settlements.** Unlike the levee settlements, self-weight consolidation also matters for the area fill. The total long-term settlements without geologic subsidence are about 20 to 25% of the as-completed fill thickness. Geologic subsidence adds about 6 inches over the 20-year project life.

A.8 Cut/Fill Ratios. For the levees, 1.3 to 1.5 cubic yards of cut will produce 1.0 cubic yard of in-place material. In the case of the area fill, this reduces to about 1.1 cubic yards of cut to achieve 1.0 cubic yard of in-place fill.

B - PELICAN HEADLAND

B.1 Project. The Pelican Headland portion of the project will raise some 630 acres by providing an encircling levee totaling some 6 miles in length, then filling the encircled area. The south (gulf) side levee location has not yet been fixed.

B.2 Scope of Work. This consisted of drilling 10 borings in the construction area plus two more in the borrow area, plus laboratory testing, and engineering analyses to determine stability of slopes, settlement amounts and rates, sedimentation times for the area fill, and cut/fill ratios.

B.3 Subsurface Conditions. All of the soils mentioned are of Holocene (Recent) origin. Most of the soils are of the cohesive types; little sand or silt was encountered. In general, the soils from mudline to around -10 feet NAVD are very soft Organic Clays (OH) and Peat (PT). Below that level are predominately very soft to soft Clays (CH), whose strength increases somewhat with depth.

B.4 Slope Stabilities. The soils underlying the Pelican Headland area are weaker than those in the Chaland area. In general, side slopes of 1(V):4(H) will be acceptable for levees with up to 3 feet of freeboard, except for the South and North Levees. There, side slopes of 1(V):8(H) are indicated for levees not on the beach ridge. Reference must be made to Table 3.2-1 for design.

B.5 Levee Settlements. In general, the weight-related settlements will range from 40 to 50% of the total height (freeboard plus water depth) for the lower levees, i.e., those with total heights up to about 6 feet. This drops to about 20-25% of the total height for taller levees. Again, geologic subsidence adds about 6 inches of "settlement" over the 20-year life of the project.

B.6 Dewatering Time. Due to the high proportion of very fine (clay-sized) particles, the area fill will require some 2 to 4 weeks to essentially complete its dewatering.

B.7 Deposition Area Settlements. The total long-term weight-related settlements will be some 45 to 60% of the as-completed area fill thickness. Again, geologic subsidence adds about 6 inches of "settlement" over the 20-year life of the project.

B.8 Cut/Fill Ratios. For the levees, 1.5 to 1.8 cubic yards of cut will produce 1.0 cubic yard of in-place material. In the case of the area fill, this reduces to about 1.3 cubic yards of cut to achieve 1.0 cubic yard of in-place fill.

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REPORT OF GEOTECHNICAL INVESTIGATION BARATARIA BARRIER ISLAND RESTORATION COMPLEX PROJECT BA-38 PLAQUEMINES PARISH, LOUISIANA

The findings of this investigation, together with the analyses and conclusions based on them, are discussed below. Following the Introduction section, the Chaland and Pelican Headlands are discussed separately. The field and laboratory investigations are described in Appendix A.

1.0 INTRODUCTION

1.1 OVERALL DESCRIPTIONS

1.1.1 General. The Barataria Barrier Island Restoration Complex Project covered by this investigation consists of two parts: the Chaland Headland area and the Pelican Headland area. Both will consist of encircling the existing headlands with levees, which will retain hydraulic fill used to build up the headlands to resist erosion and assist in dune and marsh creation. The general location of the project is illustrated on Figure G-1.

Information on land loss rates in this area was available from studies by Penland (2003). They indicate that the shoreline at Scofield Bayou in the project area averaged about 10 feet per year for the period 1884-1985, but increased to 21 feet per year for the period 1985-2002. Geologic subsidence in this area was furnished by LDNR as about 6 inches in 20 years.

The objective of this project is to reduce erosion rates in the project area and create dune and marsh habitat. The project consists of construction of a beach berm, dune platform and marsh platform in both the Pass La Mer to Chaland Pass and the Pelican Island areas. Construction of the features is to be completed using a hydraulic dredge for material placement and bucket dredge for containment. The various project features include protection of barrier islands from an encroaching shoreline by reducing the rates of erosion along the western end and creating more land along the northern shoreline. Specifics of this project involve construction of earthen levees and filling the areas between the earthen levees and the existing barrier islands. At this time, the gulf side (S) levees may be built over the existing dune line or may be built just offshore. No detailed survey information on surface topography is currently available. The dredge borrow areas are located at Quatre Bayou and the Empire & Scofield Borrow areas.

1.1.2 Chaland Headland Area. This area is illustrated on Figure C-1. It is centered at roughly N29°-18'-46.6", W89°-45'-36.2", lying between Pass La Mer and Pass Chaland. The project area is roughly 2.9 miles E-W and 0.2 to 0.5 miles N-S. There will be approximately 3.0 miles of gulfside (S) levee and 3.5 miles of marshside (N) levee. The total area enclosed is roughly 590 acres.

1.1.3 Pelican Headland Area. This area is illustrated on Figure P-1. It is centered at roughly N29°-15'-09", W89°-35'-10". The project area is roughly 2.5 miles E-W and 0.4 to 0.5 miles N-S. There will be approximately 2.6 miles of gulfside (S) levee, 0.6 miles of levee along Bayou Fontanelle on the W end, 0.4 miles of levee along Scofield Bayou on the E end, and 2.3 miles of marshside (N) levee. The total area enclosed is roughly 630 acres.

1.2 SCOPE OF WORK

STE's scope of work consisted of the following items:

- For the Chaland Headland area, drill twelve soil borings (two for the borrow area) to depths ranging from 20 to 70 feet.
- For the Pelican Headland area, drill twelve soil borings (two for the borrow area) to depths ranging from 20 to 80 feet. Two borrow pit borings originally included (S-1 and S-2) were deleted from the project.
- Perform laboratory tests to determine classification, strength, and compressibility characteristics for engineering analyses.
- Perform slope stability and settlement analyses for the proposed levees.
- Analyze settlements which will be caused by placement of the hydraulic fill.

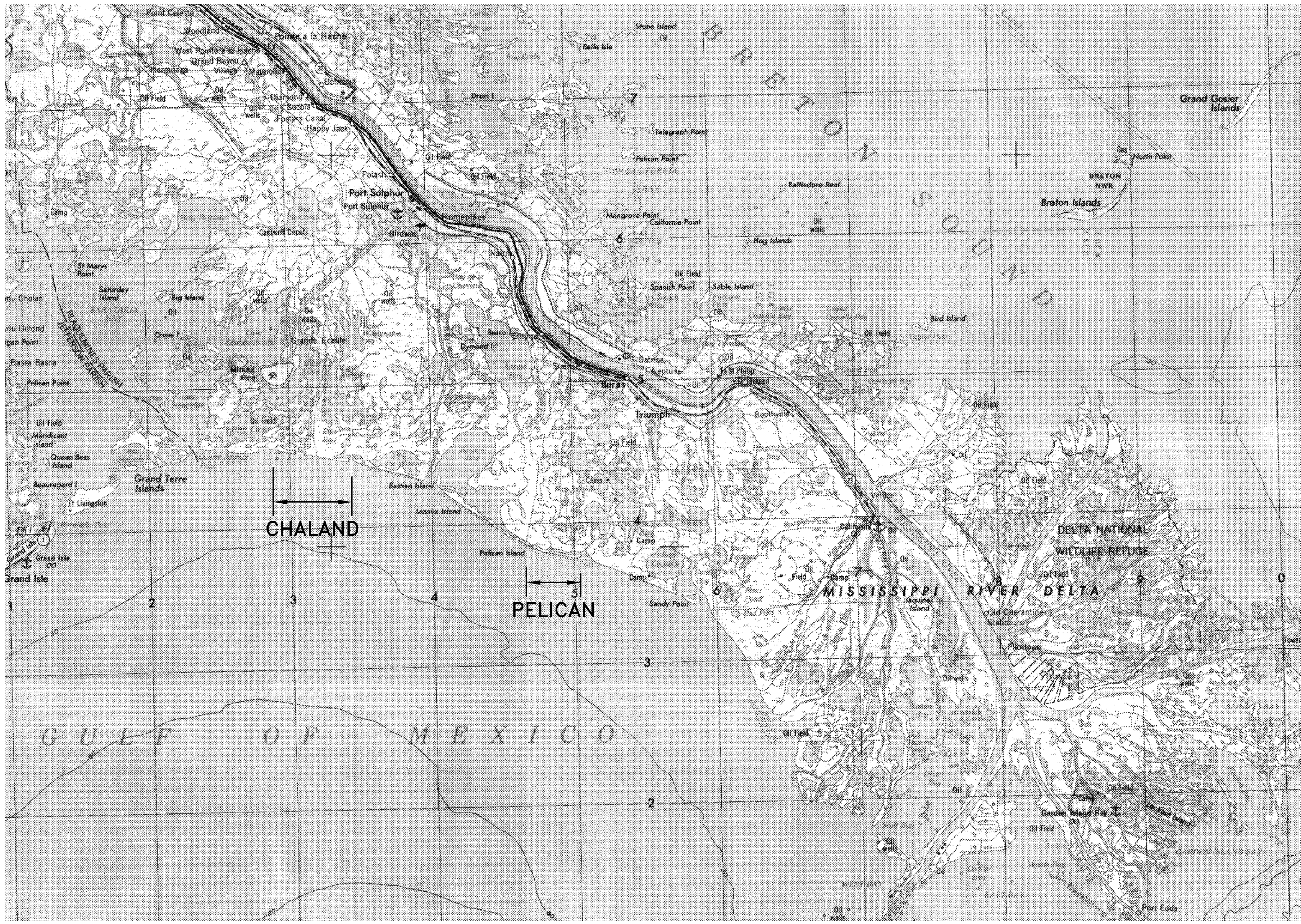
1.3 LIMITATIONS

The analyses and recommendations presented in this report are based on the results of the investigation, and the furnished information as provided by the Louisiana Department of Natural Resources. While it is not too likely that conditions will differ greatly from those observed in the borings, it is always possible that variations can occur between or away from the widely spaced borehole locations. If it becomes apparent during construction that subsurface conditions differing significantly from those discussed in Section 2 are being encountered, this office should be notified at once so that their effects can be determined and any remedial measures necessary prescribed. Also, should the nature of the project change considerably, these recommendations may have to be re-evaluated.

This report has been prepared for the exclusive use of the Department of Natural Resources and their consultants for the purpose of designing the proposed Barataria Barrier Island Restoration Project as generally described in Section 1.1. The recommendations provided are site specific and are not intended for use at any other site.

1.4 REPORT ORGANIZATION.

The main body of this report is divided into three sections: this Introduction (Section 1.0), the Chaland Headland area (Section 2.0), and the Pelican Headland area (Section 3.0). Within Sections 2.0 and 3.0, the report is divided into subsections based on the scope of work mentioned in Section 1.2.



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SCALE

REFERENCE:
USGS NH 16-7 of Breton Sound, LA,
1957 edition, revised 1973.

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
(CHALAND & PELICAN HEADLANDS)
PROJECT BA-38
PLAQUEMINES PARISH, LOUISIANA

for
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
BATON ROUGE, LOUISIANA

C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer: G.P. Boutwell	Drawn by: DMS	Checked by:
File No.: 03-1114	Date: 10-21-03	Figure No.: G-1

Title: **VICINITY MAP**

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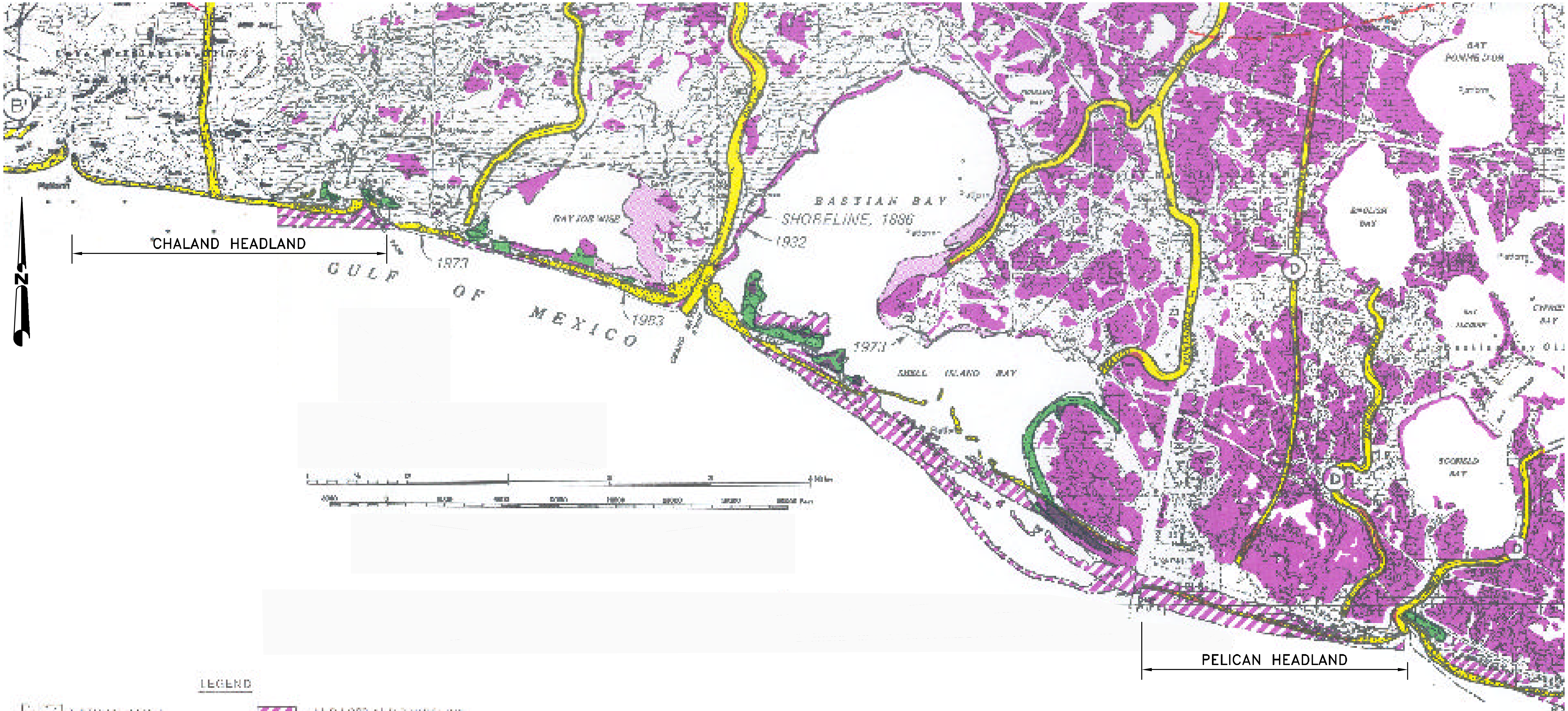

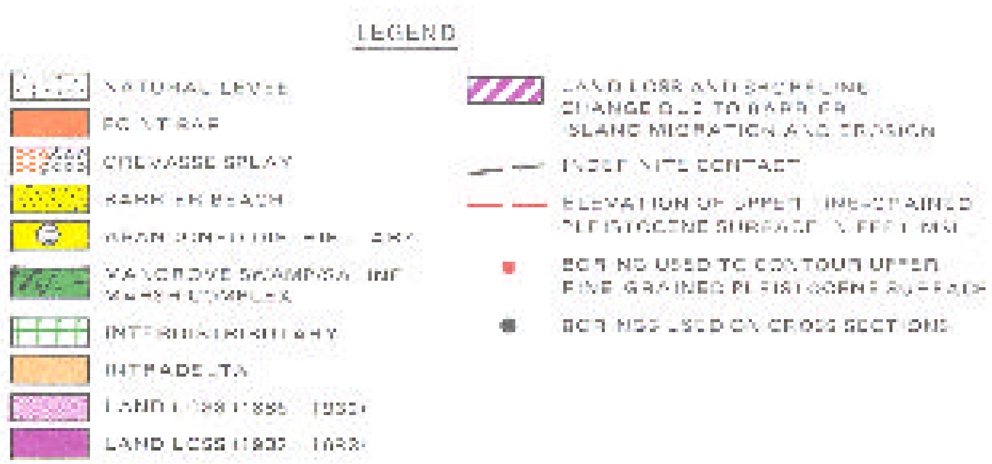

REFERENCE:
USA/COE "Distribution of Deltaic and Marine Deposits," of Empire, LA (1987) and Ft. Livingston, LA (1990).

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P:\2003\03-1114\CADD\031114-G2 GEOLOGIC MAPPING.DWG

BARATARIA BARRIER ISLAND SHORELINE RESTORATION

(PELICAN HEADLAND)

PROJECT BA-38

PLAQUEMINES PARISH, LOUISIANA

for

LOUISIANA DEPARTMENT OF NATURAL RESOURCES

BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 10-14-03	Figure No.: G-2

Title:
GEOLOGIC MAPPING

- 2.1 and 3.1: These sections discuss the site, geology, and soil conditions for the Chaland and Pelican areas, respectively.
- 2.2 and 3.2: These sections present the engineering analyses (methodologies and results) for the Chaland and Pelican areas, respectively.

The field and laboratory programs for both areas are covered in Appendix A.

2.0 CHALAND HEADLAND AREA

2.1 GEOLOGICAL AND SOIL CONDITIONS

2.1.1 Site and Geology Conditions. This site is bounded on the west by Pass La Mer and on the east by Pass Chaland; see Figures G-1 and G-2. The surface is either water (at about 0 feet NAVD), marshland (at undefined elevations less than +5 feet NAVD), or, along the south side, a barrier beach (again, elevations undefined). Reference is made to Figure G-2 and the sources cited on that figure. Even there, the subsurface geology is poorly defined. A Barrier Beach some 300 feet wide is shown along the south (gulf) shore. An Abandoned Course some 500 feet wide follows an old N-S bayou which crosses the area near its center. A profile on the "Ft. Livingston" USA/COE geologic map passes about 2 miles inland from the site. It indicates Holocene marsh deposits to around elevation -200 feet NAVD, followed by Holocene-Pleistocene sand to around -320 feet NAVD, where Pleistocene-age clays begin. The marsh deposits frequently have sand bodies (relict beaches) in the -20 to -50 feet NAVD range. Barrier Beach sands typically extend to about -10 feet NAVD.

2.1.2 Soil Conditions - Project Construction Area. Ten (10) borings were made to determine the subsurface conditions in the Chaland Headland project area. All of these borings were given a "C" - number (C, CF, or CS as designated by LDNR); their approximate locations are illustrated on Figure C-1. Global Positioning System (GPS) coordinates taken during drilling are shown on the individual logs of the borings in Appendix A. Soil profiles are given on Figures C-2 through C-4. The borings can be divided into three groups having roughly similar characteristics for ease of comprehension.

2.1.2.1 Borings CF-5, CF-7, and C-10. The average soil conditions at these three borings on the west end of the project can be summarized as shown on Table 2.1-1, below.

TABLE 2.1-1
SOILS DATA: WEST END OF SITE

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-3	Water	-	-	-	-	0	0	0/0/0
3-9	CL, CH	30	13	45	73	0.16	NT	44/29/27
9-18	SM, SC	NT	NT	27	90	3.01	12	55/34/11
18-24+	CH	59	36	53	NT	0.21	3	NT

*	Below waterline	DD:	Dry Density
LL:	Liquid Limit	Su:	Undrained Shear Strength
PI:	Plas. Index	N:	Standard Penetration Resistance
W:	Water Content	NT:	Not Tested

2.1.2.2 *Borings CS-1, CS-2, CS-3, CS-4, CS-6, and CS-9.* These borings cover most of the remaining project area. The average soil conditions at these borings can be summarized as shown in Table 2.1-2, below:

TABLE 2.1-2
SOILS DATA: MOST OF SITE

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-5	Water	-	-	-	-	0	0	0/0/0
5-7	PT, OH	172	115	176	40	0.09	NT	NT
7-19	SM, SC	NT	NT	28	92	2.74	23	61/31/8
19-30	CL, CH	60	37	44	82	0.45	5	1/44/55
30-44	ML, SC	NT	NT	30	84	1.58	13	51/40/9
44-73+	CH, CL	66	46	43	73	0.36	NT	NT

Notes: Same as Table 2.1-1

Also, it should be noted that the (PT, OH) stratum was not present at CS-3, CF-4, and CF-6. The deeper (ML, SC) stratum was not present at CF-9.

2.1.2.3 *Boring CF-8.* This boring is on the extreme east end of the project area. Its average soil conditions can be summarized as shown in Table 2.1-3, below:

TABLE 2.1-3
SOILS DATA: EAST END OF SITE

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-6	Water	-	-	-	-	0	0	0
6-8	SM	NT	NT	46	NT	NT	NT	82/11/7
8-14	CL	29	11	51	NT	NT	3	NT
14-26+	ML	NT	NT	30	NT	NT	9	43/50/7

Notes: Same as Table 2.1-1

2.1.3 Soil Conditions - Borrow Area (Borings Q-1 and Q-2). These borings were located approximately 1 mile offshore (south) and 2.5 miles west of the project construction area; see Figure C-1. A soil profile is given as Figure C-5. The average soil conditions at these two borings can be summarized as shown in Table 2.1-4, below:

TABLE 2.1-4
SOILS DATA: BORROW PIT BORINGS

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-12	Water	-	-	-	-	0	0	0/0/0
12-15	CH, CL	54	28	51	62	0.15	NT	NT
15-29	SM, ML	NT	NT	34	NT	NT	13	52/40/8
29-31+	CH	63	40	40	83	0.50	6	NT

Notes: Same as Table 2.1-1

It should be noted that the two clay strata (CH, CL and CH) were found only in Boring Q-2.

2.1.4 Limitations. The descriptions given above are (1) averages and (2) based on boreholes spaced 600 to 2000 feet apart. The soils can be expected to vary between borehole locations. For details at a particular location consult the individual logs of the borings in Appendix A.

2.2 ENGINEERING ANALYSES

This section presents the methodologies used in the analyses, their results, and recommendations for geotechnical construction.

2.2.1 Assignments. The engineering assignments given to STE were outlined in STE's proposal to C-K dated July 2, 2003. They can be summarized as follows:

2.2.1.1 New Earthen Containment Levees. The most significant items for design are stability and settlement. These include maximum allowable construction elevation, crown width, and side slopes (stability) plus settlements (1) during a 1-year construction period and (2) time to settle to average marsh elevation. The settlements are to be computed for five different fill (levee) heights.

2.2.1.2 Dredge Borrow and Fill. These are primarily settlement-related items such as fill settlements (maximum fill: 0.5 feet below as-built levee tops) over 20 years, and fill-related items such as suitability of the borrow area soils, dewatering times, and cut/fill ratios.

These various items are covered in the following sections.

2.2.2 Levee Stability Analysis. This section presents the methodology used in the slope stability analyses for the Chaland Headland levees, the cases analyzed, and the results.

2.2.2.1 Slope Stability Analysis - General. A slope has two types of forces acting on it. The soil weight and any seepage forces try to make the soil slide; these are called the "driving forces." The weight of soil below the waterline is its "effective" or, buoyant weight. Therefore, a foot of soil above water has 2 to 3 times the driving force of a foot of soil below water. The strength of the soil tries to keep it from sliding; this is called the "resisting force." Both depend on the geometry of the situation: the "Failure surface." The procedure is to isolate a block of soil (mentally), and compute the resisting and driving forces. Their ratio is called the "safety factor," and is the measure of stability. In practice, one analyses many soil blocks until the block yielding the lowest safety factor is found. This is assumed to govern, and the safety factor for the slope is the lowest safety factor determined. The calculations for any but the simplest conditions are quite laborious. They are therefore now performed on a digital computer, using a proven code such as PCSTABL, XSTABL, UTEXAS3, etc. For this project, the slope stability analyses were performed using XSTABL marketed by Interactive Software Designs, Inc. This program evolved from PCSTABL by Purdue University. The program is capable of searching for the minimum safety factor with an easy to use interface. The Bishop method of analysis was used for this project. The accepted measure of a slope's stability is its "safety factor," as defined above. Typical acceptable safety factors common in practice are:

Low Water Condition:	1.3 - 1.5
Rapid Drawdown Condition:	1.0 - 1.1

The rapid drawdown case is not applicable for this project due to the nature of the tidal conditions at the proposed structures.

2.2.2.2 *Cases Analysed.* Since the soil strengths are the dominant factor in slope stability, the levee area was divided into three sections having similar soil conditions (See Section 2.1). As mentioned in Section 1.1.1, the gulfside (south) levee may be built either atop the existing beach "ridge" or slightly offshore of it; the decision has not yet been finalized. Also, neither soil data nor detailed elevations are available on the beach "ridge." Therefore, certain assumptions had to be made for levees so located. The cases analysed are summarized below:

- West Levee: Borings CF-5, C-7, C-10
- North/East Levee: Borings C-7, C-9, CS-1, CS-3, CS-2, CS-4, CF-8
- South Levee: Borings C-10, CS-3, CF-6
  - Levee on Beach Ridge (with assumptions)
  - Levee offshore of beach

In each area, analyses were made for the following levee geometries:

- Initial Freeboard: 1.0, 1.5, 2.0, and 3.0 feet at least
- Water Depth: 2 to 6 feet
- Side Slopes: 1(V):4(H), 1(V):6(H) and 1(V):8(H)
- Crown Widths: 5, 10, and 20 feet.

The levees were considered to be of two material types: dredged silt/sand and dredged clay. This was done to account for variability in the borrow pit area (See Section 2.1.3 and the logs of borings Q-1 and Q-2). The lower safety factor obtained for the two materials was assumed to govern and is tabulated below.

The Beach Ridge was assumed to be 2 feet above sea level, and, for conservatism, to extend no deeper than 5 feet below sea level (-5 feet NAVD).

2.2.2.3 *Results.* The results of illustrative stability analyses are presented on Figures C-6 and C-6A (West), C-7 and C-7A (North/East), C-8 (South-on Ridge), and C-9 (South-offshore) for the steeper slopes [1(V):4(H) and 1(V):6(H)]. In general, the crown widths of the levees had only a nominal effect on stability. The results can be summarized as in Table 2.2-1 below. The safety factors for the deeper water conditions govern. Since most of those safety factors exceeded the desired 1.3, the other water conditions are not presented.

TABLE 2.2-1
LEVEE SAFETY FACTORS - CHALAND HEADLAND

Levee Area	Initial Freeboard (ft.)	Safety Factor for Side Slope		
		1(V):4(H)	1(V):6(H)	1(V):8(H)
West	1.0	1.8	2.4	3.1
	1.5	1.7	2.1	2.9
	2.0	1.5	2.0	2.6
	3.0	1.3	1.7	2.3
North & East	1.0	2.1	2.7	3.5
	1.5	1.9	2.5	3.2
	2.0	1.6	2.3	3.0
	3.0	1.5	2.1	2.6
	6.0	**1.2**	1.7	2.2
South (Ridge)	1.0	>3.0	>3.0	>3.0
	1.5	>3.0	>3.0	>3.0
	2.0	>3.0	>3.0	>3.0
	4.0	2.9	>2.9	>2.9
	5.0	2.4	>2.4	>2.4
	6.0	1.9	>1.9	>1.9
South (Water)	1.0	2.4	>2.4	>2.4
	1.5	2.3	>2.3	>2.3
	2.0	2.0	>2.0	>2.0
	4.0	**1.2**	1.6	2.0
	5.0	**1.0**	1.4	1.7

Bold: SF less than desired 1.3

2.2.2.4 *Summary of Stability Results.* The soils in the Chaland Headland area are relatively strong, which leads to good stability. The safety factors are acceptable for:

- All levees with 3 feet of freeboard or less, using 1(V):4(H) side slopes.
- All levees with up to 6 feet of freeboard using 1(V):6(H) side slopes.

2.2.2.5 *Strengthening.* It is clear that designs with about 6 or more feet of freeboard will usually have safety factors less than desired (See Table 2.2-1). Geotextile reinforcement is indicated for such conditions. The geotextile should have an allowable tensile strength of at least 1,000 pounds per lineal foot (measured perpendicular to the levee centerline). It should extend under the full width of the levee. Should levees exceeding 6 feet of freeboard be needed, contact this office for specific analyses and designs.

2.2.2.6 Levee Borrow. It is often desirable to obtain the borrow material for the levees from near the levee. Excavating this material from too close to the levee toe can affect the stability of the levee adversely. It is therefore recommended that the edge of the borrow pit not be closer to the levee toe than about 20 feet plus the depth of the borrow excavation.

Also, the near-surface soils are occasionally Peats (Pt) to around 2 feet below ground surface. Peats should be spoiled or used in general fill, and not used for levee construction. The materials encountered in the Borrow Area (especially in Boring Q-2) are suitable for levee construction. Granular materials which would be good for levee construction were also encountered near the surface at most of the borings except CF-6 and the west end of the project (CF-5, CF-7, and C-10).

2.2.3 Levee Settlement Analyses. The assignments relative to Chaland Headland levee settlements were given in Section 3.2.1. They require calculating both the total amounts of settlement which will occur after a very long time, and the time-rates at which these movements will occur. Levee settlement is composed of three parts:

- Settlement in the foundation soils due to the weight of the levee,
- Settlement within the levee itself due to self-weight consolidation (minor), and
- Geological Subsidence. This rate was furnished by LDNR as about 6 inches in 20 years, or 0.025 feet per year.

2.2.3.1 Analyses - Total Amount of Settlement due to Levee Weight. The total amount of settlement depends on the geometry and intensity of the applied load (levee fill) and on the compressibilities of the underlying soil strata. As settlement progresses, the net intensity of the applied load decreases. This is especially true for levees built in water. The maximum possible settlement is that calculated without taking this phenomenon into account, and forms the basis for calculations which do use load intensity decrease. Note that this decrease occurs if the levees are not periodically rebuilt to their initial elevations.

The actual settlement calculations were performed using the computer code VSTRESS, originally developed by the Corps of Engineers, and SETOFF as developed by Ensoft, Inc. These programs calculate one-dimensional settlement based on either Boussinesq or Westergaard stress distributions. The Boussinesq stress distribution was used for these analyses. For the soil types that had consolidation tests, actual consolidation curves were used in the calculations. Published correlations were used for other soil types to obtain consolidation indices using Atterberg Limits and moisture content values.

2.2.3.2 Cases Analysed. Since the clayey soils (PT, OH, CH, CL) are highly compressible (See Table A-1 in Appendix A), they contribute far more to settlement than do the less compressible granular soils (ML, SC, SM). Therefore, calculations were made for the generalized conditions corresponding to:

- CS-1 and CS-3 (Large amounts of organic soil)
- CS-2 (Intermediate amount of granular soil)
- CS-4 and CF-7 (Small amount of granular soil)

The deeper soil conditions, below about 40 feet, were taken as those of the 70+ foot boring, C-9. Calculations were made for crown widths of 5 to 20 feet, and using the average levee slope [1(V):6(H)]. On the West, North/East levees, levee heights above water were taken as 1, 2, 3, and 4 feet, with water depths of 0, 2, 4, and 6 feet. The South levee had 2 general cases (on the "ridge" and offshore) as discussed in Section 2.2.2. For the ridge, the levee heights were taken as 1, 2, and 3 feet above ground level. The settlements for the potential offshore location were calculated for levee heights of 1, 2, 3, and 4 feet above water, with water depths of 2, 4, 6, 8, and 10 feet.

2.2.3.3 Effect of Settlement on Further Settlement. Most of these levees will or may be constructed in water. The levees are originally built to some level above water, and produce a stress level which includes the *total* weight of levee material above water. As settlement proceeds, some of the material which was originally above water becomes submerged. That material now exerts pressure due to its *buoyant* weight, which is less than its total weight. The net result is that the pressure decreases and the real settlement is less than would be predicted using the total weight. There are two other factors which must be considered:

- If the levee heights are rebuilt, settlement will tend to reach the "total weight" movements.

- At most locations, the levee will be underlain by a substantial amount of granular soils, which consolidate rapidly. The movements due to these soils will probably occur during construction, so that the "total weight" movements in these granular materials (only) will be realized during construction.

2.2.3.4 Total Settlements due to Levee Weight. The starting point is the "raw" settlement computed using the total unit weight for above-water fill. For the observable post-construction settlements, these must be reduced by the movements occurring in the granular layers during construction, termed "adjusted" settlement. Then, the effect of the remaining long-term settlement on the applied pressure must be considered (See Section 2.2.3.3). This is termed the "net" settlement.

The results of these analyses are presented below. Table 2.2-2 provides the settlement data for the West and North/East levees, Table 2.2-3 gives the settlements for the South levee if constructed on the Beach Ridge, and Table 2.2-4 gives the settlements if the South levee were constructed offshore.

TABLE 2.2-2
LONG-TERM SETTLEMENTS: WEST AND NORTH/EAST LEVEES

Geometry Situation		Centerline Settlement (feet) due to Levee Weight									
		CS-1 + CS-3			CS-2			CS-4 + CF-7			Avg. Net
Water (ft.)	Height[A] (ft.)	Raw	Adj.	Net	Raw	Adj.	Net	Raw	Adj.	Net	
0	1	0.49	0.25	0.22	0.17	0.09	0.08	0.21	0.16	0.15	0.15
	2	0.75	0.41	0.38	0.31	0.17	0.16	0.44	0.35	0.31	0.28
	3	1.00	0.57	0.51	0.45	0.26	0.24	0.69	0.55	0.49	0.41
	4	1.24	0.70	0.64	0.60	0.36	0.33	0.94	0.78	0.69	0.55
2	1	0.74	0.44	0.40	0.30	0.19	0.17	0.44	0.29	0.25	0.27
	2	0.99	0.59	0.54	0.44	0.27	0.25	0.67	0.45	0.40	0.40
	3	1.22	0.73	0.69	0.59	0.37	0.34	0.93	0.62	0.55	0.53
	4	1.45	0.87	0.80	0.74	0.46	0.44	1.19	0.80	0.69	0.64
4	1	0.99	0.59	0.51	0.45	0.28	0.24	0.68	0.46	0.37	0.37
	2	1.21	0.72	0.65	0.59	0.37	0.32	0.92	0.62	0.51	0.49
	3	1.50	0.90	0.80	0.74	0.46	0.41	1.18	0.79	0.65	0.62
	4	1.89	1.13	0.96	0.89	0.55	0.50	1.44	0.96	0.79	0.75
6	1	1.21	0.72	0.64	0.60	0.36	0.35	0.93	0.77	0.68	0.56
	2	1.49	0.90	0.81	0.74	0.45	0.43	1.18	0.97	0.86	0.70
	3	1.77	1.10	0.98	0.90	0.55	0.51	1.44	1.18	1.05	0.85
	4	2.02	1.30	1.15	1.05	0.65	0.60	1.69	1.39	1.23	0.99

[A] As-Built height above water level

TABLE 2.2-3
LONG-TERM SETTLEMENTS: SOUTH LEVEE ON BEACH RIDGE

Geometry Situation		Centerline Settlement (feet) due to Levee Weight		
Water (ft.)	Height[b] (ft.)	Raw	Adj.	Net
0	1	0.23	0.14	0.13
	2	0.43	0.27	0.25
	3	0.60	0.38	0.41
	4	0.86	0.51	0.48

[b] Above ground surface (+2 feet NGVD)
CS-1 conditions govern

TABLE 2.2-4
LONG-TERM SETTLEMENTS: SOUTH LEVEE OFFSHORE

Geometry Situation		Centerline Settlement (feet) due to Levee Weight		
Water (ft.)	Height[a] (ft.)	Raw	Adj.	Net
2	1	0.56	0.34	0.30
	2	0.78	0.47	0.42
	3	0.99	0.60	0.58
	4	1.24	0.74	0.68
4	1	0.78	0.47	0.40
	2	0.99	0.59	0.53
	3	1.22	0.73	0.65
	4	1.46	0.88	0.77
6	1	1.00	0.60	0.50
	2	1.22	0.73	0.62
	3	1.46	0.88	0.74
	4	1.68	1.01	0.90

8	1	1.23	0.74	0.59
	2	1.46	0.88	0.72
	3	1.68	1.01	0.89
	4	1.89	1.13	1.02
10	1	1.77	1.17	1.10
	2	2.02	1.25	1.19
	3	2.24	1.32	1.26
	4	2.45	1.45	1.36

CS-1 conditions govern

In the above Tables 2.2-2 through 2.2-4, the "Net" settlements should be used to evaluate long-term performance unless the levees are raised by additional fill at some time in the future. In the latter case, the "Adjusted" settlements would be more appropriate.

2.2.3.5 Geologic Subsidence. The only other significant source of settlement will be that due to geologic subsidence. This rate was furnished by LDNR as about 0.025 feet per year. This is of little consequence for the first few years, but becomes significant over long periods. For example, the movement due to geologic subsidence is 0.1 feet in the first 4 years, but increases to 0.5 feet at the end of the estimated project life at 20 years after construction.

2.2.3.6 Analyses - Time Rate of Settlement due to Levee Weight. The time-rate of settlement as observed at the ground surface depends on several factors, as discussed below:

- Soil Rate Parameter (c_v). This is intrinsic to each soil type, but varies with the total vertical pressure in the soil layer. In general, settlement within the granular soils (ML, SC, SM) will occur virtually during construction.

- Drainage Path Length (L). Consolidation is a process of squeezing water out of the soil voids. The water has to go somewhere, and that is to either the surface or a relatively permeable layer (such as a silt layer in a clay mass).

- Vertical Distribution of the Total Settlement. The time rate applies to each layer; the contribution of each layer is its own ultimate settlement multiplied by its degree of consolidation at a particular time.

Like other problems in time-dependent flow in soils, the analysis for the time-rate of consolidation is inherently inaccurate. Normally, settlement occurs faster than the prediction.

Calculations were made for the soil conditions at the locations cited in Section 2.3.3.2. The results were normalized by dividing the "Net" settlements at various times by the ultimate (long-term) "Net" settlement. This approach accounts directly for the settlements which occur in the more granular materials during construction. Settlement rates were analyzed for the tallest and the lowest levee heights and averaged. In general, the lower levees settle slightly faster than the taller levees where there are deep clays. This is because the taller levees exert greater stress in the deeper materials. The percentages of settlement completed in 1 year are typically 5-10% higher than given in Table 2.2-5 for the low levees, and 5-10% lower than given for the taller levees. The percentages of settlement given in Table 2.2-5 should be applied to the "Net" total settlements given in Tables 2.2-2 through 2.2-4.

TABLE 2.2-5
NET RATES OF WEIGHT-INDUCED SETTLEMENT

Time (years)[d]	Percentage of Weight - Induced Settlement Complete			
	CS-1	CS-2	CS-4	Average
0.0	0	0	0	0
0.5	66	56	47	56
1.0	75	62	62	66
2.0	78	72	75	75
5.0	87	88	91	89
10.0	96	93	97	95
20.0	99	99	99	99

[d]: After construction is complete

2.2.3.7 Time to Reach Marsh Elevation. The average marsh elevation is assumed to be approximately +1 feet NAVD, equal to about one foot above water level at the site. It is assumed that the initial levee top elevation will be up to 4 feet above the site water level, or +5 feet NAVD. The "Net" settlement data from Sections 2.2.3.4 (no rebuilding) was analyzed. If the levees are built at least 1 foot above marsh elevation, they will not ever settle below that elevation under their own weight. The geologic subsidence rate, however, must be considered. It adds about 0.025 feet per year. Hence, levees originally set 1 foot above marsh elevation will settle below marsh elevation due to the combination of their weight-induced settlement and the geologic subsidence, but only if the water depth exceeds 6 feet. In this case, the time required is for levees originally built to 1 foot above marsh elevation is about 10 to 20 years, depending on water depth. Levees with an initial height of 2 or more feet will not settle below +1 feet NAVD during the 20-year life of the project.

2.2.3.8 Applicability. Borings with similar soil conditions, should have similar total settlements and similar time-rates. The soil conditions below the bottoms of the 20-foot borings are unknown and must be "guesstimated." It is recommended that the settlements at borings other than those where full-depth calculations could be and were made be taken as follows:

TABLE 2.2-6
BOREHOLE MATCHING FOR SETTLEMENT

Boring No.	Settlement from Boring No. [c]	Boring No.	Settlement from Boring No. [c]
CS-1	CS-1	CF-6	CS-1
CS-2	CS-2	CF-7	CS-4
CS-3	CS-1	CF-8	CS-2
CS-4	CS-4	C-9	CS-2
CF-5	CS-4	C-10	CS-2

[c]: Data from Tables 2.2-2 through 2.2-5

2.2.4 Suitability of Borrow Area Soil. As shown in Section 2.1.3, the soils in the borrow pit area are predominately granular (SM, ML). These are good fill materials. About 64% of the soils are silts or sands. The clays in the borrow area are not highly organic, and are suitable for both levee and area fills. Over most of the construction area, there is a 2 to 4 foot thick layer of Peat (PT) and Organic Clay (OH) which is suitable for area fill but should not be used in levee construction if at all possible. The majority of the remaining material is suitable for both types of construction.

2.2.5 Dewatering Time for Area Fill. When soil particles are in suspensions with low concentration of solids, particles settle as individual entities, and there is no significant interaction with neighboring particles (Type I settling). With increasing solids concentration, the particles coalesce or flocculate. By coalescing, the particles increase in mass and settle at a faster rate (Type II settling). With further increase in concentration, the interparticle forces are sufficient to hinder the neighboring particles (Type III settling). Finally, the soil particles settle to form a structure (Type IV settling). The dredging operation typically creates a soil suspension with 5 to 10 percent solids. At this concentration range, the clayey portion of the soils settles at a rate close to Type III. Types I and II settling are applicable for the more granular fills on this project. These two types are typically used for sediment transport modeling. Type IV settling is typically simulated with the diffusion equation using either Terzaghi or Gibson consolidation theory and is discussed in Section 2.2.6.

The dewatering time varies with type of soils and salinity of the water and is often determined using a column test. In this case, however, the bulk of the borrow material will be relatively granular soil. Settling velocities for such materials are commonly calculated using Stokes' Law (see, e.g., ASTM D422). Velocities for various particle size groups were calculated following D422 and are given in

Table 2.2-7, together with an estimate of the percentage of the Q-1 plus Q-2 borrow material falling into each size group.

TABLE 2.2-7
PARTICLE SETTLING VELOCITIES

Partiate Group	Size Range (mm)	Settling Velocity (ft./day)	Portion of Borrow (%)
Medium Sand	0.2-0.4	>1000	1
Fine Sand	0.07-0.2	>1000	5
Coarse Silt	0.02-0.07	330	56
Fine Silt	0.005-0.02	24	2
Clay	<0.005	1-6	36

Clearly, the granular portion (64%) of the fill will settle out of suspension in a period of a few days or less. The clay portion (36%) would theoretically be kept in suspension by Brownian movement. However results from a column test performed on similar materials from the Barataria Landbridge Project (BA-36) indicate it will actually flocculate and settle out in a period of less than about 1 to 2 months.

2.2.6 Settlements Induced by Area Fill. The area fill within the deposition areas will induce two types of settlements:

- Settlements within the deposition areas
- Additional settlements at the perimeter levees.

In addition, the surface of the Area Fill will exhibit settlement from two other sources: consolidation within the fill itself and geologic subsidence.

The settlements induced by the weight of the Area Fill are described below.

2.2.6.1 Method of Analyses. The calculations were made in the manner outlined in Section 2.2.3.1. The settlement data contained in the table in Section 2.2.3.4 indicated that the variations in settlement along the boring locations are typically within the ±25% accuracy commonly achieved in settlement analyses. Therefore, the computations were performed for the soil conditions at the same borings (CS-1, CS-2, and CS-4) to bound the additional levee settlements.

2.2.6.2 Settlements within Deposition Areas. The major consideration here is the loading which will occur as the soil grains settle out of suspension in the introduced water. It has been assumed that sediment-laden water will be added periodically until the sediment surface is approximately 0.5 feet below the design long-term levee crests. Various sediment heights were also checked for completeness. The applied loading will be the resulting sediment thickness multiplied by the unit weight of the sediment. The latter was taken from earlier Column Tests and the densities observed for the shallow granular sediments in the boreholes; the design value was 70 lb/cu.ft. Net settlements adjusted for the effects of settlement on applied loading as described in Section 2.2.3.3 were used. The resulting settlement values are tabulated below:

TABLE 2.2-8
LONG-TERM AREA SETTLEMENTS DUE TO WEIGHT OF GENERAL FILL

Boring	Additional Area Settlement Due to General Fill (feet)			
	Elev. +1.0[f]	Elev. +1.5[f]	Elev. +2.0[f]	Elev.+3.0[f]
CS-1	0.22	0.26	0.32	0.44
CS-2	0.12	0.15	0.18	0.22
CS-4	0.12	0.16	0.21	0.30
Average	0.15	0.19	0.24	0.32

[f]: Design top of sediment (ft. NAVD); min. 0.5 feet freeboard. Marsh Elevation: 0.0 ft. NAVD
Settlements calculated for 30+ feet from levee

The values tabulated above are valid for relatively uniformly loaded areas at least 30 feet away from the toes of the levees. In the zones closer to the levees, the settlements can be approximated (if necessary) by interpolating between the values given above and those for additional levee settlements given in Section 2.2.6.4.

As described in Section 2.2.5, Type I and Type II settling will dominate even at the solids concentration expected from the dredging operation. However, the time to complete the two processes will be relatively short as compared to Type III settling process. The next step is dewatering (Type III), during which the unit weight of the newly-placed sediments change from the buoyant to the total state. Given these complications, a time-rate analysis is only an approximation. However, it is estimated that the settlement rates will be approximately as follows. Upon completion of final filling (5 year estimate), about 30% to 40% of the tabulated within fill settlement values will be completed (See Table 2.2-9). Another 20% to 30% will occur during the dewatering period, leaving 30 to 50% to take place after dewatering is complete. Figure C-11 presents the rate of settlement estimated without considering the dewatering time. Figure C-11A includes the dewatering (consolidation) within the fill itself, and C-11B adds the effect of geologic subsidence.

2.2.6.3 *Overall Settlement Rate.* The overall settlement rate is the combination of the effects from the three major sources:

- Settlement due to weight of Area Fill,
- Self-Weight Consolidation within the fill, and
- Geologic Subsidence.

These are combined in Table 2.2-9, below:

TABLE 2.2-9
AVERAGE POST-CONSTRUCTION AREA SETTLEMENT

Initial Fill Top Elevation (ft.NAVD)	Time After Construction (years)	Post-Construction Settlement (feet) due to			Total Post-Construction Settlement (feet)
		Soils Below Fill	Within Fill	Geologic Subsidence	
+1.0	0.5	0.08	0.03	0.01	0.12
	1.0	0.09	0.06	0.02	0.17
	2.0	0.11	0.08	0.05	0.24
	5.0	0.13	0.09	0.12	0.34
	10.0	0.14	0.10	0.25	0.49
	20.0	0.15	0.10	0.50	0.75
+1.5	0.5	0.10	0.02	0.01	0.13
	1.0	0.12	0.05	0.02	0.19
	2.0	0.14	0.09	0.05	0.28
	5.0	0.16	0.13	0.12	0.41
	10.0	0.18	0.14	0.25	0.57
	20.0	0.19	0.15	0.50	0.84
+2.0	0.5	0.13	0.02	0.01	0.16
	1.0	0.16	0.03	0.02	0.21
	2.0	0.18	0.07	0.05	0.30
	5.0	0.21	0.15	0.12	0.48
	10.0	0.22	0.18	0.25	0.65
	20.0	0.23	0.19	0.50	0.92
+3.0	0.5	0.17	0.02	0.01	0.20
	1.0	0.21	0.03	0.02	0.26
	2.0	0.24	0.05	0.05	0.34
	5.0	0.28	0.12	0.12	0.52
	10.0	0.30	0.21	0.25	0.76
	20.0	0.31	0.27	0.50	1.08

The total, overall rate is presented graphically for the various initial Area Fill elevations on Figure C-10.

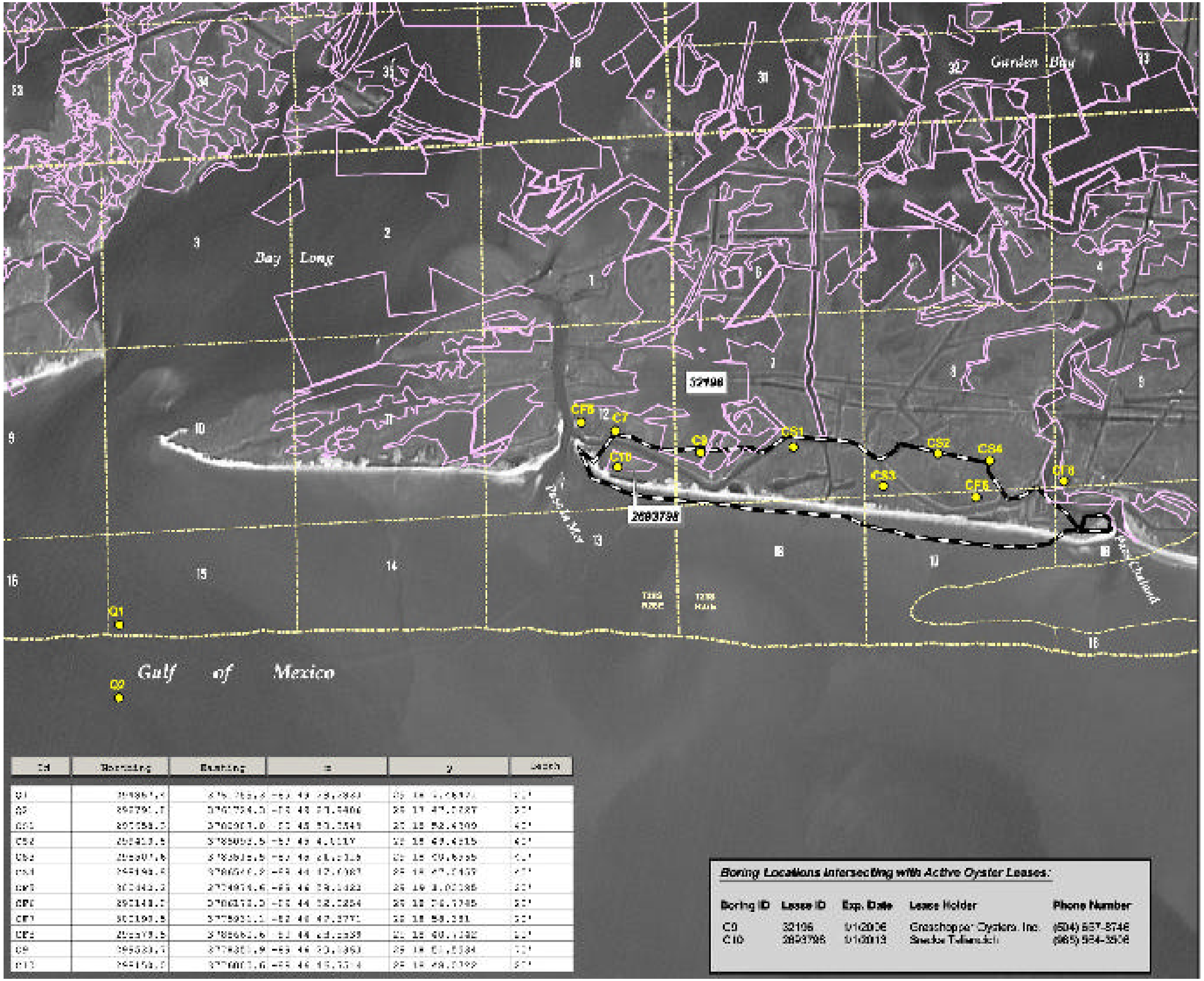
2.2.6.4 Settlement Effects on Levees. The weight of the new sediments adjacent to the levees will cause additional settlements of these levees. These movements were calculated for the two borings (CS-1 and CS-4) showing the least and most compressible soil conditions along the levees in order to "bound" the movements. They indicated total, long-term centerline adjusted settlements of the levees of around 0.1 feet at both locations. These movements will occur at approximately the rates given for the Depositional Areas in Section 2.2.6.2.

2.2.7 Cut/Fill Ratios. Two cases should be considered here. The first is the amount of cut necessary to create a given amount of levee fill. The levee fill is assumed to be placed mechanically (i.e., with draglines or similar equipment), not hydraulically. The general fill will be placed hydraulically, and will therefore have a cut/fill ratio different from that applicable to mechanically placed fill. Both cases are described below.

2.2.7.1 Levee Fill. Reference is made to the descriptions of the soil conditions along the levees given in Section 2.1.2. Overall, about 36% of the cut material will be clay (CH), which is not as suitable for levee construction as the more granular materials. The shrinkage of the more suitable SM and ML soils from pit to levee will depend primarily on transport losses and loss of water content. The former (transport) is best obtained from experienced contractors, but is expected to be on the order of 25%. The water loss shrinkage is estimated as 10% to 15% of the pit volume. Overall, then, preliminary estimate can be based on about 1.3 to 1.5 cubic yards of suitable cut to produce 1.0 cubic yard of levee fill.

2.2.7.2 Area Fill. It is very difficult to determine the cut/fill ratios for the hydraulically placed area fill. As discussed in Section 2.2.5, sedimentation or settlement occur in stages, thereby the volume of fill changes. A reasonable assumption of the initial fill height is when the density of the fill reaches the end of Type III settling (fast) or beginning of the Type IV settling (slow). The fill soil volume then can be related to the density and cut/fill ratio determined. Based on a column test performed for the Barataria Landbridge Project (BA-36). The cut/fill ratio is approximately 1.1, i.e., 1.1 cubic yards of suitable cut should produce 1.0 cubic yard of in-place area fill.

2.2.8 Erosion Protection. A large portion of the levees will consist of ML, SC, and SM soils, which are highly erodible. Erosion protection will be required, especially on the gulf side of the South levee. It must be flexible to withstand the anticipated settlements; rip-rap is indicated. A filter fabric is recommended against the fill to prevent washing of the fines. It should be a non-woven geotextile having a weight of at least 8 ounces per square yard (ASTM D3776) an Equivalent Opening Size around 0.05 mm as determined by ASTM D4751, and a grab strength of at least 125 lb. by ASTM D4632. The 6 to 12 inch layer of riprap adjacent to the fabric should be 6 inch maximum stone. The remainder of the riprap should be sized according to the appropriate methods for the wave action anticipated.



Id	Northing	Easting	x	y	Depth
Q1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Q2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CS1	[illegible]	[illegible]	[illegible]	[illegible]	40'
CS2	[illegible]	[illegible]	[illegible]	[illegible]	40'
CS3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CS4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CF5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CF6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CF7	[illegible]	[illegible]	[illegible]	29 18 58.231	[illegible]
CF8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Boring Locations intersecting with Active Oyster Leases:

Boring ID	Lease ID	Exp. Date	Lease Holder	Phone Number
C9	32106	1/1/2006	Grasshopper Oysters, Inc.	(504) 657-8746
C10	2693796	1/1/2013	[illegible]	(985) 594-3906

REFERENCE:
MAP ID: USGS-NWRC 2003-04-0305

P:\2003\03-1114\CADD\031114-C1 CHALAND BORING PLAN.DWG

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
(CHALAND HEADLAND)
PROJECT BA-38)
PLAQUEMINES PARISH, LOUISIANA

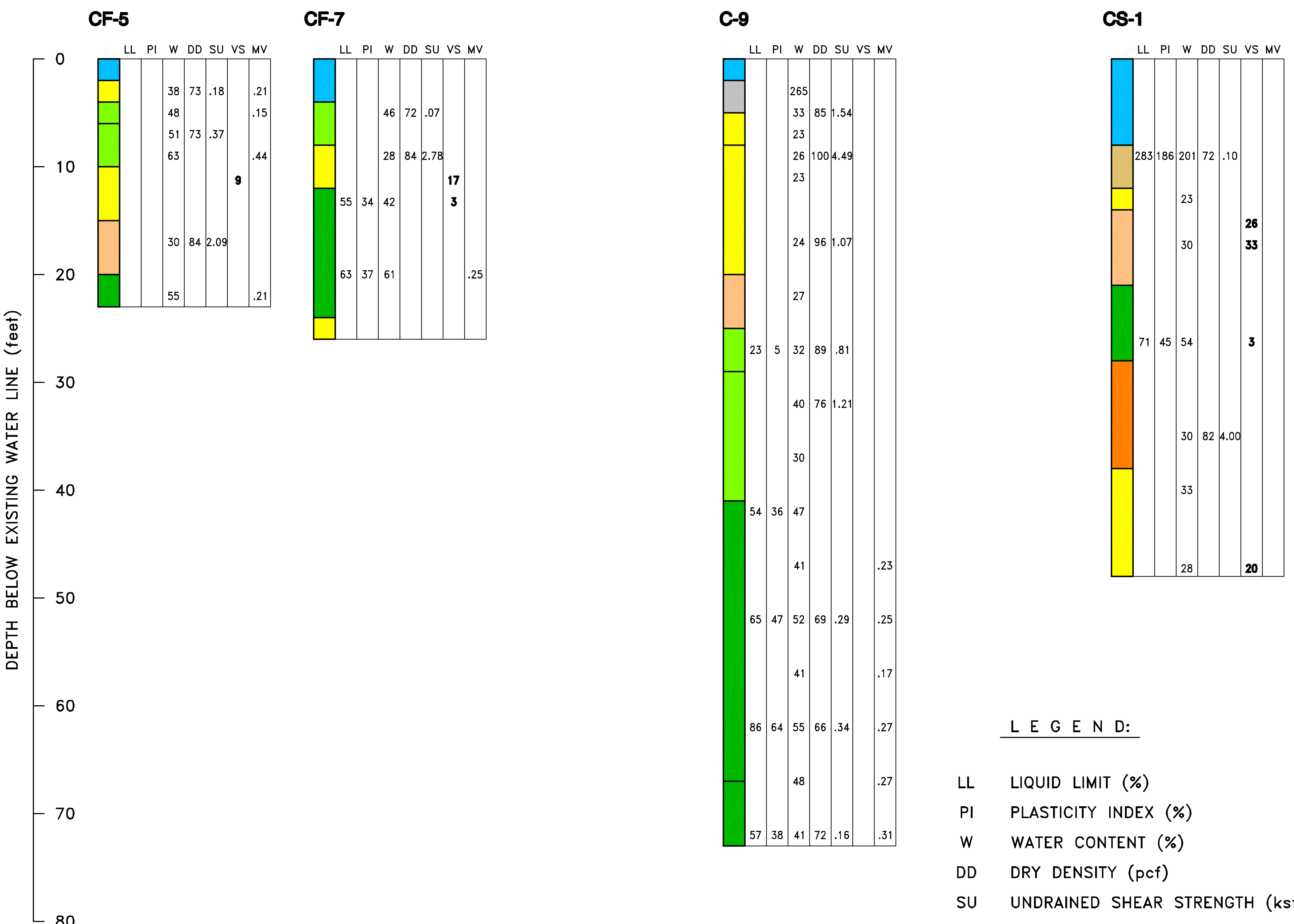
for
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
BATON ROUGE, LOUISIANA

C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 9-18-03	Figure No.: C-1

Title:
BORING PLAN



SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

LEGEND:

LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
W	WATER CONTENT (%)
DD	DRY DENSITY (pcf)
SU	UNDRAINED SHEAR STRENGTH (ksf)
VS	FIELD VANE SHEAR (ksf)
	NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)
MV	MINIATURE LAB VANE SHEAR (ksf)

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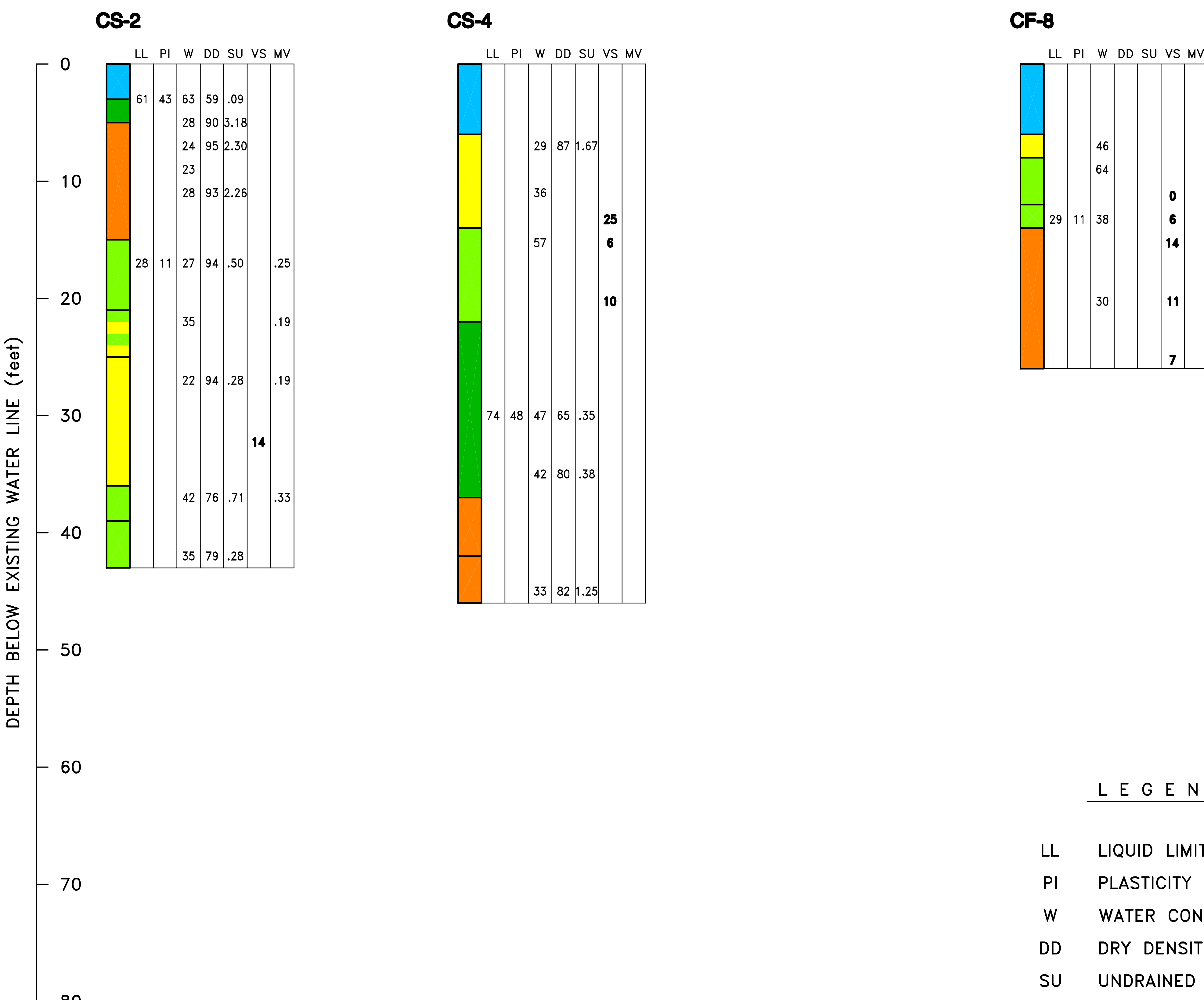
Project Engineer: G.P. Boutwell	Drawn by: DMS	Checked by:
File No.: 03-1114	Date: 9-22-03	Figure No.: C-2

Title: **SOIL PROFILE CF-5, CF-7, C-9 & CS-1**



SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

L E G E N D:

LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
W	WATER CONTENT (%)
DD	DRY DENSITY (pcf)
SU	UNDRAINED SHEAR STRENGTH (ksf)
VS	FIELD VANE SHEAR (ksf)
	NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)
MV	MINIATURE LAB VANE SHEAR (ksf)

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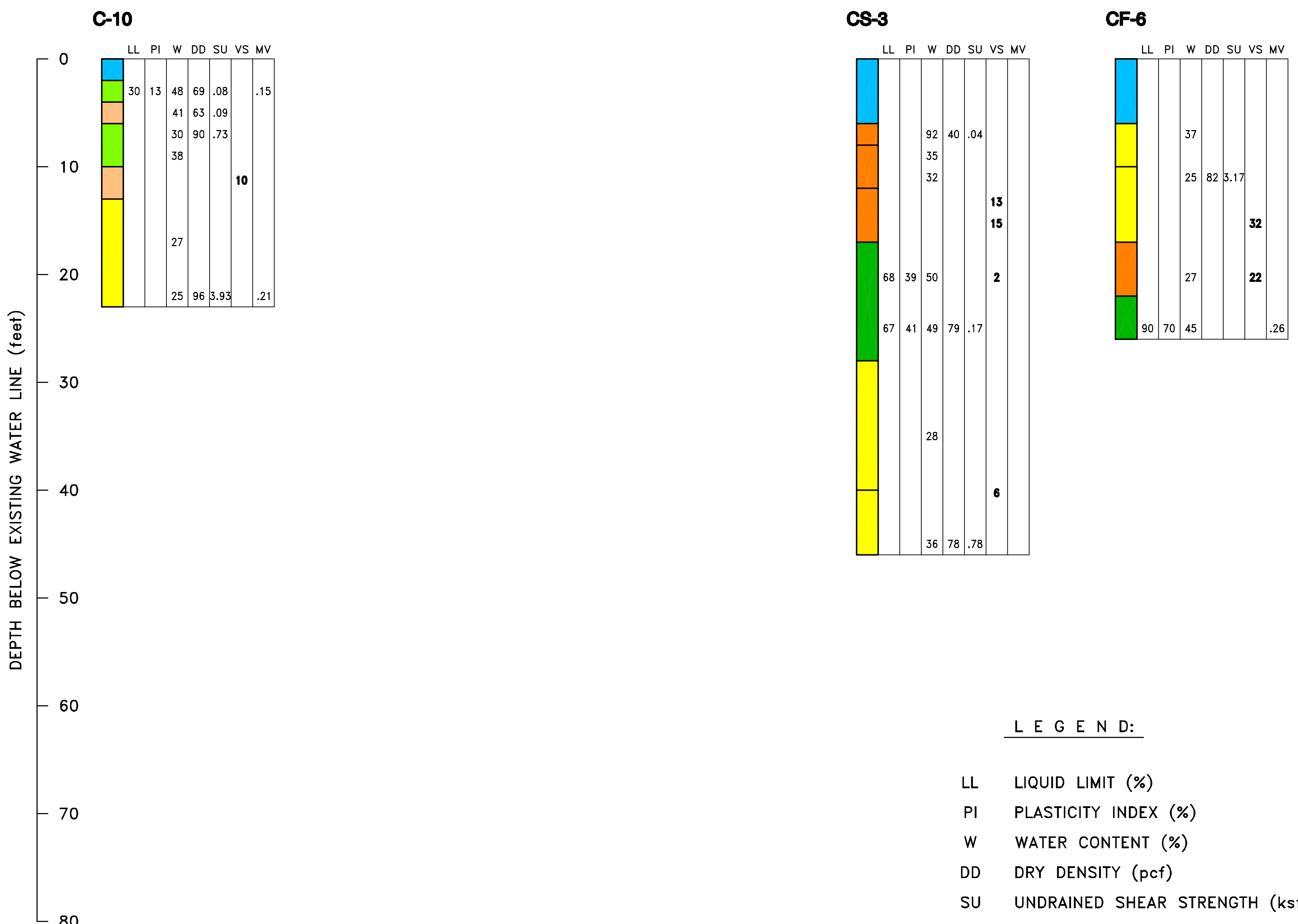
File No.: 03-1114	Date: 9-22-03	Figure No.: C-3

Title: **SOIL PROFILE CS-2, CS-4 & CF-8**

P:\2003\03-1114\CADD\031114-C3 PROFILE CS2 CS4 CF8.DWG

Oct 29, 2003 - 3:47pm

Oct 29, 2003 - 3:47pm



SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

LEGEND:

LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
W	WATER CONTENT (%)
DD	DRY DENSITY (pcf)
SU	UNDRAINED SHEAR STRENGTH (ksf)
VS	FIELD VANE SHEAR (ksf)
	NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)
MV	MINIATURE LAB VANE SHEAR (ksf)

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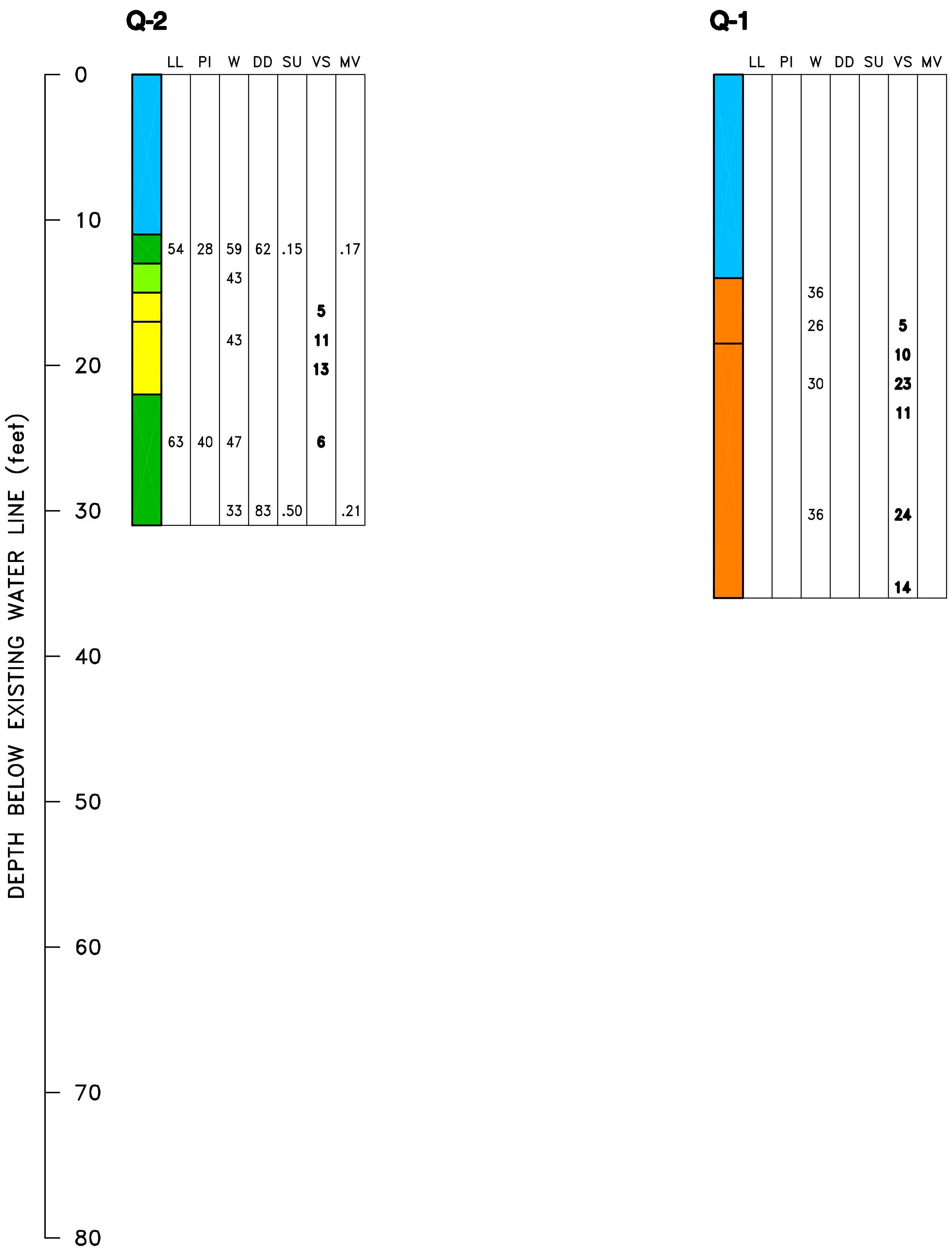
File No.: 03-1114	Date: 9-22-03	Figure No.: C-4

Title: **SOIL PROFILE C-10, CS-3 & CF-6**

P:\2003\03-1114\CADD\031114-C4 PROFILE C10 CS3 CF6.DWG



SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

LEGEND:

LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
W	WATER CONTENT (%)
DD	DRY DENSITY (pcf)
SU	UNDRAINED SHEAR STRENGTH (ksf)
VS	FIELD VANE SHEAR (ksf)
	NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)
MV	MINIATURE LAB VANE SHEAR (ksf)

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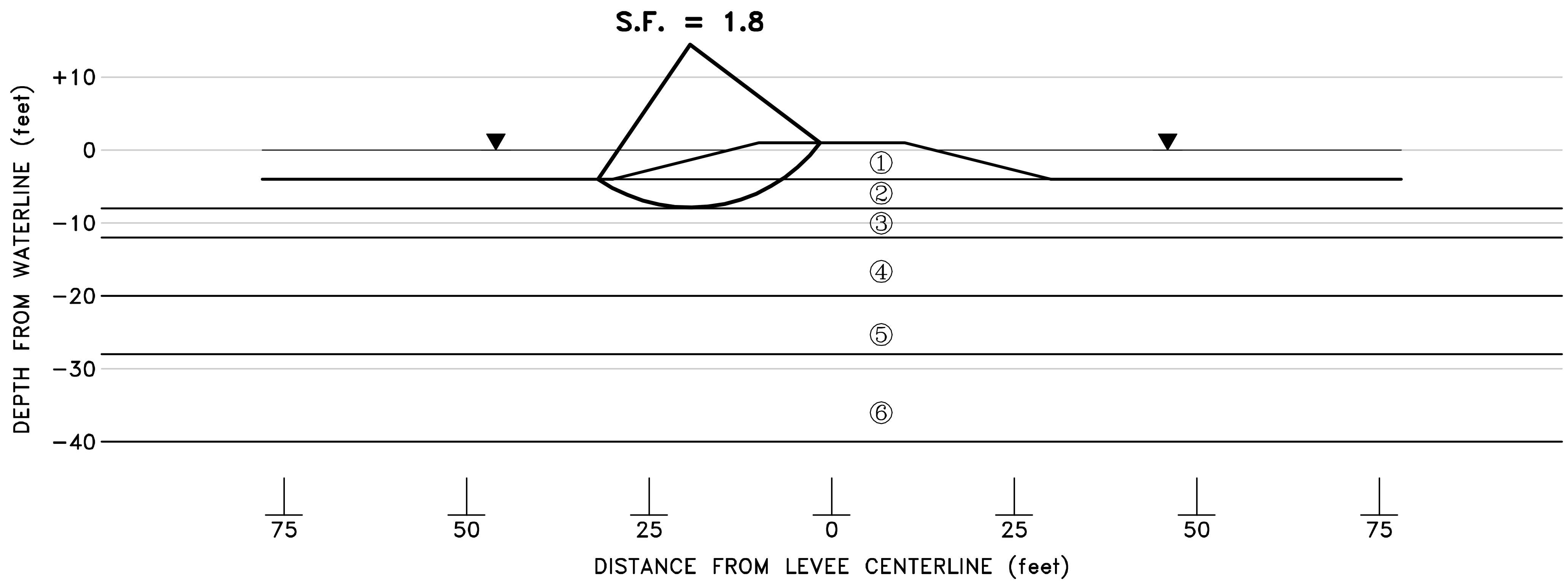
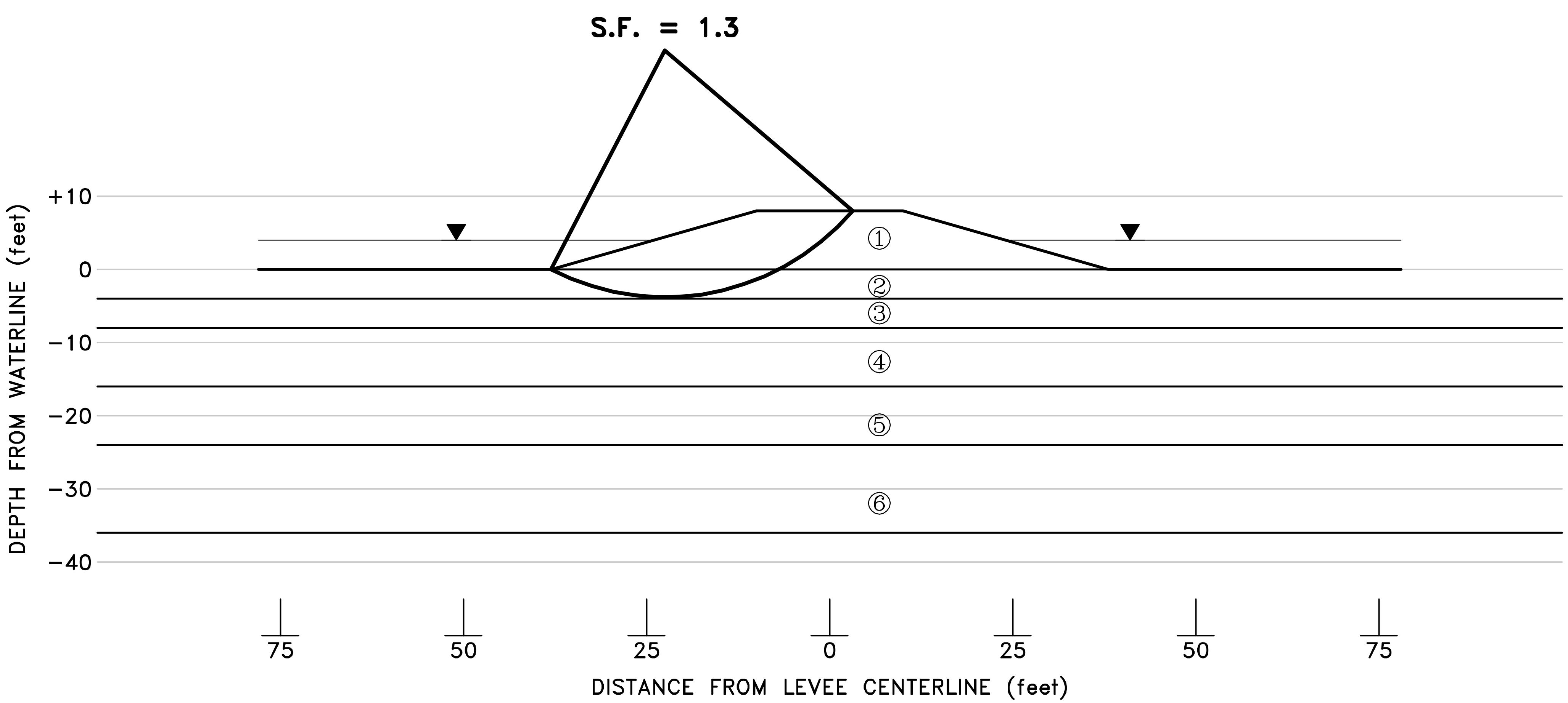
File No.: 03-1114	Date: 9-22-03	Figure No.: C-5

Title: **SOIL PROFILE Q-1 & Q-2**



1 FOOT FREEBOARD, 1(V):4(H) SLOPES



3 FOOT FREEBOARD, 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	70	105	0
3	0	108	28
4	300	105	0
5	50	117	22
6	280	106	0

a: Analyzed for both fill types. Lowest SF illustrated.

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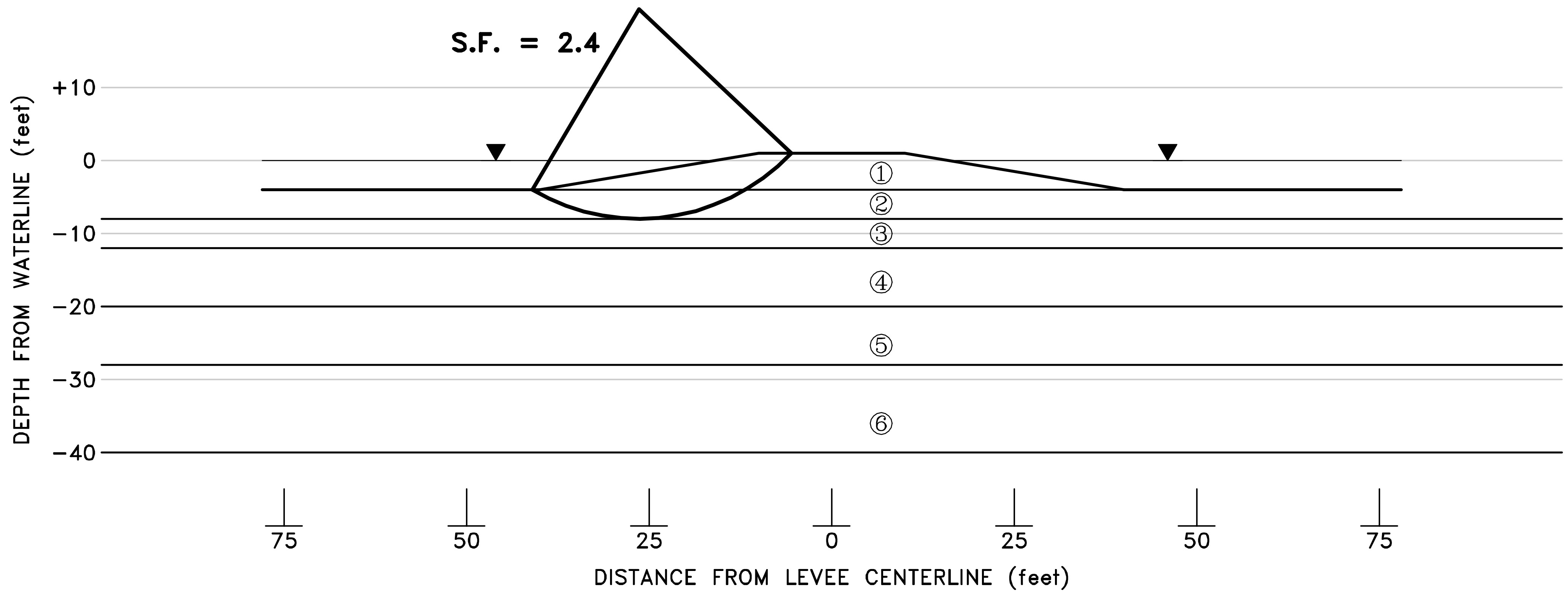
File No.: 03−1114	Date: 10−29−03	Figure No.: **C-6**

Title: **STABILITY ANALYSES WEST LEVEE**

Oct 29, 2003 − 3:48pm

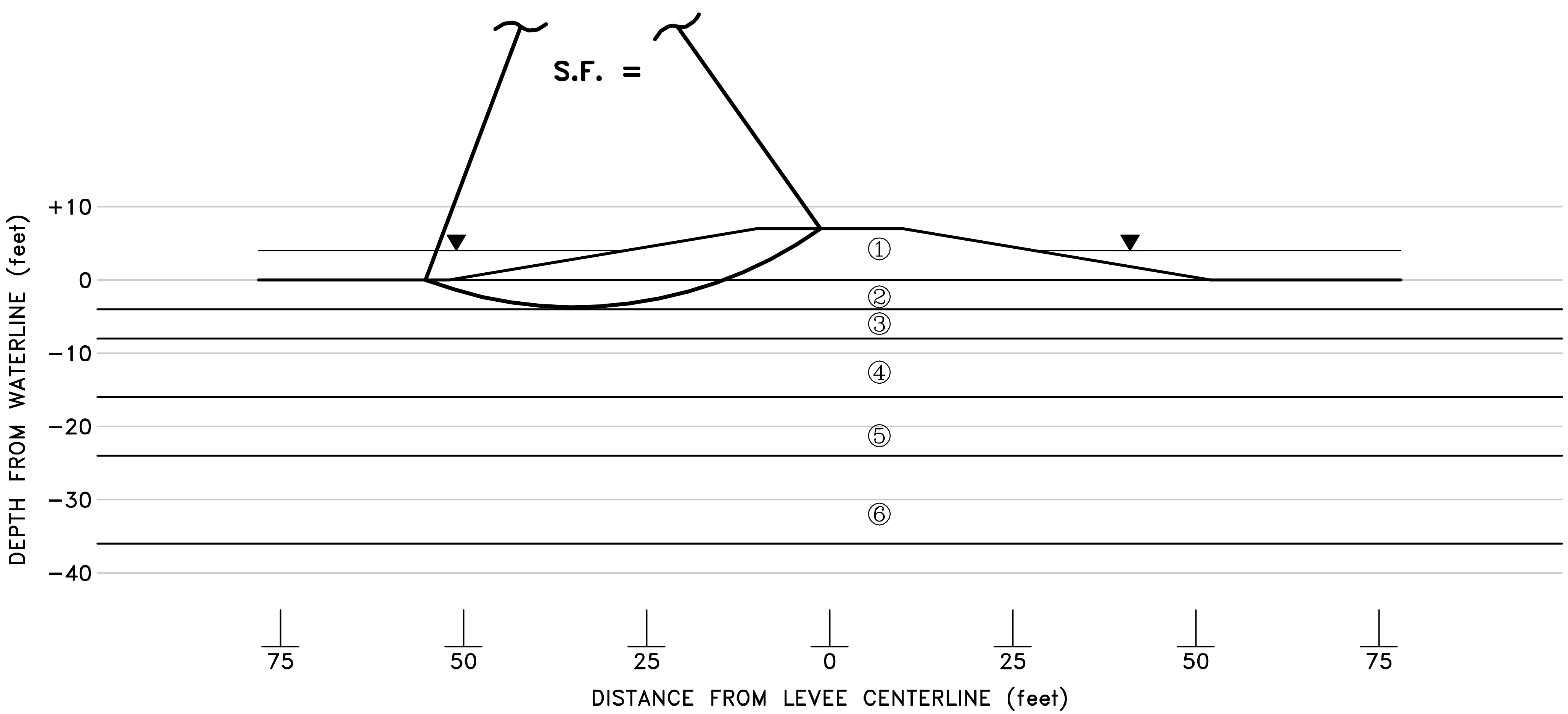
P:\2003\03−1114\CADD\031114−C6 WEST LEVEE STABILITY.DWG



1 FOOT FREEBOARD, 1(V):6(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	70	105	0
3	0	108	28
4	300	105	0
5	50	117	22
6	280	106	0

a: Analyzed for both fill types. Lowest SF illustrated.



3 FOOT FREEBOARD, 1(V):6(H) SLOPES

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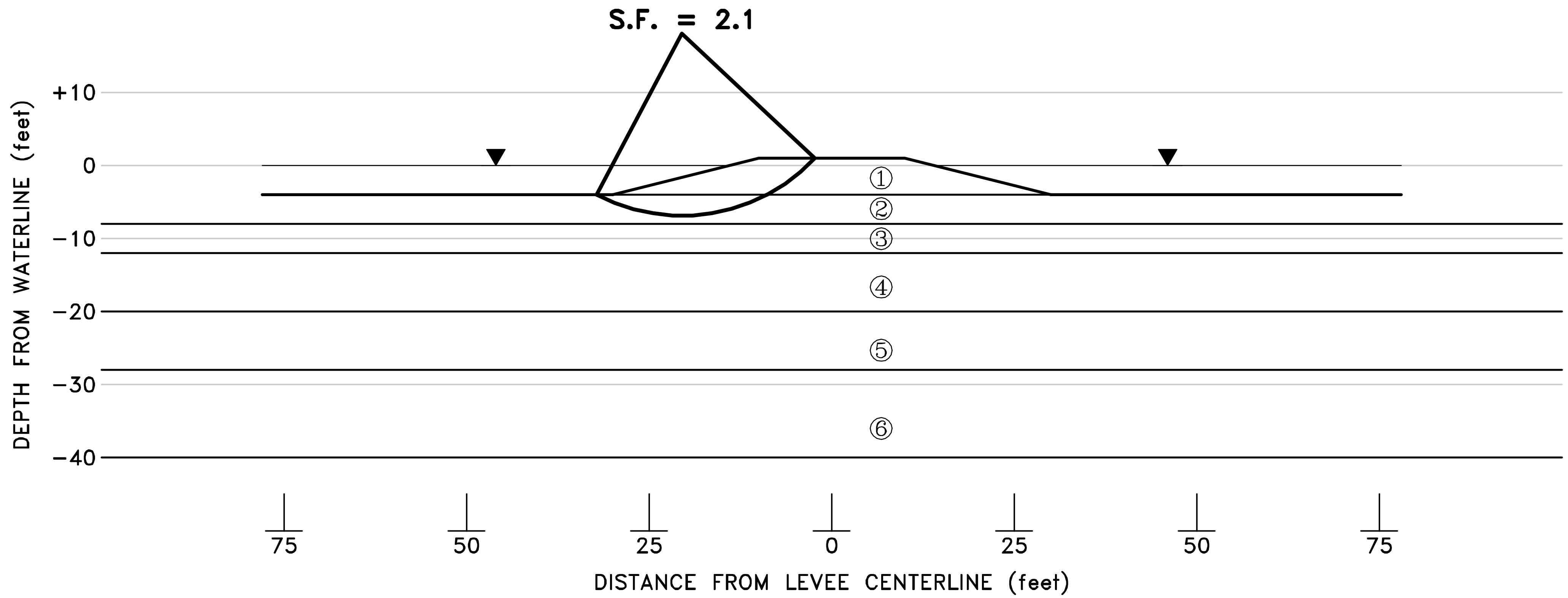
File No.: 03-1114	Date: 10-29-03	Figure No.: C-6A

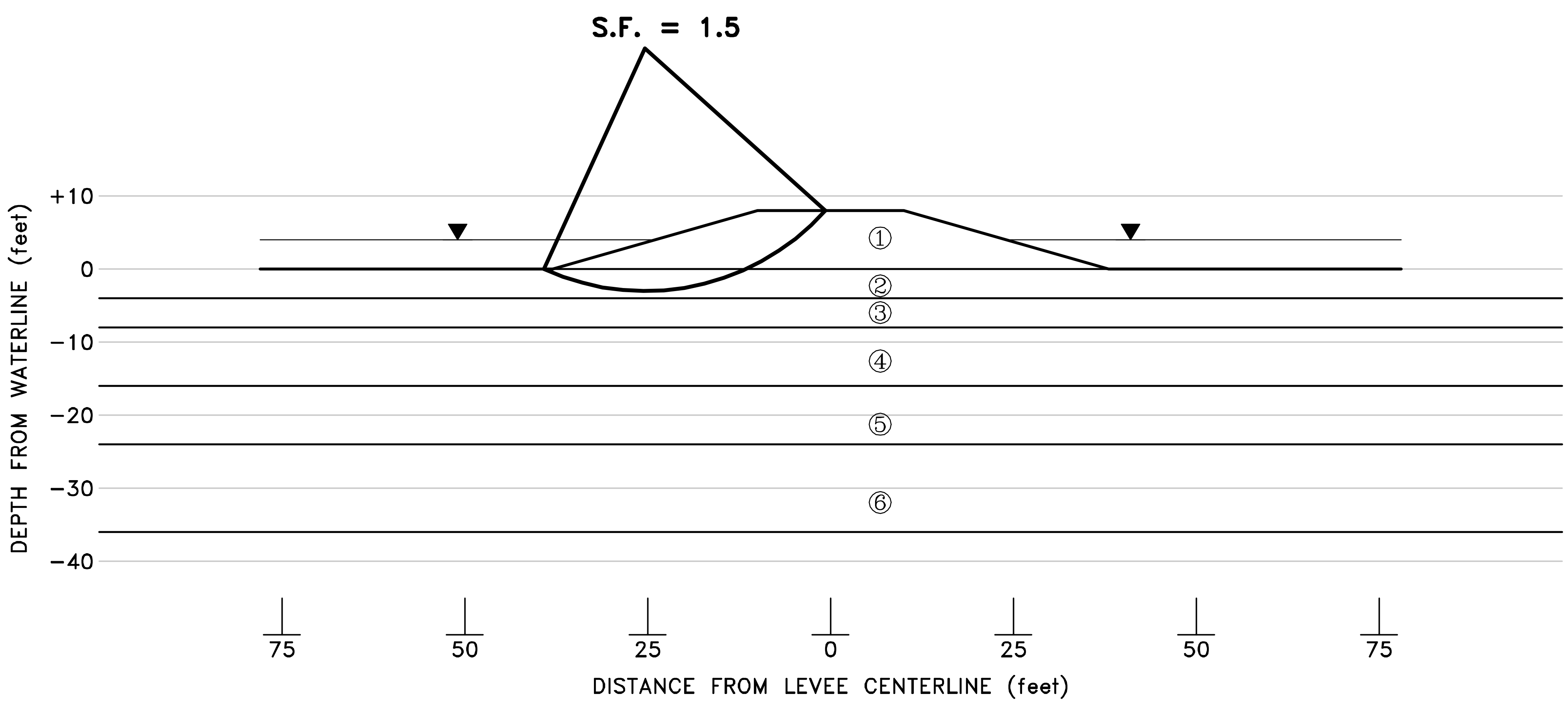
Title: **STABILITY ANALYSES WEST LEVEE**

P:\2003\03-1114\CADD\031114-C6A WEST LEVEE STABILITY.DWG

Oct 29, 2003 - 3:49pm



1 FOOT FREEBOARD, 1(V):4(H) SLOPES



3 FOOT FREEBOARD, 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	100	90	0
3	0	110	26
4	100	120	28
5	350	104	0
6	0	107	24

a: Analyzed for both fill types. Lowest SF illustrated.

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ENGINEERS
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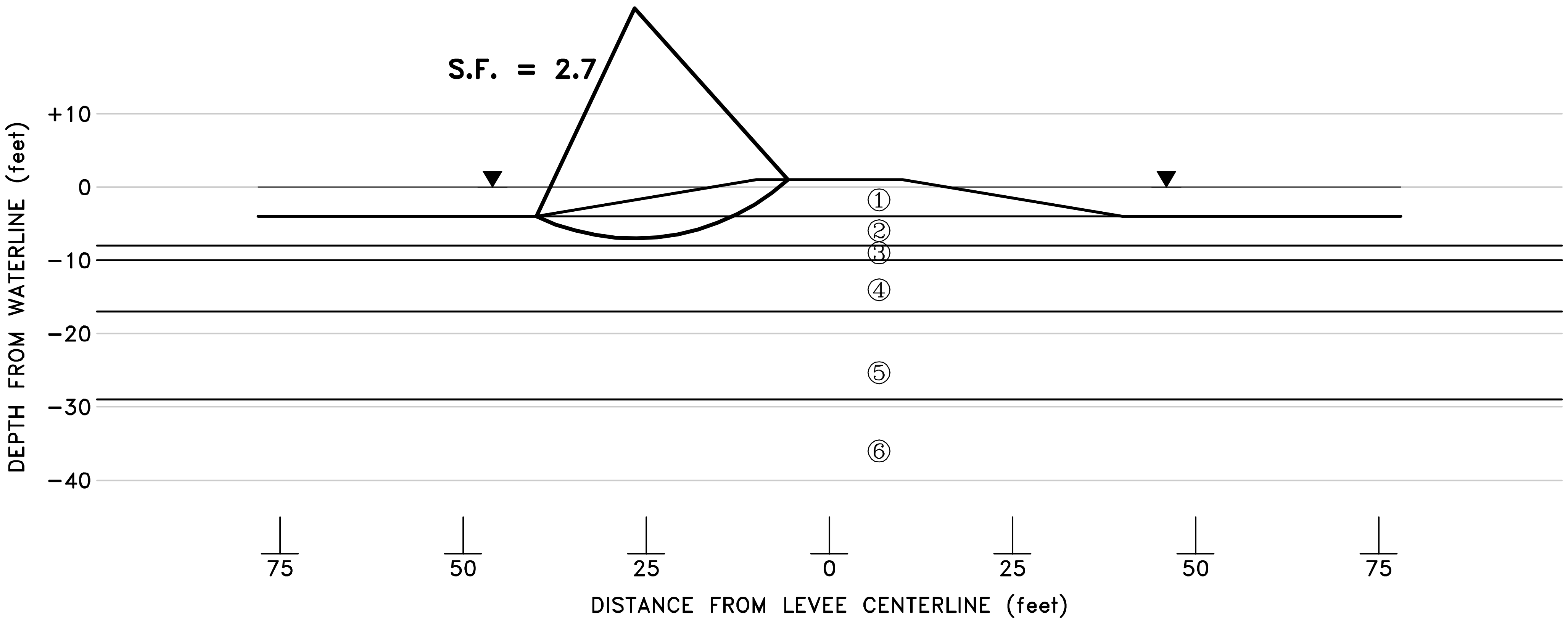
File No.: 03−1114	Date: 10−29−03	Figure No.: **C-7**

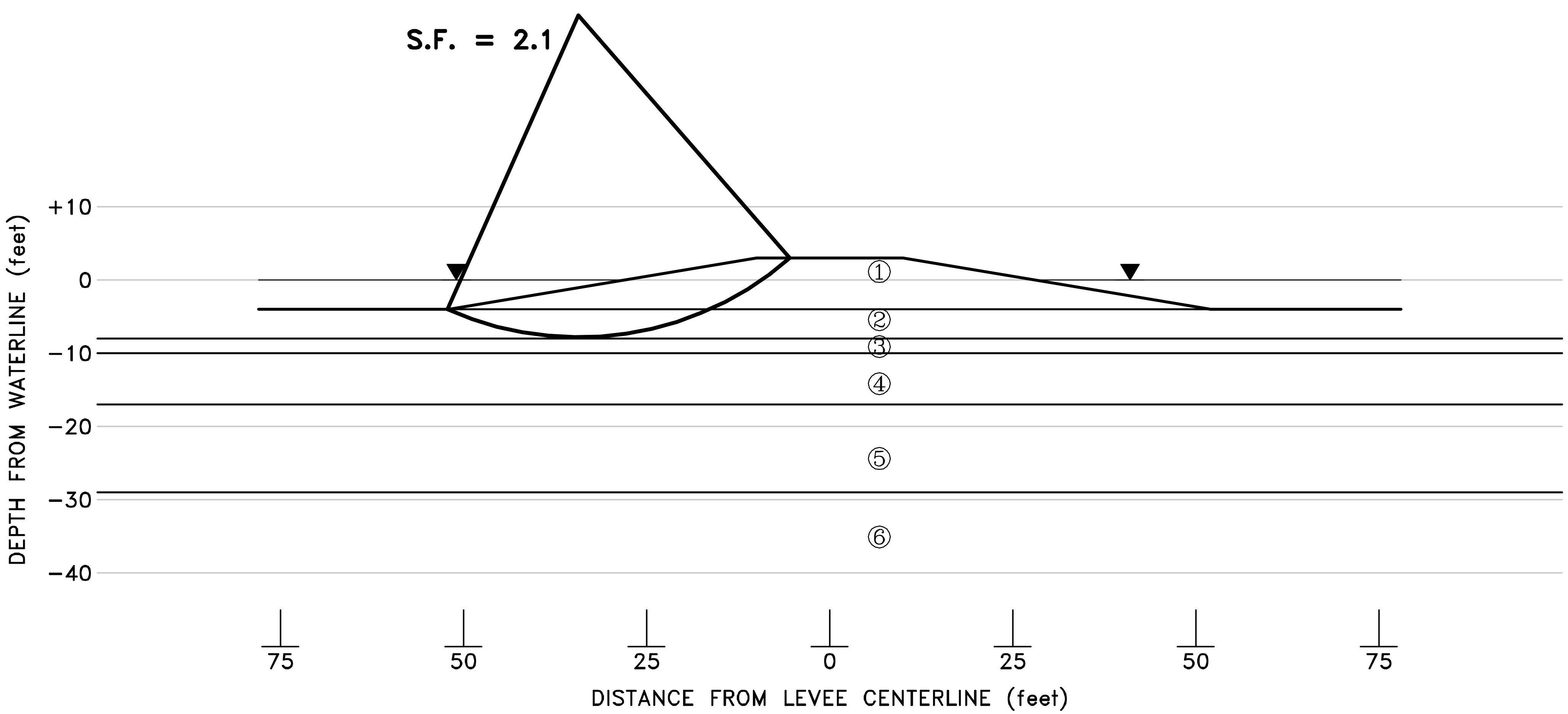
Title: **STABILITY ANALYSES NORTH/EAST LEVEE**



1 FOOT FREEBOARD, 1(V):6(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	100	90	0
3	0	110	26
4	100	120	28
5	350	104	0
6	0	107	24

a: Analyzed for both fill types. Lowest SF illustrated.



3 FOOT FREEBOARD, 1(V):6(H) SLOPES

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File No.: 03-1114	Date: 10-29-03	Figure No.: C-7A

Title: **STABILITY ANALYSES NORTH/EAST LEVEE**

Oct 30, 2003 - 1:09pm

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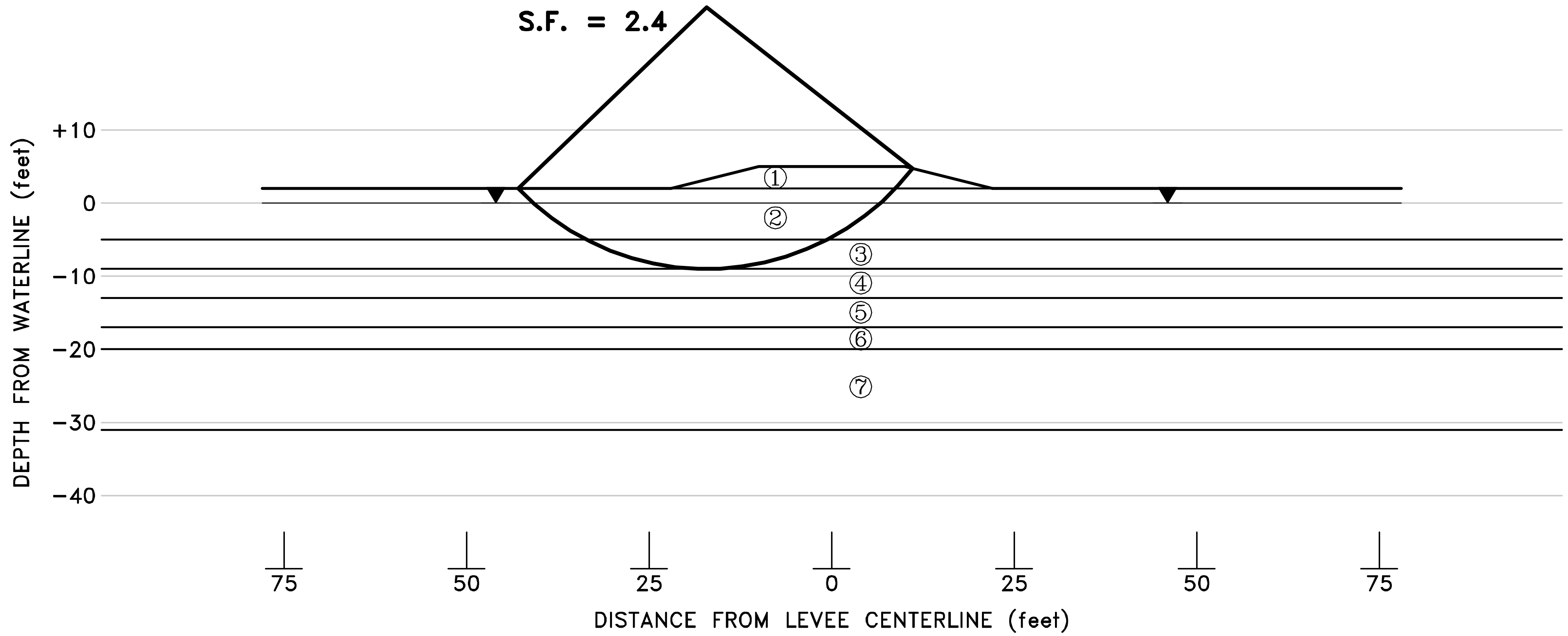
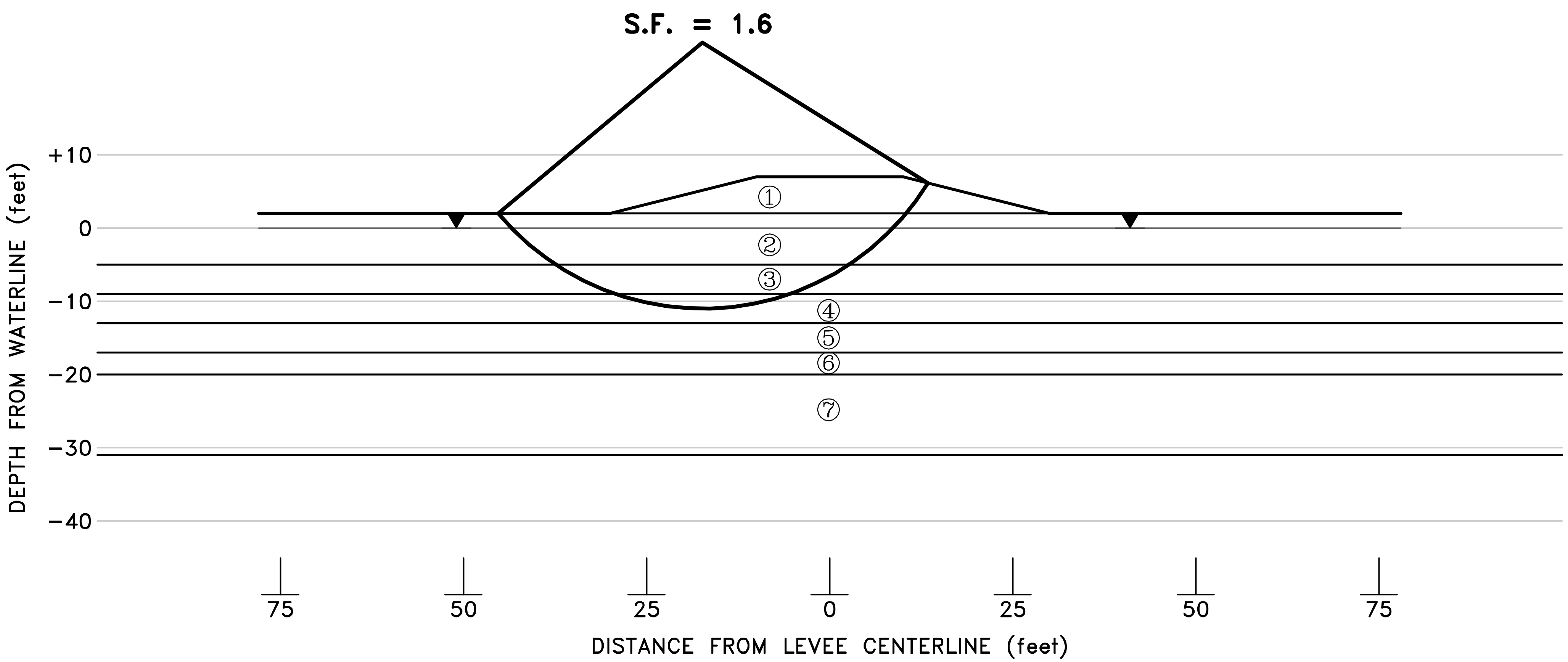


LEVEE TOP 3 FEET ABOVE RIDGE (5 FOOT FREEBOARD) 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	0	112	26
3	80	89	0
4	370	113	0
5	50	110	22
6	0	110	28
7	170	117	0

a: Analyzed for both fill types. Lowest SF illustrated.



LEVEE TOP 5 FEET ABOVE RIDGE (7 FOOT FREEBOARD) 1(V):4(H) SLOPES

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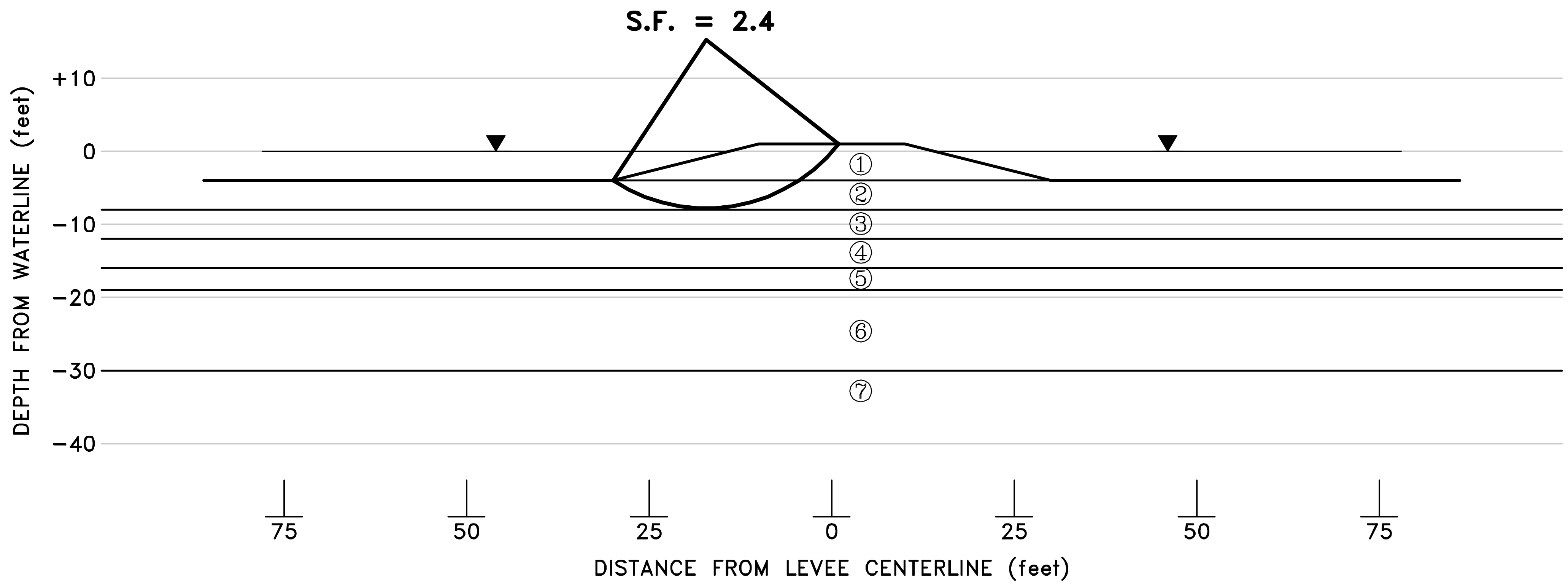
G.P. Boutwell	DMS	
File No.: 03−1114	Date: 10−29−03	Figure No.: C-8

Title: **STABILITY ANALYSES SOUTH LEVEE ON BEACH RIDGE**

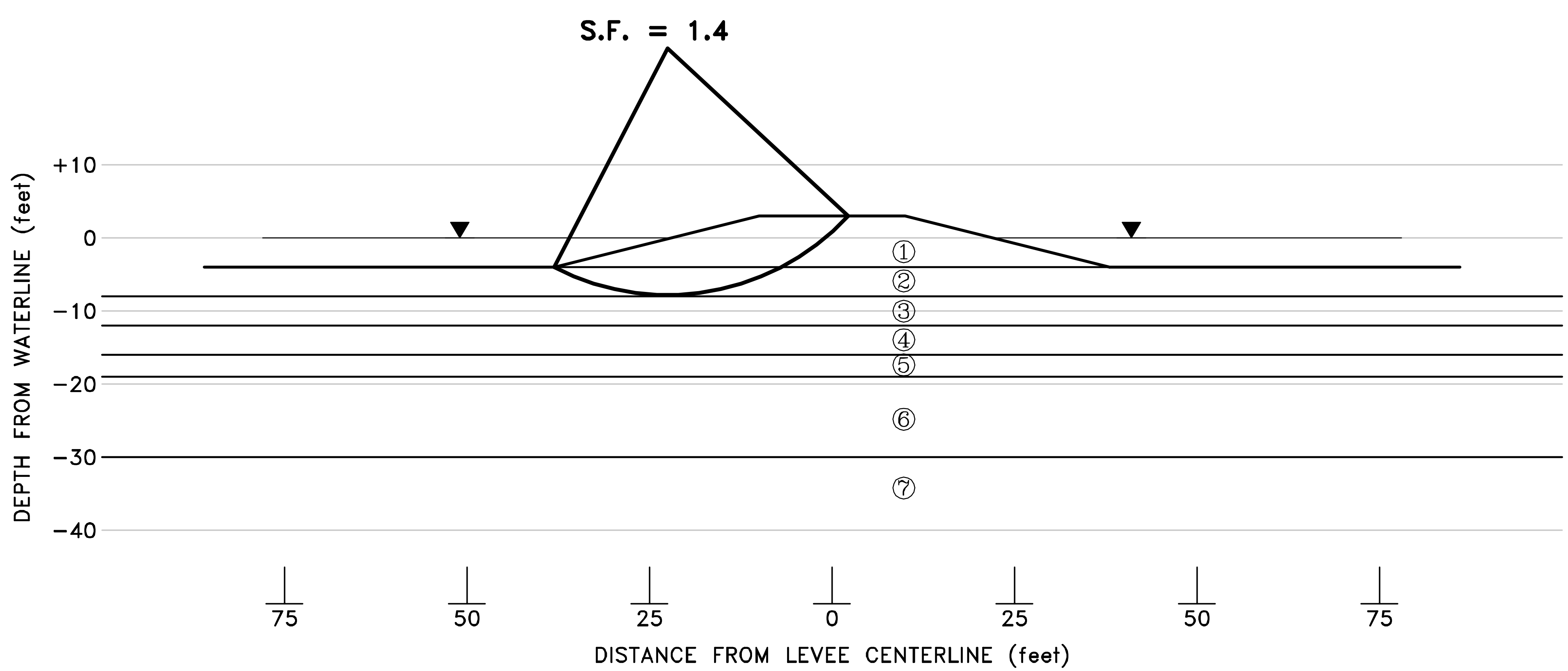
Oct 29, 2003 – 3:50pm



1 FOOT FREEBOARD 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	80	89	0
3	370	113	0
4	50	110	22
5	0	110	28
6	170	117	0
7	0	106	28

a: Analyzed for both fill types. Lowest SF illustrated.



3 FEET FREEBOARD 1(V):4(H) SLOPES

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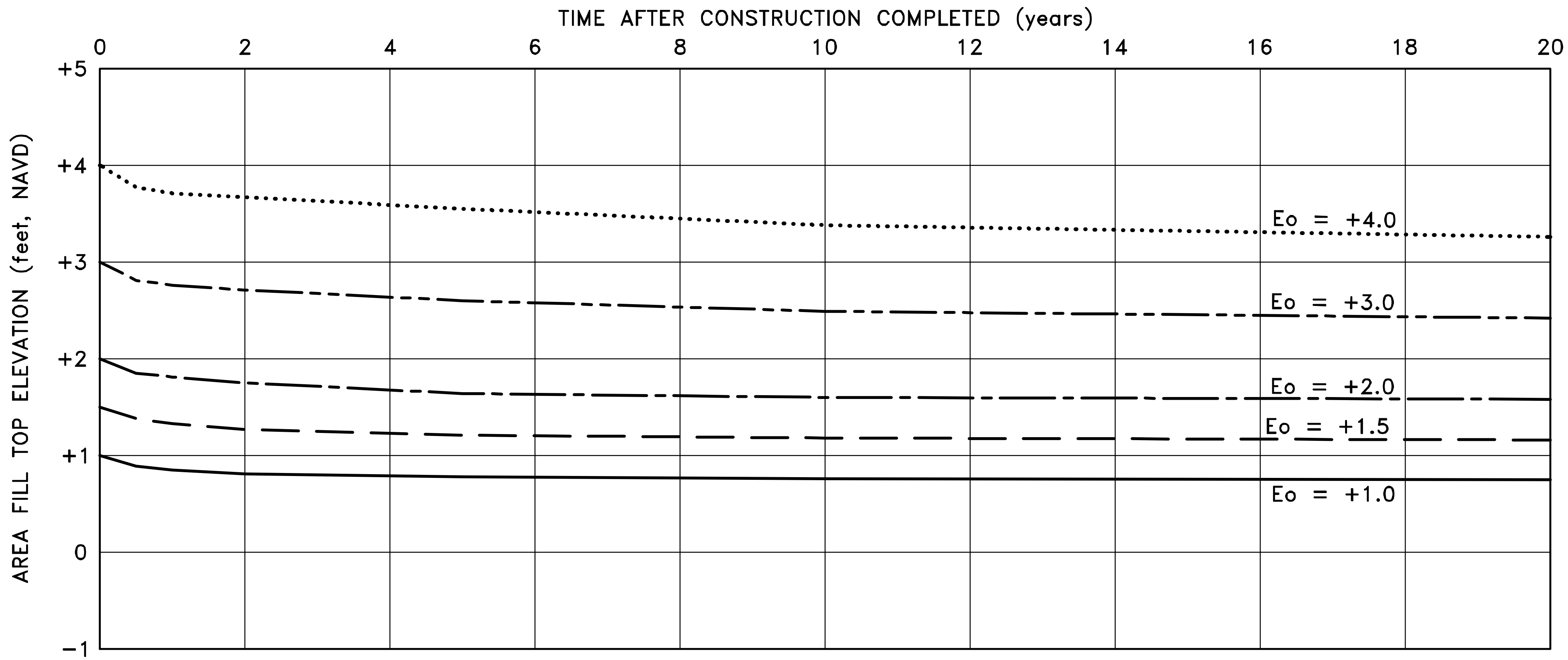
Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03–1114	Date: 10–29–03	Figure No.: C-9

Title: **STABILITY ANALYSES SOUTH LEVEE - OFFSHORE**

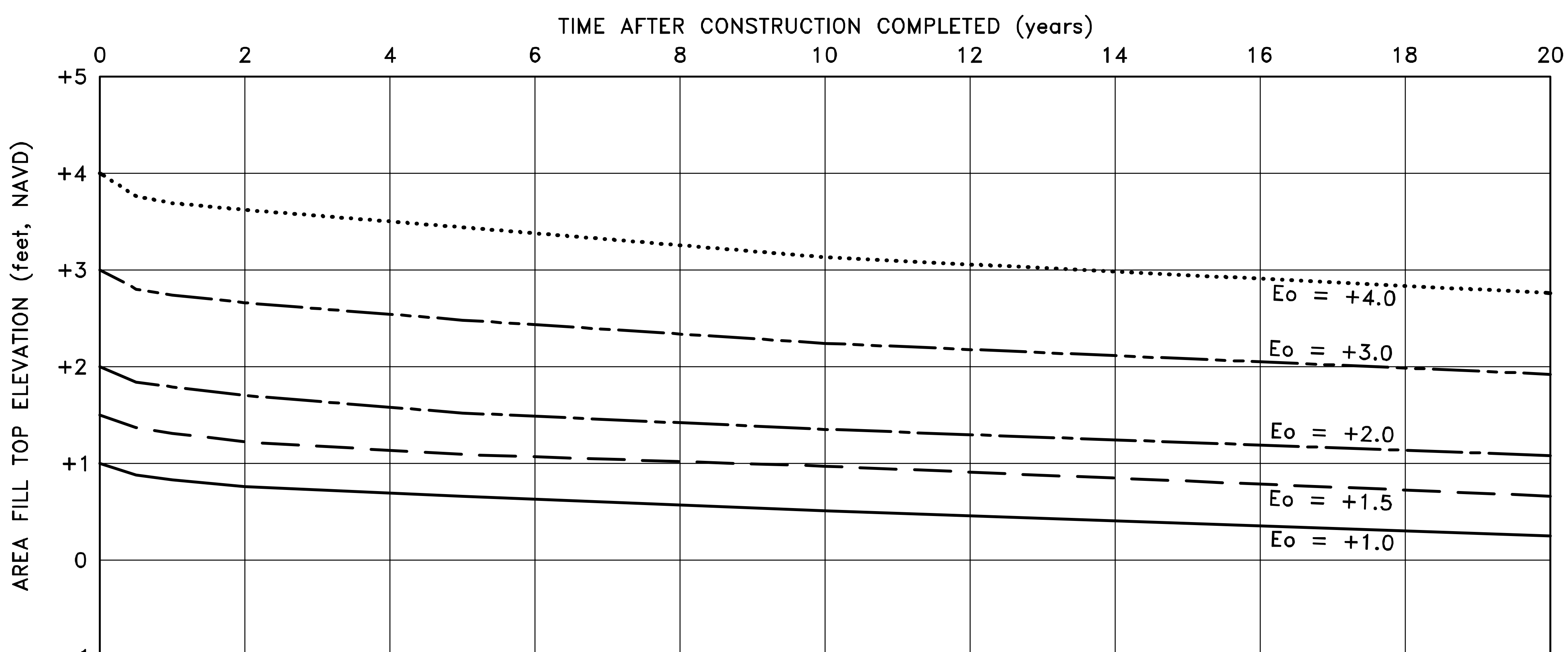
P:\2003\03–1114\CADD\031114–C9 SOUTH LEVEE STABILITY.DWG

Oct 29, 2003 - 3:50pm

P:\2003\03-1114\CADD\031114-C10 TIME SETTLEMENT.DWG



WITHOUT GEOLOGIC SUBSIDENCE



WITH GEOLOGIC SUBSIDENCE

NOTES:

1. Settlements include both self−weight consolidation and weight−induced settlements in foundation soils.

2. Geologic subsidence rate furnished by LDNR = 0.5 ft./20 yr.

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ENGINEERS
BATON ROUGE, LOUISIANA

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Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03−1114	Date: 10−29−03	Figure No.: **C-10**

Title: **TIME-SETTLEMENT CURVES: AREA FILL**

3.0 PELICAN HEADLAND AREA

3.1 GEOLOGICAL AND SOIL CONDITIONS

3.1.1 Site and Geology Conditions. This site is bounded on the west by Bayou Fontanelle and on the east by Scofield Bayou; see Figures G-1 and G-2. The surface is either water (at about 0 feet NAVD), marshland (at undefined elevations less than 5 feet NAVD), or, along the eastern tip of the south side, a barrier beach (again, elevations undefined). Reference is made to Figure G-2 and the sources cited on that figure. It indicates that the former barrier beach has generally been last to island migration and erosion. Abandoned courses traverse the project area in an essentially N-S direction about 1 mile east of Bayou Fontanelle and at English Bayou, roughly 0.7 miles west of Scofield Bayou.

STE was unable to find a published geological section close to the site. However, it appears that Holocene deposits will be found to below Elevation -200 feet NAVD, where Pleistocene-age materials begin. It must be assumed that the beach ridge exists to about Elevation -10 feet NAVD similarly to the data noted for Chaland Headland in Section 2.1.1.

3.1.2 Soil Conditions - Project Construction Area. Ten (10) borings were made to determine the subsurface conditions in the Pelican Headland project area. All of these borings were given a "P"-number (P, PF, or PS as designated by LDNR); their approximate locations are given on Figure P-I. Global Positioning System (GPS) coordinates taken during drilling are shown on the individual logs of the borings in Appendix A. The borings can be divided into three groups having roughly similar characteristics for ease of comparison.

> *3.1.2.1 Borings PS-1, PS-2, PF-5, PF-6, and P-9.* These borings cover most of the project construction area, except for an apparent old N-S channel through the western part (See Section 3.1.2.2), and the far east end of the project construction area (See Section 3.1.2.3). The average conditions at these five borings can be summarized as shown in Table 3.1-1, below.

TABLE 3.1-1
SOILS DATA: MAJORITY OF SITE

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-4	Water	-	-	-	-	0	0	0/0/0
4-11	OH	125	93	124	38	0.08	NT	NT
11-22	CH	81	57	71	57	0.11	NT	NT
22-26	ML, SM	33	14	36	79	0.57	NT	NT
26-42	CH	93	63	61	63	0.23	NT	NT
42-47	SM	NT	NT	NT	NT	0.23	NT	NT
47-78	CH	NT	NT	54	64	0.33	NT	NT
78-81+	SM	NT	NT	NT	NT	NT	60	NT

*	Below waterline	DD:	Dry Density
LL:	Liquid Limit	Su:	Undrained Shear Strength
PI:	Plas. Index	N:	Standard Penetration Resistance
W:	Water Content	NT:	Not Tested

3.1.2.2 *Borings P-7 and P-8.* These two borings apparently fall in an old N-S channel which passes through the site some 3500-4000 feet east of Bayou Fontanelle. The average soil conditions at these 23 feet deep borings are given in Table 3.1-2, below:

TABLE 3.1-2
SOILS DATA: BORINGS P-7 AND P-8

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-3	Water	-	-	-	-	0	0	0/0/0
3-6	OH, PT	134	101	180	29	0.06	NT	NT
6-9	CH	98	70	76	49	0.09	NT	NT
9-21	MS, SM	NT	NT	29	90	0.68	NT	14/72/14
21-23	CL	NT	NT	39	77	0.21	NY	NT

Notes: Same as Table 3.1-1

The soils below the 23 foot level are probably similar to those in the nearby deeper borings, PS-1 and P-9. For a general description of the likely deeper soils, see Section 3.1.1.1.

3.1.2.3 Borings PS-3 and PF-4. These two borings are located on the far east and the project construction area, adjacent to Scofield Bayou. The average conditions at these two relatively deep borings are given in Table 3.1-3, below:

TABLE 3.1-3
SOILS DATA: BORINGS PS-3 AND PF-4

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-12	Water	-	-	-	-	0	0	0/0/0
12-28	OH	139	103	115	38	0.16	NT	NT
28-30	CH	71	47	61	NT	NT	NT	NT
30-46	ML, SC	NT	NT	28	92	1.96	6	NT
46-53	CL	49	28	39	77	0.19	NT	NT
53-61+	CH	NT	NT	NT	NT	NT	4	NT

Notes: Same as Table 3.1-1

3.1.3 Soil Conditions - Borrow Area (Borings E-1 and E-2). Originally four borings were planned, two each in two different potential borrow areas. Borings S-1 and S-2 were to have been located some 2 miles south of Bayou Conquette, but were deleted. Borings E-1 and E-2 were drilled. These borings were located approximately 1 1/2 miles offshore (south) and 0.5 miles west of the project construction area; see Figure P-1. A soil profile is given as Figure P-4. The average soil conditions at these two borings can be summarized as shown in Table 3.1-4, below:

TABLE 3.1-4
SOILS DATA: BORROW PIT BORINGS

Depth* (feet)	Soil Type	LL (%)	PI (%)	W (%)	DD (%)	Su (ksf)	N (b/f)	Content (%) of Sand/Silt/Clay
0-30	Water	-	-	-	-	0	0	0/0/0
30-32	CH	68	43	57	NT	0.10	NT	NT
32-35	ML, SM	27	6	34	NT	NT	21	35/56/9
35-48	CL	38	18	44	NT	0.15	8	NT
48-53+	CH	72	50	54	NT	0.16	NT	NT

Notes: Same as Table 3.1-1

3.1.4 Limitations. The descriptions given above are (1) averages and (2) based on boreholes spaced 1000 to 3500 feet apart. The soils can be expected to vary between borehole locations. For details at a particular location consult the individual logs of the borings in Appendix A.

3.2 ENGINEERING ANALYSES

This section presents the methodologies used in the analyses, their results, and recommendations for geotechnical construction.

3.2.1 Assignments. The engineering assignments given to STE for the Pelican Headland area were outlined in STE's proposal to C-K dated July 2, 2003. They can be summarized as follows:

> *3.2.1.1 New Earthen Containment Levees.* The most significant items for design are stability and settlement. These include maximum allowable construction elevation, crown width, and side slopes (stability) plus settlements (1) during a 1-year construction period and (2) time to settle to average marsh elevation. The settlements are to be computed for five different fill (levee) heights.
>
> *3.2.1.2 Dredge Borrow and Fill.* These are primarily settlement-related items such as fill settlements (maximum fill: 0.5 feet below as-built levee tops) over 20 years, and fill-related items such as suitability of the borrow area soils, dewatering times, and cut/fill ratios.

These various items are covered in the following sections.

3.2.2 Levee Stability Analysis. This section presents the methodology used in the slope stability analyses for the Pelican Headland area levees, the cases analyzed, and the results.

3.2.2.1 Slope Stability Analysis - General. A slope has two types of forces acting on it. The soil weight and any seepage forces try to make the soil slide; these are called the "driving forces." The weight of soil below the waterline is its "effective" or, buoyant weight. Therefore, a foot of soil above water has 2 to 3 times the driving force of a foot of soil below water. The strength of the soil tries to keep it from sliding; this is called the "resisting force." Both depend on the geometry of the situation: the "Failure surface." The procedure is to isolate a block of soil (mentally), and compute the resisting and driving forces. Their ratio is called the "safety factor," and is the measure of stability. In practice, one analyses many soil blocks until the block yielding the lowest safety factor is found. This is assumed to govern, and the safety factor for the slope is the lowest safety factor determined. The calculations for any but the simplest conditions are quite laborious. They are therefore now performed on a digital computer, using a proven code such as PCSTABL, XSTABL, UTEXAS3, etc. For this project, the slope stability analyses were performed using XSTABL marketed by Interactive Software Designs, Inc. This program evolved from PCSTABL by Purdue University. The program is capable of searching for the minimum safety factor with an easy to use interface. The Bishop method of analysis was used for this project. The accepted measure of a slope's stability is its "safety factor," as defined above. Typical acceptable safety factors common in practice are:

Low Water Condition:	1.3 - 1.5
Rapid Drawdown Condition:	1.0 - 1.1

The rapid drawdown case is not applicable for this project due to the nature of the tidal conditions at the proposed structures.

3.2.2.2 Cases Analysed. Since the soil strengths are the dominant factor in slope stability, the levee area was divided into four sections having similar soil conditions (See Section 3.1). As mentioned in Section 1.1.1, the gulfside (south) levee may be built either atop the existing beach "ridge" or slightly offshore of it; the decision has not yet been finalized. Also, neither soil data nor detailed elevations are available on the beach "ridge." Therefore, certain assumptions had to be made for levees so located. The cases analysed are summarized below:

- West Levee: Borings PS-1 and PF-6
- North Levee: Borings P-7, P-8, P-10, and PS-3
- East Levee: Borings PS-3 and PS-4
- South Levee: Borings PF-6, P-5, PS-2, PF-5, and PF-4
  - Levee on Beach Ridge (with assumptions)
  - Levee offshore of beach

In each area, analyses were made for the following levee geometries:

- Initial Freeboard: 1.0, 1.5, 2.0, and 3.0 feet at least
- Water Depth: Per borings (0 to 10 feet)

- Side Slopes: 1(V):4(H), 1(V):6(H) and 1(V):8(H)
- Crown Widths: 5, 10, and 20 feet.

The soils in the borrow area are predominately cohesive materials (See Section 3.1.3 and the logs of borings E-1 and E-2). The levee fill material was therefore assumed to be a dredged clay. Calculations were also made for silt/sand fill; the lower safety factor was assumed to govern.

The Beach Ridge was assumed to be at about sea level, and, for conservatism, to extend no deeper than 5 feet below sea level (-5 feet NAVD).

3.2.2.3 *Results.* The results of the stability analyses for the Pelican Headland area are presented on Figures P-5 and P-5A (West), P-6 and P-6A (North), P-7 and P-7A (East), P-8 (South-on Ridge), and P-9 and P-9A (South-offshore) for the flatter slopes [1(V):6(H) and 1(V):8(H)]. In general, the crown widths of the levees had only a nominal effect on stability. The results can be summarized as in the table below:

TABLE 3.2-1
LEVEE SAFETY FACTORS

Levee Area	Initial Freeboard (ft.)	Safety Factor for Side Slope			
		1(V):4(H)	1(V):6(H)	1(V):8(H)	Remarks
West	1.0	1.8	>1.8	>1.8	4' Water
	1.5	1.5	>1.8	>1.8	4' Water
	2.0	**0.9**	**1.0**	**1.1**	4' Water
	2.0	1.7	>1.7	>1.7	2' Water
	3.0	<0.9	**1.0**	**1.1**	2' Water
	3.0	1.3	1.3	>1.3	2' Water
North	1.0	**0.8**	**0.9**	**1.0**	8' Water
	1.0	**0.9**	**1.0**	**1.2**	6' Water
	1.0	**1.1**	**1.2**	1.4	4' Water
	1.0	1.7	1.8	1.9	2' Water
	1.5	**0.8**	**0.9**	**1.0**	8' Water
	1.5	**0.9**	**1.0**	**1.1**	6' Water
	1.5	**1.0**	**1.1**	1.3	4' Water
	1.5	1.5	1.6	1.6	2' Water
	2.0	**0.8**	**0.9**	**1.0**	6' Water
	2.0	**1.0**	**1.1**	**1.2**	4' Water
	2.0	1.3	1.4	1.5	2' Water
	3.0	**0.8**	**1.0**	**1.1**	4' Water
	3.0	**1.1**	**1.2**	1.3	2' Water

East	1.0	1.6	>1.6	>1.6	10' Water
	1.0	2.9	>2.9	>2.9	2' Water
	1.5	1.9	>1.9	>1.9	2' Water
	2.0	1.4	>1.4	>1.4	10' Water
	2.0	1.5	>1.5	>1.5	2' Water
	3.0	**1.2**	1.3	1.5	10' Water
	3.0	1.4	>1.4	>1.4	3' Water
	4.0	**1.1**	**1.2**	1.3	10' Water
	4.0	**1.2**	1.4	1.5	6' Water
	4.0	1.3	1.5	1.7	2' Water
South (Ridge)	1.0[a]	1.8	2.3	2.8	0' Water
	1.5[a]	1.7	2.2	2.7	0' Water
	2.0[a]	1.7	2.1	2.4	0' Water
	3.0	1.7	1.8	1.8	0' Water
	4.0	1.4	1.4	1.5	0' Water
South (Water)	1.0	**1.1**	**1.1**	**1.2**	4' Water
	1.0	1.7	1.7	1.8	2' Water
	1.0	>2.0	>2.0	>2.0	0' Water
	1.5	**1.0**	**1.0**	**1.1**	4' Water
	1.5	1.4	1.5	1.6	2' Water
	1.5	>2.0	>2.0	>2.0	0' Water
	2.0	**0.9**	**1.0**	**1.0**	4' Water
	2.0	1.3	1.4	1.4	2' Water
	2.0	>2.0	>2.0	>2.0	0' Water
	3.0	**0.8**	**0.8**	**0.9**	4' Water
	3.0	**1.1**	**1.2**	1.3	2' Water
	3.0	1.7	1.7	1.8	0' Water

Bold: SF less than desired 1.3

3.2.2.4 Summary of Stability Results. The soils in the Pelican Headland area are weaker than those in the Chaland Headland area. The Pelican area conditions are more typical of the region. These weak soils have an adverse effect on stability. Acceptable safety factors were achieved without reinforcement only for:

- Levees on the Beach Ridge, up to about 4 feet high above the ridge level, using 1(V):4(H) side slopes.
- Levees with up to 3 feet of freeboard, provided that the water depth did not exceed 2 to 3 feet. See Table 3.2-1 for details.

3.2.2.5 Strengthening. It is clear that designs with freeboards exceeding about 3 feet and those in deeper water (over 2 feet) will usually have safety factors less than desired. Geotextile reinforcement is indicated for such conditions. The geotextile should have an allowable tensile strength of at least 1,000 pounds per lineal foot (measured perpendicular to the levee centerline). It should extend under the full width of the levee.

3.2.2.6 Levee Borrow. It is often desirable to obtain the borrow material for the levees from near the levee. Excavating this material from too close to the levee toe can affect the stability of the levee adversely. It is therefore recommended that the edge of the borrow pit not be closer to the levee toe than about 20 feet plus the depth of the borrow excavation.

The soils encountered in the borrow pit borings (E-1 and E-2) were discussed in Section 3.2.1, and were presented graphically on Figure P-4. These are primarily fine-grained cohesive soils; only 13% of the materials encountered were relatively granular. The CL and CH soils found in these borings are not as suitable for fill purposes as the more granular soils found in the Chaland Headland borrow area (See Section 2.2.4). However, they are better than the PT and OH soils found on other projects.

3.2.3 Levee Settlement Analyses. The assignments relative to levee settlements in the Pelican Headland area were given in Section 3.2.1. They require calculating both the total amounts of settlement which will occur after a very long time, and the time-rates at which these movements will occur. Levee settlement is composed of three parts:

- Settlement in the foundation soils due to the weight of the levee,
- Settlement within the levee itself due to self-weight consolidation (minor), and
- Geological Subsidence. This rate was furnished by LDNR as about 0.025 feet per year.

3.2.3.1 Analyses - Total Amount of Settlement due to Levee Weight. The total amount of settlement depends on the geometry and intensity of the applied load (levee fill) and on the compressibilities of the underlying soil strata. As settlement progresses, the net intensity of the applied load decreases. This is especially true for levees built in water. The maximum possible settlement is that calculated without taking this phenomenon into account, and forms the basis for calculations which do use load intensity decrease. Note that this decrease occurs if the levees are not periodically rebuilt to their initial elevations.

The actual settlement calculations were performed using the computer code VSTRESS, originally developed by the Corps of Engineers, and SETOFF as developed by Ensoft, Inc. These programs calculate one-dimensional settlement based on either Boussinesq or Westergaard stress distributions. The Boussinesq stress distribution was used for these analyses. For the soil types that had consolidation tests, actual consolidation curves were used in the calculations. Published correlations were used for other soil types to obtain consolidation indices using Atterberg Limits and moisture content values.

3.2.3.2 Cases Analysed. Since the clayey soils (PT, OH, CH, CL), and especially the organic types (PT, OH), are highly compressible (See Table A-1 in Appendix A), they contribute far more to settlement than do the less compressible granular soils (ML, SC, SM). Therefore, calculations were made for the generalized conditions corresponding to:

- PS-2, PS-3, and PF-4 (Large amounts of organic soil)
- PS-1, PF-5, P-9, and P-10 (Large amounts of clays)
- P-7 and P-8 (Large amounts of near-surface granular soils)

The soil conditions below the 23 foot bottoms of Borings P-7 and P-8 were assumed to be similar to those of the nearby, deeper PS-1. In all cases, the soils below about the 45 foot depth were assumed to be similar to those of the deepest boring on-site, P-9. Calculations were made for crown widths of 5 to 20 feet, and using the average levee slope [1(V):6(H)]. On the West, North, and East levees, levee heights above water were taken as 1, 2, 3, and 4 feet, with water depths of 0, 2, 4, 6, 8, and 10 feet. The South levee had 2 general cases (on the "ridge" and offshore) as discussed in Section 3.2.2. For the ridge, the levee heights were taken as 1, 2, and 3 feet above ground level.

3.2.3.3 Effect of Settlement on Further Settlement. Most of these levees will or may be constructed in water. The levees are originally built to some level above water, and produce a stress level which includes the *total* weight of levee material above water. As settlement proceeds, some of the material which was originally above water becomes submerged. That material now exerts pressure due to its *buoyant* weight, which is less than its total weight. The net result is that the pressure decreases and the real settlement is less than would be predicted using the total weight. There are two other factors which must be considered:

- If the levee heights are rebuilt, settlement will tend to reach the "total weight" movements.

- At most locations, the levee will be underlain by a substantial amount of granular soils, which consolidate rapidly. The movements due to these soils will probably occur during construction, so that the "total weight" movements in these granular materials (only) will be realized during construction.

3.2.3.4 Total Settlements due to Levee Weight. The starting point is the "raw" settlement computed using the total unit weight for above-water fill. For the observable post-construction settlements, these must be reduced by the movements occurring in the granular layers during construction, termed "adjusted" settlement. Then, the effect of the remaining long-term settlement on the applied pressure must be considered (See Section 3.2.3.3). This is termed the "net" settlement.

The results of these analyses are presented below. Table 3.2-2 provides the settlement data for the levees built over marsh or water, and Table 3.2.3 gives the settlements for the South levee if it is constructed on the beach ridge.

TABLE 3.2-2
LONG-TERM SETTLEMENTS: LEVEES NOT ON BEACH RIDGE

Geometry Situation		Centerline Settlement (feet)									
		PS-2, PS-3, PF-4			PS-1, PF-5, P-9, P-10			P-7 and P-8			Avg. Net
Water (ft.)	Height[a] (ft.)	Raw	Adj.	Net	Raw	Adj.	Net	Raw	Adj.	Net	
0	1	0.84	0.72	0.55	0.81	0.68	0.50	0.72	0.61	0.50	0.52
	2	1.46	1.24	0.94	1.42	1.19	0.90	1.21	1.05	0.81	0.88
	3	2.06	1.74	1.33	2.00	1.73	1.31	1.68	1.44	1.13	1.26
	4	2.66	2.24	1.70	2.58	2.23	1.66	2.13	1.81	1.46	1.61
2	1	1.37	1.16	1.10	1.29	1.07	0.82	1.07	0.91	0.77	0.90
	2	1.90	1.70	1.40	1.82	1.58	1.19	1.50	1.27	1.05	1.21
	3	2.49	2.04	1.67	2.39	1.99	1.57	1.89	1.56	1.30	1.51
	4	3.08	2.38	1.96	2.96	2.41	1.91	2.25	1.83	1.56	1.81
4	1	1.78	1.53	1.21	1.70	1.49	1.23	1.28	1.04	0.87	1.10
	2	2.26	1.86	1.52	2.17	1.93	1.54	1.63	1.37	1.11	1.39
	3	2.82	2.27	1.86	2.73	2.33	1.85	1.99	1.65	1.38	1.70
	4	3.38	2.68	2.12	3.29	2.64	2.15	2.31	1.89	1.63	1.97
6	1	2.04	1.74	1.45	1.93	1.63	1.39	1.49	1.21	1.11	1.32
	2	2.52	2.12	1.72	2.42	1.91	1.62	1.83	1.56	1.30	1.55
	3	2.96	2.36	1.98	2.87	2.17	1.96	2.05	1.70	1.52	1.82
	4	3.40	2.60	2.25	3.32	2.67	2.11	2.39	1.97	1.70	2.02
8	1	2.25	1.85	1.53	2.12	1.70	1.40	1.72	1.49	1.30	1.41
	2	2.61	2.15	1.81	2.50	2.05	1.66	2.10	1.76	1.52	1.66
	3	3.10	2.50	2.08	2.96	2.36	1.94	2.37	2.00	1.73	1.92
	4	3.47	2.70	2.35	3.42	2.75	2.23	2.61	2.24	1.95	2.18
10	1	2.48	2.08	1.83	2.15	1.77	1.44	1.90	1.62	1.45	1.73
	2	2.84	2.39	2.01	2.53	2.11	1.72	2.18	1.82	1.61	1.78

	3	3.19	2.64	2.27	3.02	2.47	2.02	2.42	2.02	1.80	2.03
	4	3.54	2.89	2.53	3.51	2.82	2.31	2.65	2.32	1.98	2.27

[A] As-Built height above water level

TABLE 3.2-3
LONG-TERM SETTLEMENTS: SOUTH LEVEE ON BEACH RIDGE

Geometry Situation		Centerline Settlement (feet)									
		PS-2, PS-3. PF-4			PS-1, PF-5, P-9, P-10			P-7 and P-8			Avg. Net
Water (ft.)	Height[b] (ft.)	Raw	Adj.	Net	Raw	Adj.	Net	Raw	Adj.	Net	
0	1	0.67	0.48	0.37	0.57	0.46	0.33	0.48	0.41	0.34	0.35
	2	1.09	0.93	0.71	1.06	0.90	0.67	0.90	0.78	0.61	0.66
	3	1.65	1.39	1.06	1.58	1.36	1.04	1.34	1.15	0.90	1.00
	4	2.20	1.83	1.39	2.14	1.86	1.36	1.75	1.47	1.21	1.32

[b]: Above ground surface (+2 feet NGVD)

In the above Tables 3.2-2 and 3.2-3, the "Net" settlements should be used to evaluate long-term performance unless the levees are raised by additional fill at some time in the future. In the latter case, the "Adjusted" settlements would be more appropriate.

3.2.3.5 Geological Subsidence. The only other significant source of settlement will be that due to geological subsidence. This rate was furnished by LDNR as about 0.025 feet per year. This is of little consequence for the first few years, but becomes significant over long periods. For example, the movement due to geological subsidence is estimated as 0.1 feet in the first 4 years, but increases to 0.5 feet at the end of the estimated project life at 20 years after construction.

3.2.3.6 Analyses - Time Rate of Settlement due to Levee Weight. The time-rate of settlement as observed at the ground surface depends on several factors, as discussed below:

- Soil Rate Parameter (c_v). This is intrinsic to each soil type, but varies with the total vertical pressure in the soil layer. In general, settlement within the granular soils (ML, SC, SM) will occur virtually during construction.

- Drainage Path Length (L). Consolidation is a process of squeezing water out of the soil voids. The water has to go somewhere, and that is to either the surface or a relatively permeable layer (such as a silt layer in a clay mass).

- Vertical Distribution of the Total Settlement. The time rate applies to each layer; the contribution of each layer is its own ultimate settlement multiplied by its degree of consolidation at a particular time.

Like other problems in time-dependent flow in soils, the analysis for the time-rate of consolidation is inherently inaccurate. Normally, settlement occurs faster than the prediction.

Calculations were made for the soil conditions at the locations cited in Section 3.3.3.2. The results were normalized by dividing the "Net" settlements at various times by the ultimate (long-term) "Net" settlement. This approach accounts directly for the settlements which occur during construction. Settlement rates were analyzed for the tallest and the lowest levee heights and averaged. The percentages of settlement given in Table 3.2-4 should be applied to the "Net" total settlements given in Tables 3.2-2 and 3.2-3.

TABLE 3.2-4
NET RATES OF WEIGHT-INDUCED SETTLEMENT

Time (years)[d]	Percentage of Weight-Induced Settlement Complete			
	PS-2, PS-3, PS-4	PS-1, PF-5, P-9, P-10	P-7 and P-8	Avg.
0.0	0	0	0	0
0.5	37	52	43	44
1.0	61	66	57	61
2.0	80	79	70	76
5.0	93	89	84	88
10.0	96	95	90	93
20.0	98	98	96	97

[d]: After construction is complete

3.2.3.7 Time to Reach Marsh Elevation. The average desired marsh elevation is assumed to be approximately +1.0 feet NAVD, equal to about one foot above water level at the site. It is assumed that the initial levee top elevation will be up to 4 feet above the site water level, or +4 feet NAVD. The "Net" settlement data from Sections 3.2.3.4 (no rebuilding) and the time-rate information in Sections 3.2.3.5 and 3.2.3.5 was analyzed. The analysis showed that, even with geologic subsidence, levees with initial top elevations of +2 feet NAVD or more will never settle below +1 feet NAVD unless the water depth exceeds 6 feet. If the water depth exceeds 6 feet, the times range from 10 to 20 years.

3.2.4 Suitability of Borrow Area Soil. The soils encountered in the Borrow Area for the Pelican Headland were presented in Section 3.1.3. Only about 13% of the soils encountered were the more preferable granular types (SM, ML). The remainder were cohesive (CH, CL), but not highly organic. They are suitable for levee and area fill construction. In the main construction area, however, there is not only a lack of granular soil, but a substantial layer of organic soils (OH, PT) which averages some 7 to 8 feet thick and is located just below the mudline. If at all possible, these organic soils should not be used for levee construction. They are suitable for area fill.

3.2.5 Dewatering Time for Area Fill. When soil particles are in suspensions with low concentration of solids, particles settle as individual entities, and there is no significant interaction with neighboring particles (Type I settling). With increasing solids concentration, the particles coalesce or flocculate. By coalescing, the particles increase in mass and settle at a faster rate (Type II settling). With further increase in concentration, the interparticle forces are sufficient to hinder the neighboring particles (Type III settling). Finally, the soil particles settle to form a structure (Type IV settling). The dredging operation typically creates a soil suspension with 5 to 10 percent solids. At this concentration range, the clayey portion of the soils settles at a rate close to Type III. Types I and II settling are applicable for the more granular fills on this project. These two types are typically used for sediment transport modeling. Type IV settling is typically simulated with the diffusion equation using either Terzaghi or Gibson consolidation theory and is discussed in Section 2.2.6.

The dewatering time varies with type of soils and salinity of the water and is often determined using a column test. In this case, however, the bulk of the borrow material will be relatively granular soil. Settling velocities for such materials are commonly calculated using Stokes' Law (see, e.g., ASTM D422). Velocities for various particle size groups were calculated following D422 and are given in Table 3.2-5, together with an estimate of the percentage of the E-1 plus E-2 borrow material falling into each size group.

TABLE 3.2-5
PARTICLE SETTLING VELOCITIES

Partiate Group	Size Range (mm)	Settling Velocity (ft./day)	Portion of Borrow (%)
Medium Sand	0.2-0.4	>1000	0
Fine Sand	0.07-0.2	>1000	26
Coarse Silt	0.02-0.07	330	22
Fine Silt	0.005-0.02	24	28
Clay	<0.005	1-6	24

The time-sedimentation rate was computed from a column test performed for the Barataria Landbridge Project (BA-36) and the above data. Some 90% of the pumped fill should decant its water (i.e., sediment out) in a period of 1 to 2 months or less.

3.2.6 Settlements Induced by Area Fill. The area fill within the Pelican Headland deposition areas will induce two types of settlements:

- Settlements within the deposition areas
- Additional settlements at the perimeter levees.

In addition, the surface of the Area Fill will exhibit settlement from two other sources: consolidation within the fill itself and geologic subsidence.

The settlements induced by weight of the Area Fill are described below.

3.2.6.1 Method of Analyses. The calculations were made in the manner outlined in Section 3.2.3.1. The settlement data contained in the tables in Section 3.2.3.4 indicate that the variations in settlement among the boring locations are typically within the ± 25% accuracy commonly achieved in settlement analyses. Therefore, the computations were performed for the soil conditions at the same boring groups to bound the additional levee settlements.

3.2.6.2 Settlements within Deposition Areas. The major consideration here is the loading which will occur as the soil grains settle out of suspension in the introduced water. It has been assumed that sediment-laden water will be added periodically until the sediment surface is approximately 0.5 feet below the design long-term levee crests. Various sediment heights were also checked for completeness. The applied loading will be the resulting sediment thickness multiplied by the unit weight of the sediment. The latter was taken from earlier Column Tests and the densities observed for the shallow sediments in the boreholes; the design value was 70 lb.cu.ft. Net settlements adjusted for the effects of settlement on applied loading as described in Section 3.2.3.3 were used. The resulting settlement values are presented in Table 3.2-6 below:

TABLE 3.2-6
LONG-TERM AREA SETTLEMENTS DUE TO WEIGHT OF GENERAL FILL

Boring	Additional Area Settlement Due to General Fill (feet)			
	Elev. +1.0[f]	Elev. +1.5[f]	Elev. +2.0[f]	Elev. +3.0[f]
PS-2, etc.	0.40	0.56	0.71	1.02
PS-1, etc.	0.42	0.60	0.75	1.05
P-7 & P-8	0.40	0.53	0.66	0.94
Average	0.41	0.56	0.71	1.00

[f]: Design top of sediment (ft. NAVD); min. 0.5 feet freeboard. Marsh elevation assumed as 0.0 feet NAVD.
Settlements calculated for 30+ feet from levee

The values tabulated above are valid for relatively uniformly loaded areas at least 30 feet away from the toes of the levees. In the zones closer to the levees, the settlements can be approximated (if necessary) by interpolating between the values given above and those for additional levee settlements given in Section 3.2.6.3.

As described in Section 3.2.5, Type I and Type II settling will dominate even at the solids concentration expected from the dredging operation. However, the time to complete the two processes will be relatively short as compared to Type III settling process. The next step is dewatering (Type III), during which the unit weight of the sediments change from the buoyant to the total state. Given these complications, a time-rate analysis is only an approximation. However, it is estimated that the settlement rates will be approximately as follows. Upon completion of final filling (5 year estimate), about 30% to 40% of the tabulated within-fill settlement values will be completed (See Table 3.2-7). Another 10% to 20% will occur during the dewatering period, leaving 40 to 60% to take place after dewatering is complete. Figure P-10 presents the rate of settlement estimated including the dewatering (consolidation) within the fill itself, and also adds the effect of geologic subsidence.

3.2.6.3 Overall Settlement Rate. The overall settlement rate is the combination of the effects from the three major sources:

- Settlement due to weight of Area Fill,
- Self-Weight Consolidation within the fill, and,
- Geologic Subsidence (0.025 feet per year).

These are combined in Table 3.2-7 below:

TABLE 3.2-7
AVERAGE POST-CONSTRUCTION AREA SETTLEMENT

Initial Fill Top Elevation (ft.NAVD)	Time After Construction (years)	Post-Construction Settlement (feet) due to			Total Post-Construction Settlement (feet)
		Soils Below Fill	Within Fill	Geologic Subsidence	
+1.0	0.5	0.18	0.03	0.01	0.22
	1.0	0.25	0.06	0.02	0.33
	2.0	0.31	0.12	0.05	0.48
	5.0	0.36	0.18	0.12	0.66
	10.0	0.38	0.20	0.25	0.83
	20.0	0.39	0.20	0.50	1.09

+1.5	0.5	0.24	0.03	0.01	0.28
	1.0	0.34	0.06	0.02	0.42
	2.0	0.42	0.12	0.05	0.59
	5.0	0.49	0.18	0.12	0.79
	10.0	0.52	0.27	0.25	1.04
	20.0	0.54	0.29	0.50	1.33
+2.0	0.5	0.31	0.02	0.01	0.34
	1.0	0.43	0.04	0.02	0.49
	2.0	0.53	0.08	0.05	0.66
	5.0	0.62	0.16	0.12	0.90
	10.0	0.66	0.24	0.25	1.15
	20.0	0.68	0.36	0.50	1.54
+3.0	0.5	0.44	0.02	0.01	0.47
	1.0	0.61	0.04	0.02	0.67
	2.0	0.76	0.06	0.05	0.87
	5.0	0.88	0.12	0.12	1.12
	10.0	0.93	0.24	0.25	1.42
	20.0	0.97	0.36	0.50	1.83

The total, overall rate is presented graphically for the various initial Area Fill elevations on Figure P-10. This figure shows the anticipated fill top elevations over time, both for the case of no geologic subsidence and considering geologic subsidence.

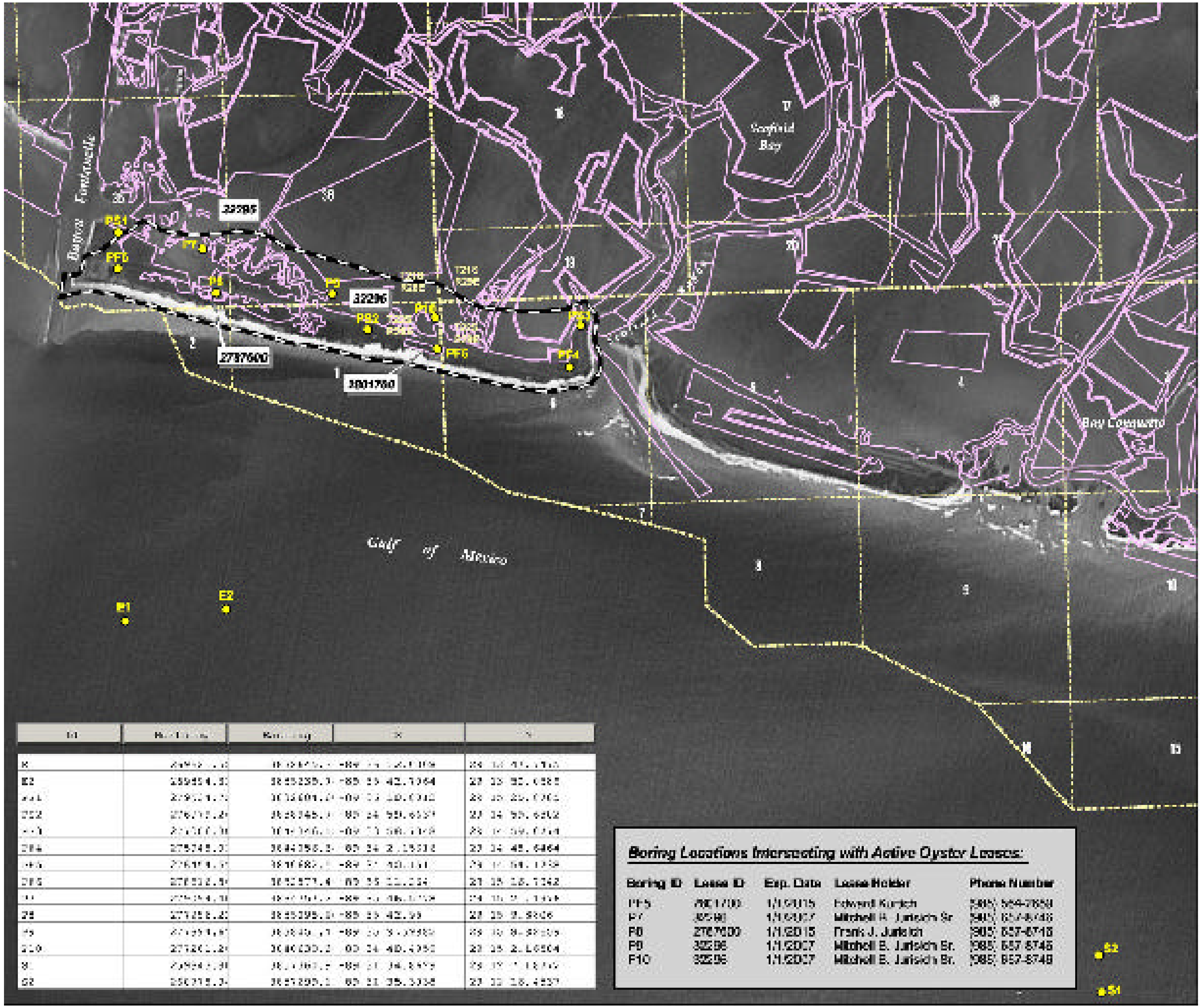
3.2.6.4 Settlement Effects on Levees. The weight of the new sediments adjacent to the levees will cause additional settlements of these levees. These movements were calculated for the two boring groups showing the least and most compressible soil conditions along the levees in order to "bound" the movements. They indicated total, long-term centerline adjusted settlements of the levees of 0.4 to 0.6 feet. These movements will occur at approximately the rates given for the Depositional Areas in Section 3.2.6.2.

3.2.7 Cut/Fill Ratios. Two cases should be considered here. The first is the amount of cut necessary to create a given amount of levee fill. The levee fill is assumed to be placed mechanically (i.e., with draglines or similar equipment), not hydraulically. The general fill will be placed hydraulically, and will therefore have a cut/fill ratio different from that applicable to mechanically placed fill. Both cases are described below.

3.2.7.1 Levee Fill. Reference is made to the descriptions of the soil conditions along the levees given in Section 3.1.2, and to the material use recommendations in Section 3.2.4. Overall, about 10% of the cut material will be Peat (Pt), which is not recommended for levee construction. The shrinkage of the more suitable SM, ML, CL, and CH soils from pit to levee will depend primarily on transport losses and loss of water content. The former (transport) is best obtained from experienced contractors, but is expected to be on the order of 25%. The water loss shrinkage is estimated as 10% to 15% of the pit volume. Overall, then, preliminary estimate can be based on about 1.5 to 1.8 cubic yards of suitable cut to produce 1.0 cubic yard of levee fill.

3.2.7.2 Area Fill. It is very difficult to determine the cut/fill ratios for the hydraulically placed area fill. As discussed in Section 3.2.5, sedimentation or settlement occurs in stages, thereby the volume of fill changes. A reasonable assumption of the initial fill height is when the density of the fill reaches the end of Type III settling (fast) or beginning of the Type IV settling (slow). The fill soil volume then can be related to the density and cut/fill ratio determined. The borrow area soils for the Pelican Headland area are similar to but dryer than those for which a Column Test was performed on the Barataria Landbridge Project (BA-36). Based on that test, and adjusting for the soils' water contents, the cut/fill ratio is expected to be about 1.3, i.e., 1.3 cubic yards of suitable cut should produce 1.0 cubic yard of in-place area fill. Note that the borrow soils for BA-36 project contains substantial higher organic content. The cut and fill ratio was adjusted empirically.

3.2.8 Erosion Protection. A large portion of the levees will consist of ML, SC, and SM soils, which are highly erodible. Erosion protection will be required, especially on the gulf side of the South levee. It must be flexible to withstand the anticipated settlements; rip-rap is indicated. A filter fabric is recommended against the fill to prevent washing of the fines. It should be a non-woven geotextile having a weight of at least 8 ounces per square yard (ASTM D3776) an Equivalent Opening Size around 0.05 mm as determined by ASTM D4751, and a grab strength of at least 125 lb. by ASTM D4632. The 6 to 12 inch layer of riprap adjacent to the fabric should be 6 inch maximum store. The remainder of the riprap should be sized according to the appropriate methods for the wave action anticipated.



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PS1	279[illegible]	[illegible]	-89 [illegible]	[illegible]
PS2	276715.2	3838345.7	-89 54 55.6537	29 34 55.6202
PS3	[illegible]	[illegible]	-89 [illegible]	[illegible]
PS4	275745.0	3844356.3	-89 54 2.15318	29 34 45.6464
PF5	[illegible]	[illegible]	-89 [illegible]	[illegible]
PF6	278512.5	3852571.4	-89 55 11.234	29 35 18.7342
P7	[illegible]	[illegible]	-89 [illegible]	[illegible]
P8	277258.2	3855295.0	-89 55 42.99	29 35 5.5806
P9	[illegible]	[illegible]	-89 [illegible]	[illegible]
P10	277201.2	3848230.2	-89 54 40.4350	29 35 2.16504
S1	[illegible]	[illegible]	-89 [illegible]	[illegible]
S2	250715.3	3857295.1	-89 51 35.5358	29 33 18.4537

Boring Locations Intersecting with Active Oyster Leases:

Boring ID	Lease ID	Exp. Date	Lease Holder	Phone Number
PF5	2801700	1/1/2015	Edward Kurtich	(985) 564-7658
P7	32585	1/1/2007	Mitchell E. Jurisich Sr.	(985) 657-8748
P8	2787600	1/1/2015	Frank J. Jurisich	(985) 657-8748
P9	32296	1/1/2007	Mitchell E. Jurisich Sr.	(985) 657-8748
P10	32296	1/1/2007	Mitchell E. Jurisich Sr.	(985) 657-8748

0.2 0 0.2 0.4 0.6 0.8 1 Miles

REFERENCE:
MAP ID: USGS-NWRC 2003-04-0306

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
(PELICAN HEADLAND)
PROJECT BA-38
PLAQUEMINES PARISH, LOUISIANA

for

LOUISIANA DEPARTMENT OF NATURAL RESOURCES
BATON ROUGE, LOUISIANA

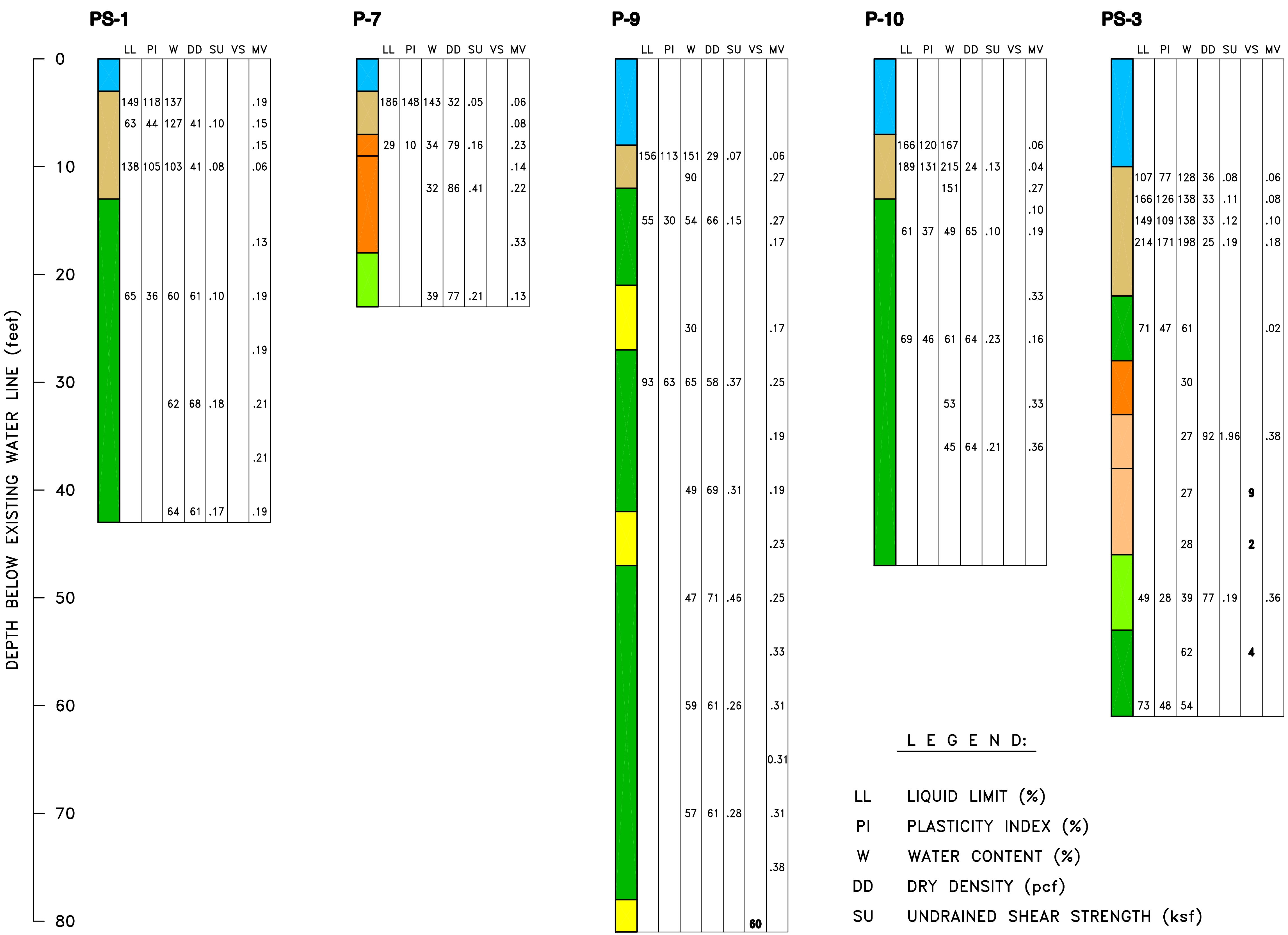
C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 9-22-03	Figure No.: **P-1**

Title:
BORING PLAN

Oct 29, 2003 - 3:52pm
P:\2003\03-1114\CADD\031114-P1 PELICAN BORING PLAN.DWG



SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

LEGEND:

- LL LIQUID LIMIT (%)
- PI PLASTICITY INDEX (%)
- W WATER CONTENT (%)
- DD DRY DENSITY (pcf)
- SU UNDRAINED SHEAR STRENGTH (ksf)
- VS FIELD VANE SHEAR (ksf)
- NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)
- MV MINIATURE LAB VANE SHEAR (ksf)

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C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

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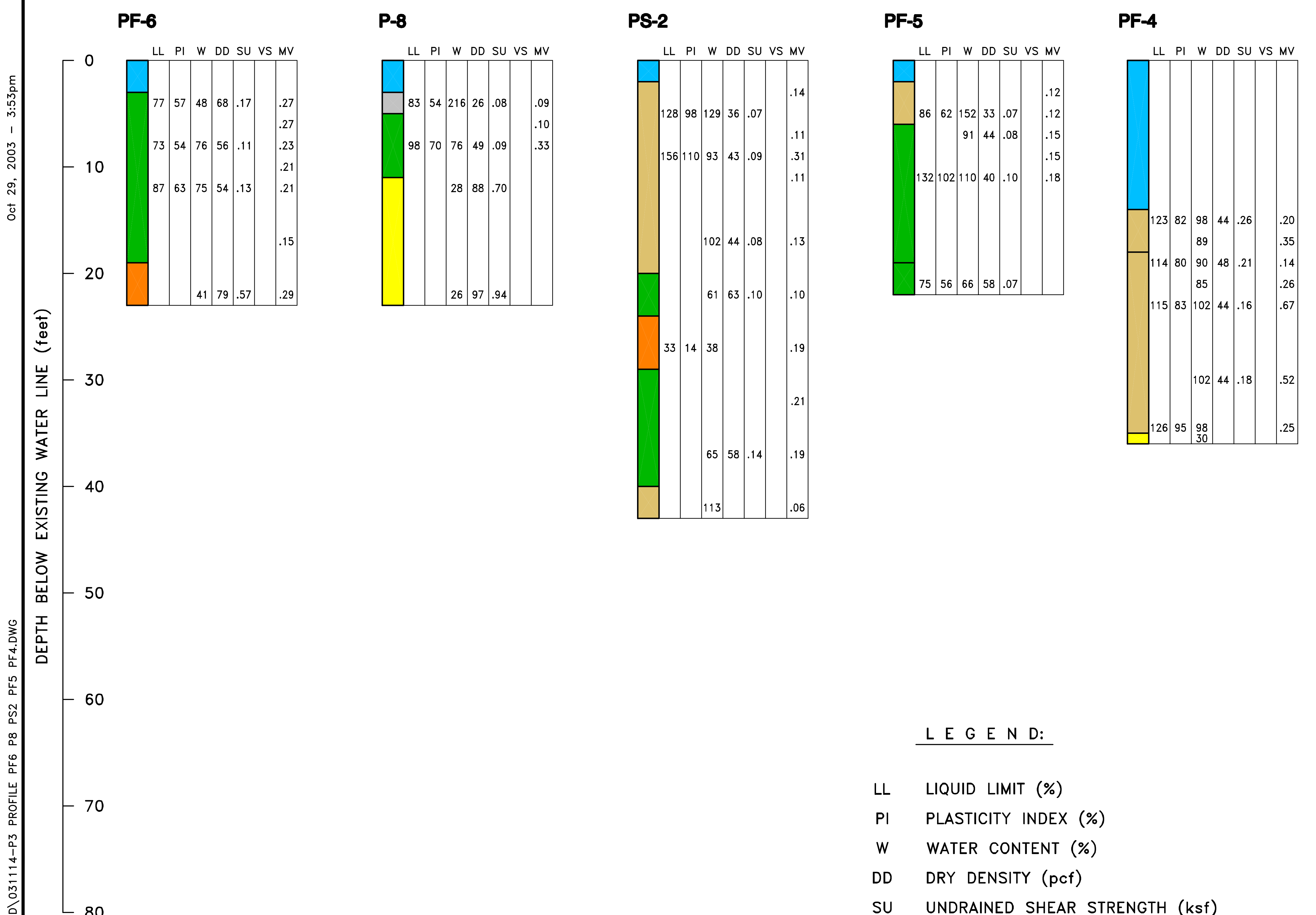
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 9-22-03	Figure No.: P-2

Title: **SOIL PROFILE PS-1, P-7, P-9, P-10 & PS-3**



SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

L E G E N D:

LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
W	WATER CONTENT (%)
DD	DRY DENSITY (pcf)
SU	UNDRAINED SHEAR STRENGTH (ksf)
VS	FIELD VANE SHEAR (ksf)
	NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)
MV	MINIATURE LAB VANE SHEAR (ksf)

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C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 9-22-03	Figure No.: **P-3**

Title: **SOIL PROFILE PF-6, P-8, PS-2, PF-5 & PF-4**

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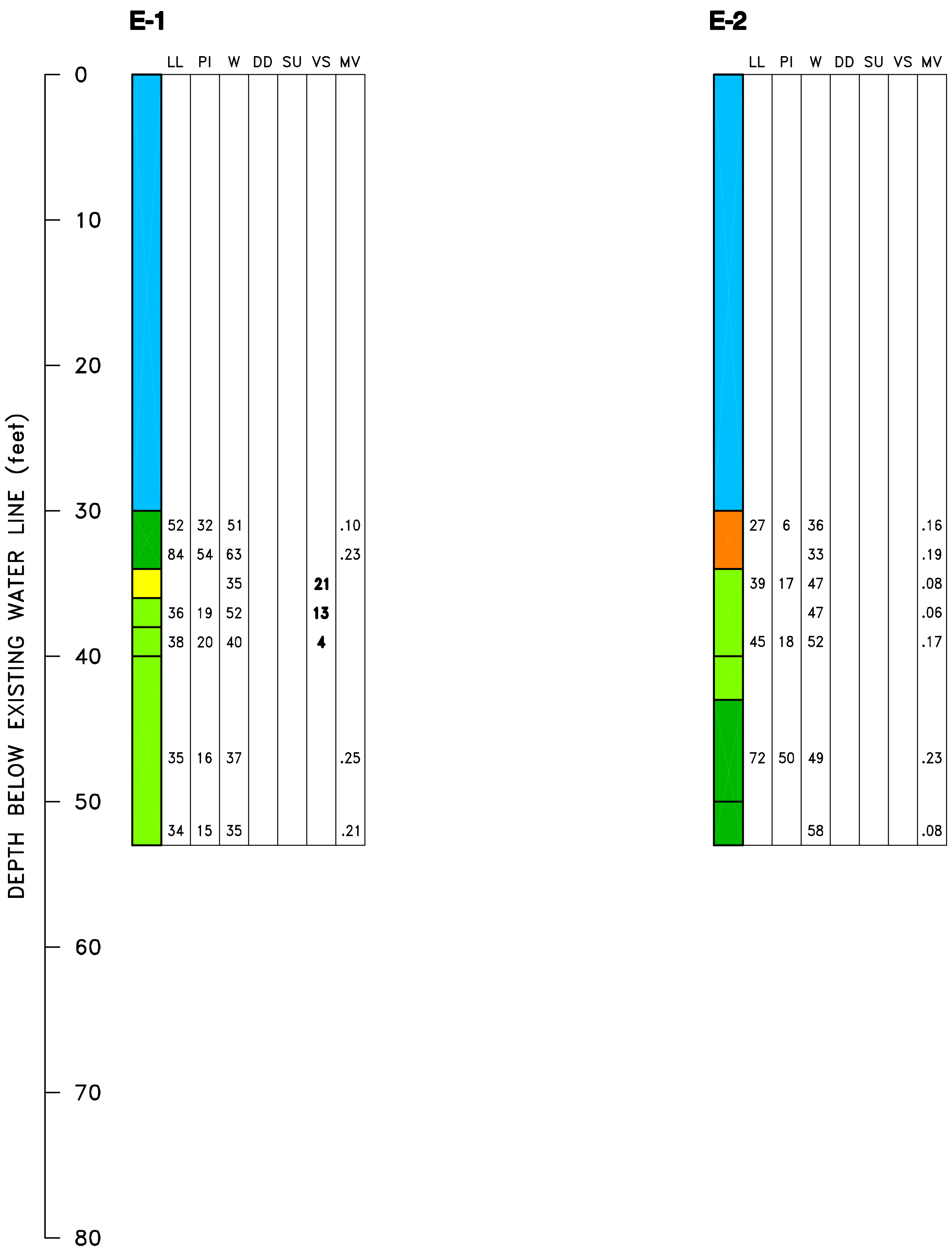

SYMBOL	SOIL TYPE
	WATER
	PEAT
	ORGANIC CLAY (OH)
	CLAY (CH)
	SILTY CLAY or SANDY CLAY (CL)
	CLAYEY SAND (SC)
	SANDY SILT, CLAYEY SILT (ML)
	SILTY SAND (SM)

LEGEND:

LL LIQUID LIMIT (%)

PI PLASTICITY INDEX (%)

W WATER CONTENT (%)

DD DRY DENSITY (pcf)

SU UNDRAINED SHEAR STRENGTH (ksf)

VS FIELD VANE SHEAR (ksf)

NOTE: **BOLD** = Standard Penetration Resistance (blows/foot)

MV MINIATURE LAB VANE SHEAR (ksf)

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C-K & ASSOCIATES, INC.

ENGINEERS

BATON ROUGE, LOUISIANA

STE

Soil Testing Engineers, Inc.

Baton Rouge, LA Lake Charles, LA Metairie, LA

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File No.: 03-1114	Date: 9-23-03	Figure No.: P-4

Title: **SOIL PROFILE E-1 & E-2**

Oct 29, 2003 - 3:53pm

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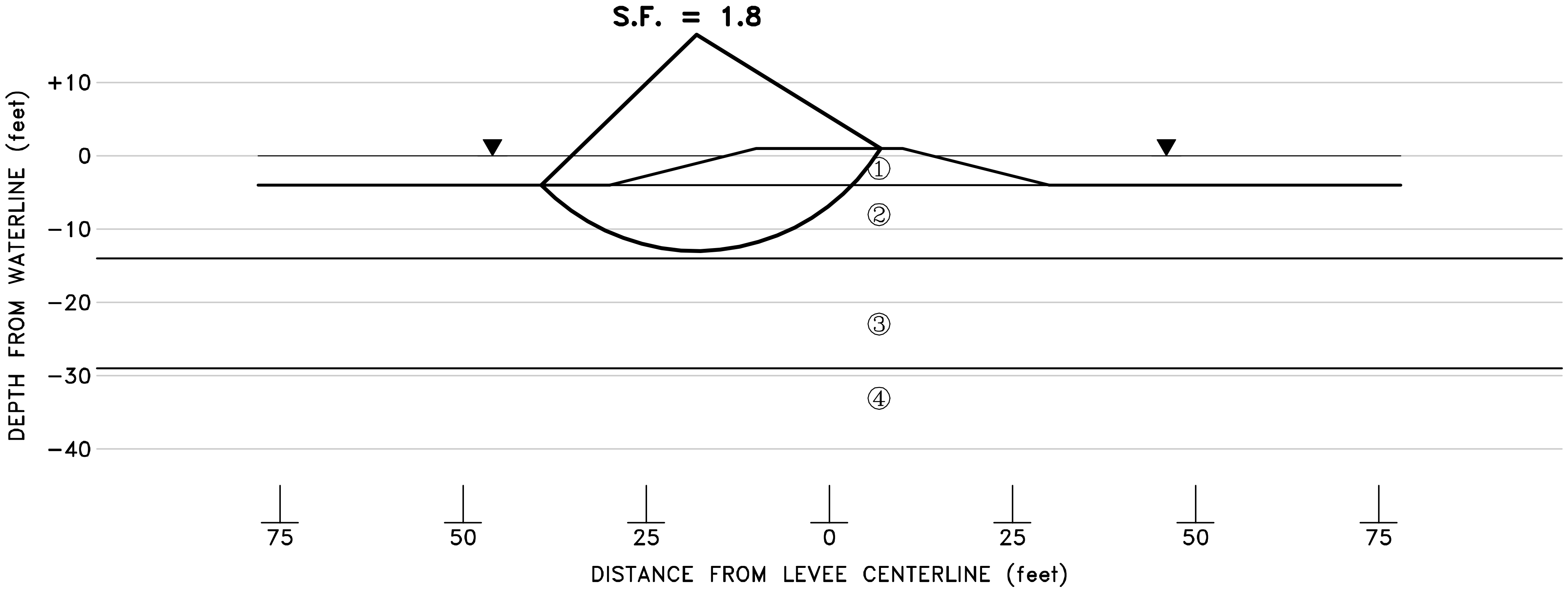
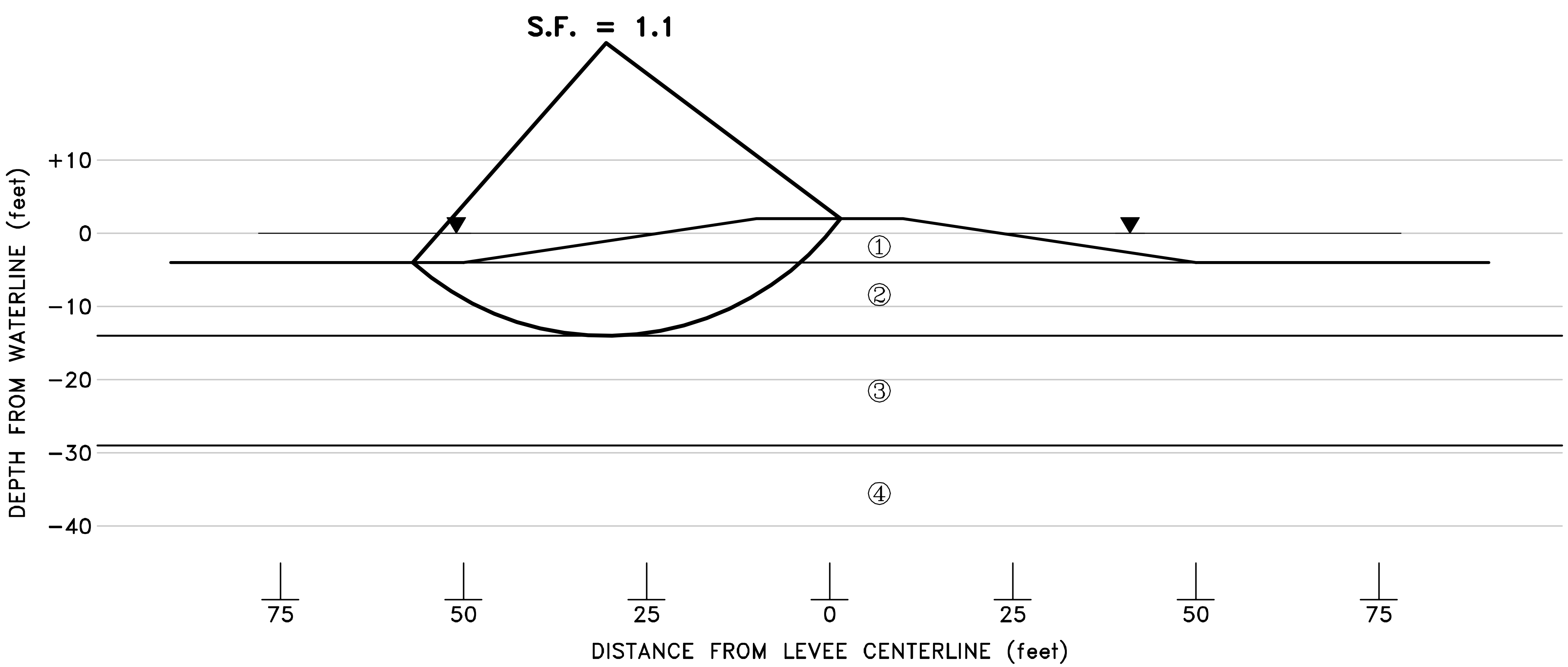


1 FOOT FREEBOARD, 4 FEET WATER, 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	80	84	0
3	90	89	0
4	170	105	0

a: Analyzed for both fill types. Lowest SF illustrated.



2 FOOT FREEBOARD, 4 FEET WATER, 1(V):8(H) SLOPES

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C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

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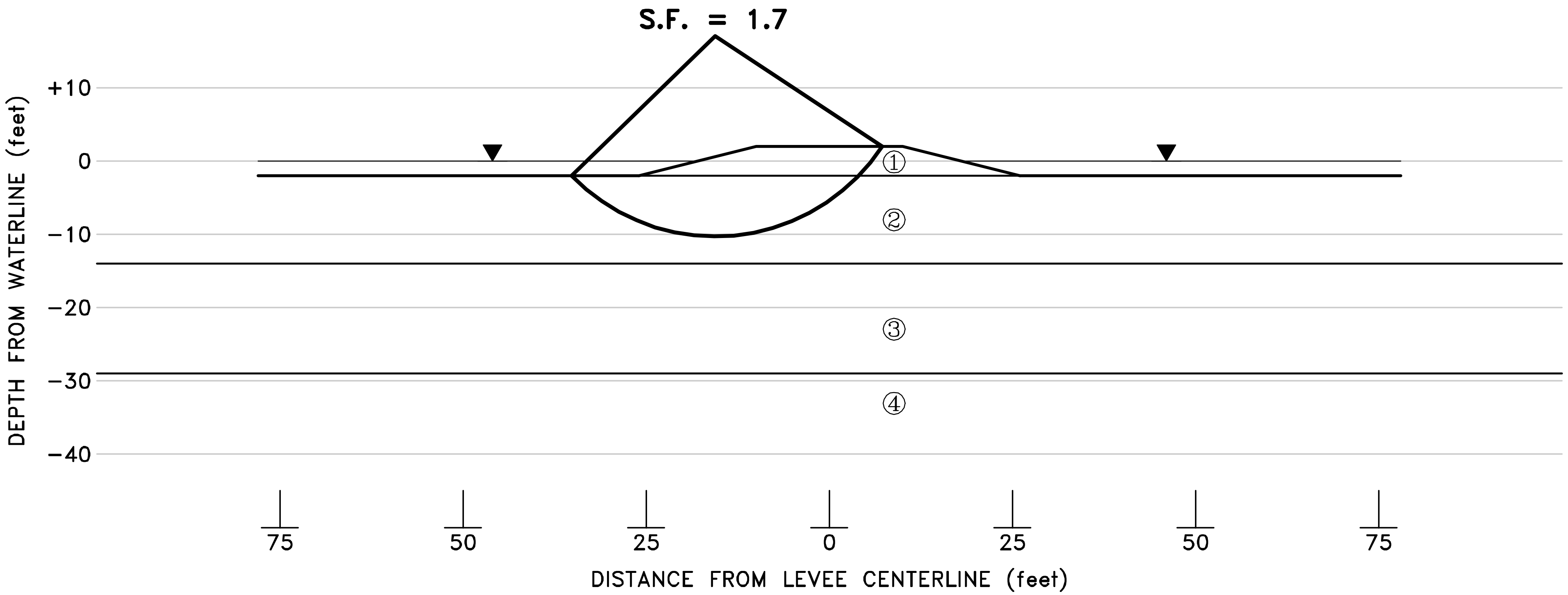
G.P. Boutwell	DMS	
File No.: 03–1114	Date: 10–29–03	Figure No.: **P-5**

Title: **STABILITY ANALYSES WEST LEVEE**



2 FOOT FREEBOARD, 2 FEET WATER, 1(V):4(H) SLOPES

3 FOOT FREEBOARD, 2 FEET WATER, 1(V):6(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	80	84	0
3	90	89	0
4	170	105	0

a: Analyzed for both fill types. Lowest SF illustrated.

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BATON ROUGE, LOUISIANA

C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

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File No.: 03−1114	Date: 10−29−03	Figure No.: **P-5A**

Title: **STABILITY ANALYSES WEST LEVEE**

Oct 29, 2003 − 3:59pm

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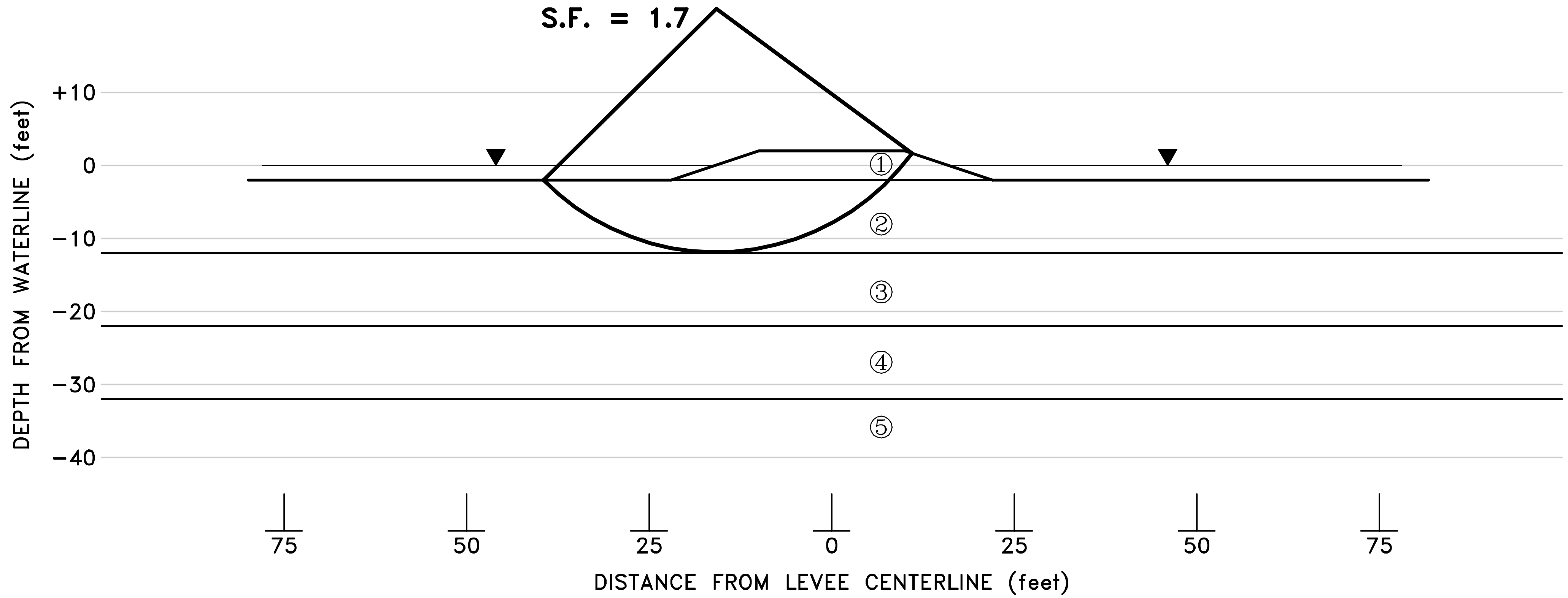
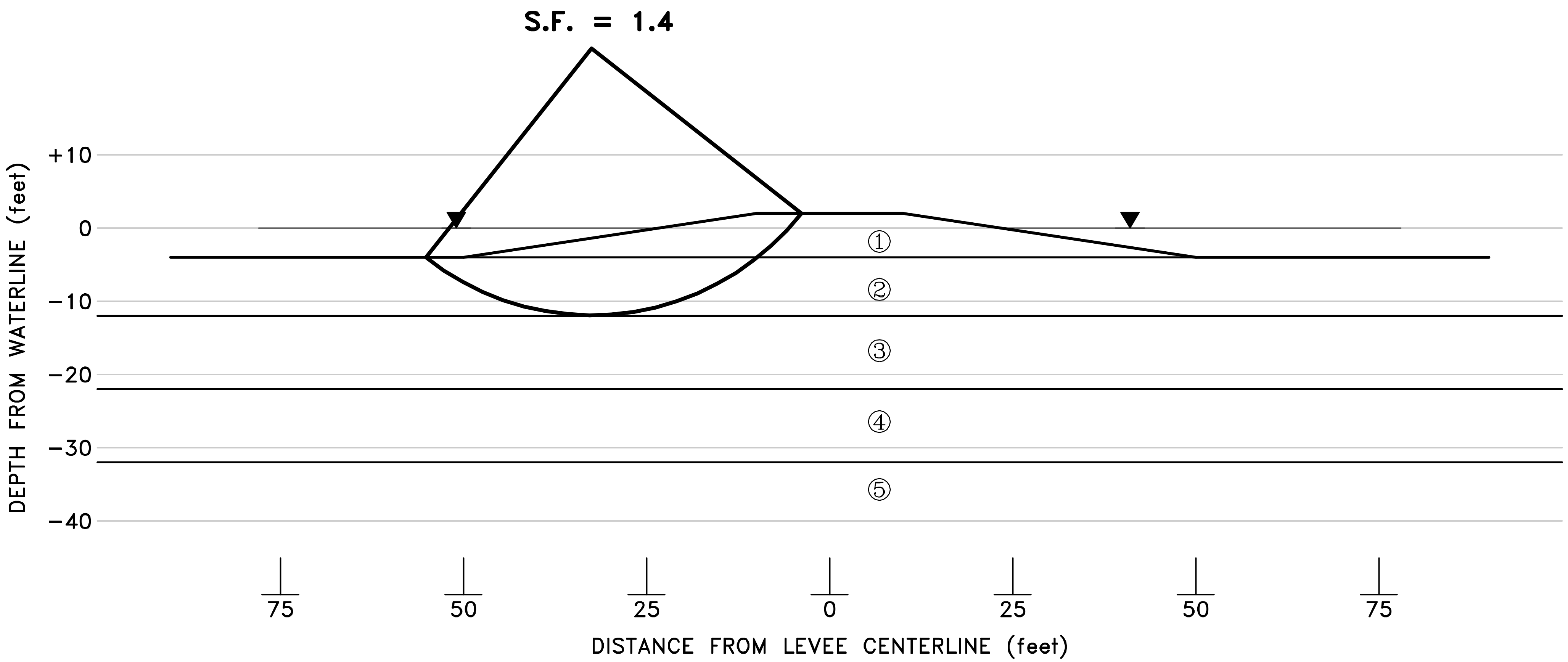


1 FOOT FREEBOARD, 2 FEET WATER, 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	85	81	0
3	120	88	0
4	200	100	0
5	240	99	0

a: Analyzed for both fill types. Lowest SF illustrated.



1 FOOT FREEBOARD, 4 FEET WATER, 1(V):8(H) SLOPES

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C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

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File No.: 03-1114	Date: 10-29-03	Figure No.: **P-6**

Title: **STABILITY ANALYSES NORTH LEVEE**

Oct 29, 2003 – 3:58pm

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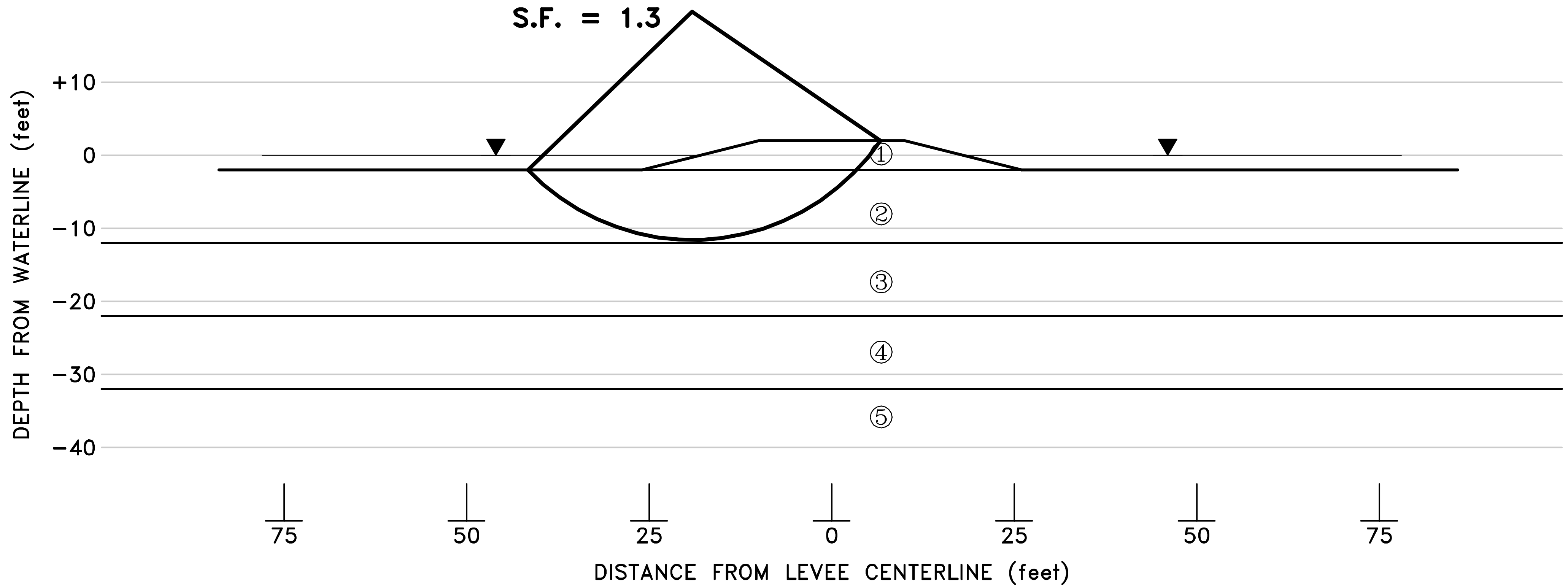
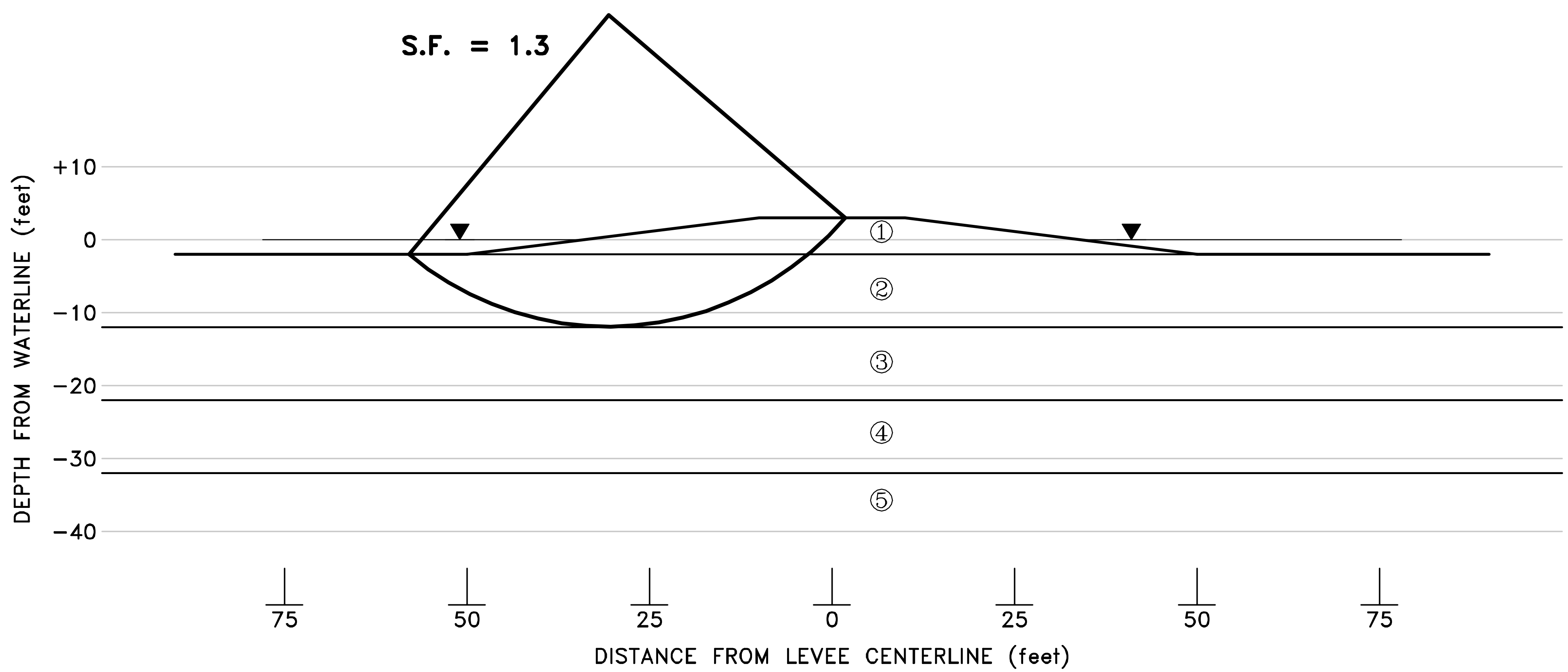


2 FOOT FREEBOARD, 2 FEET WATER, 1(V):4(H) SLOPES



3 FOOT FREEBOARD, 2 FEET WATER, 1(V):8(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	85	81	0
3	120	88	0
4	200	100	0
5	240	99	0

a: Analyzed for both fill types. Lowest SF illustrated.

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BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
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G.P. Boutwell	DMS	
File No.: 03-1114	Date: 10-29-03	Figure No.: **P-6A**

Title: **STABILITY ANALYSES NORTH LEVEE**

Oct 29, 2003 - 3:58pm
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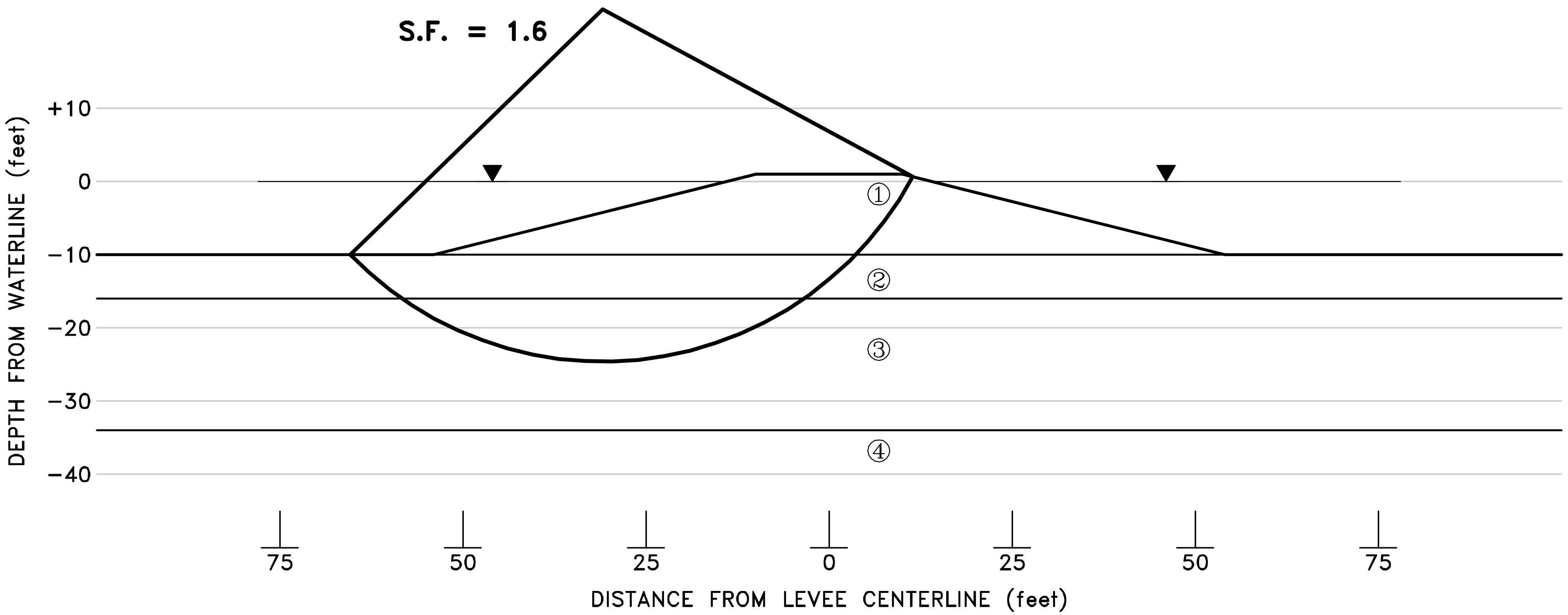
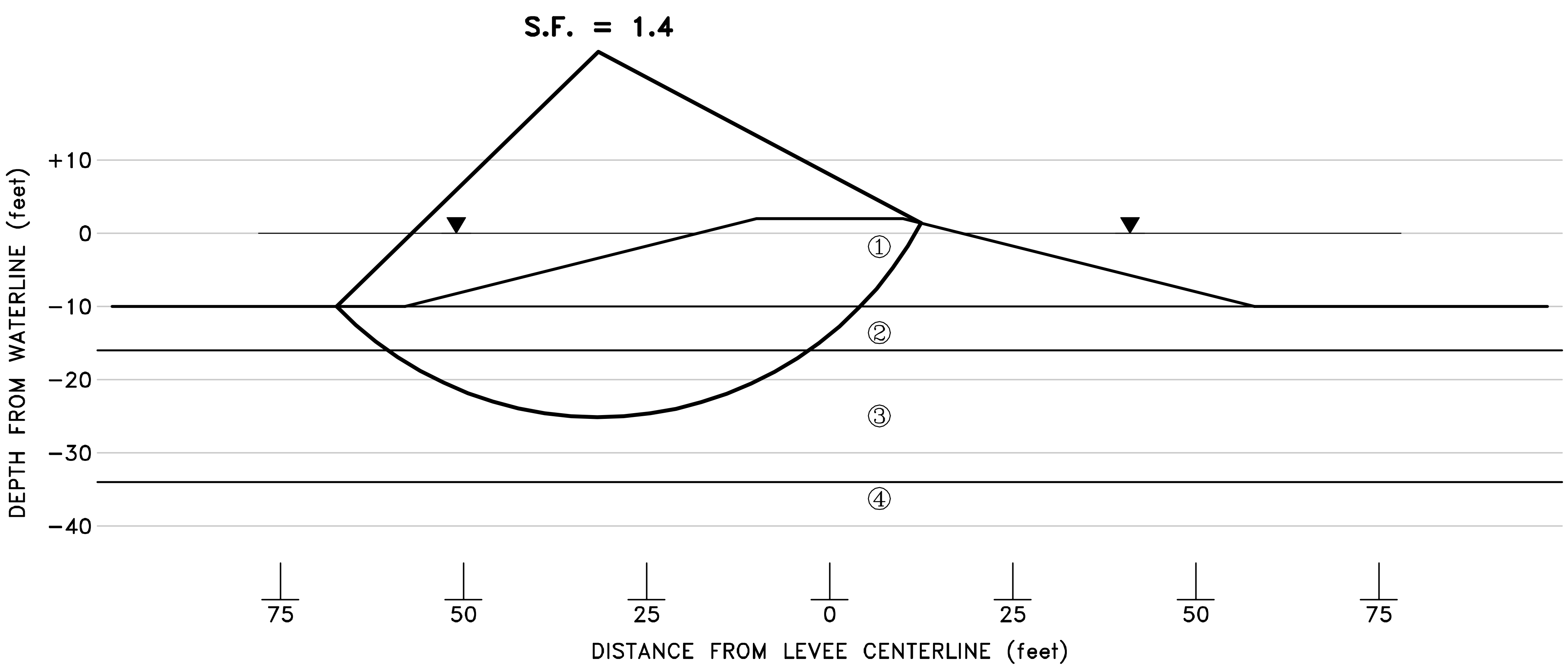
Oct 29, 2003 - 3:58pm



1 FOOT FREEBOARD, 10 FEET WATER, 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	100	80	0
3	160	84	0
4	100	110	24

a: Analyzed for both fill types. Lowest SF illustrated.



2 FOOT FREEBOARD, 10 FEET WATER, 1(V):4(H) SLOPES

P:\2003\03-1114\CADD\031114-P7 EAST LEVEE STABILITY.DWG

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ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

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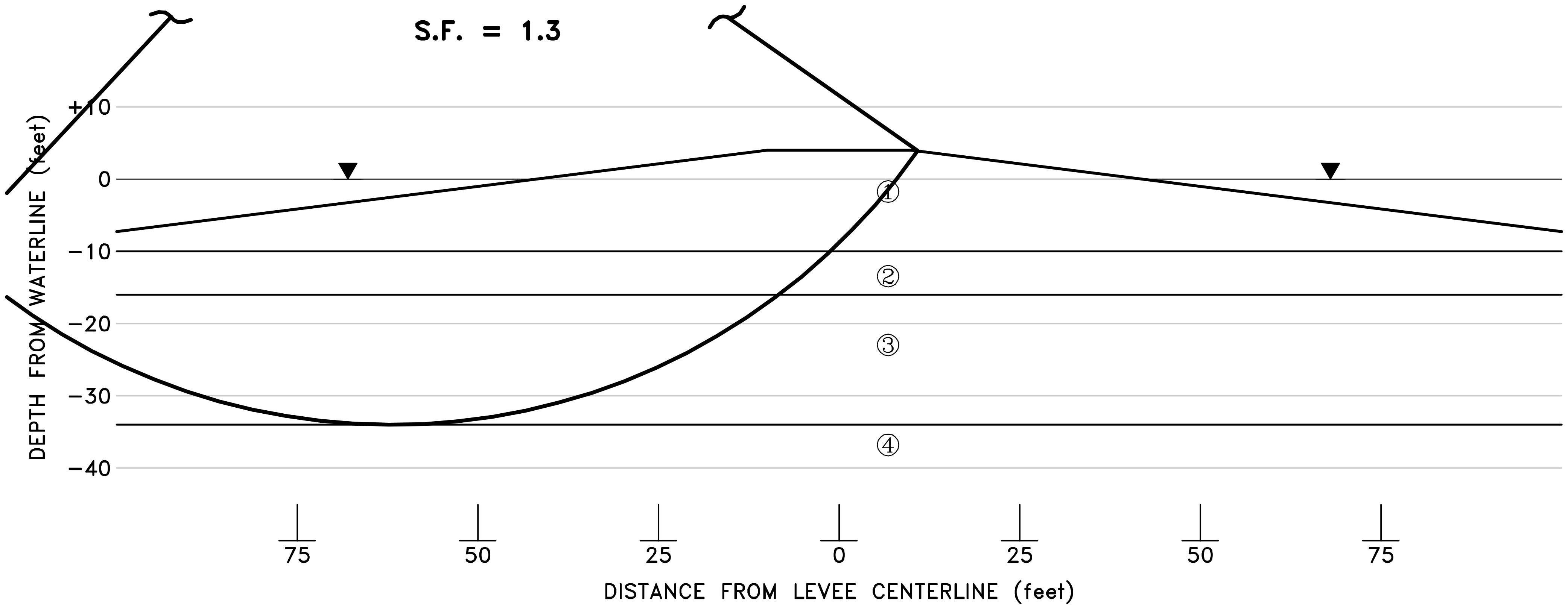
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 10-29-03	Figure No.: **P-7**

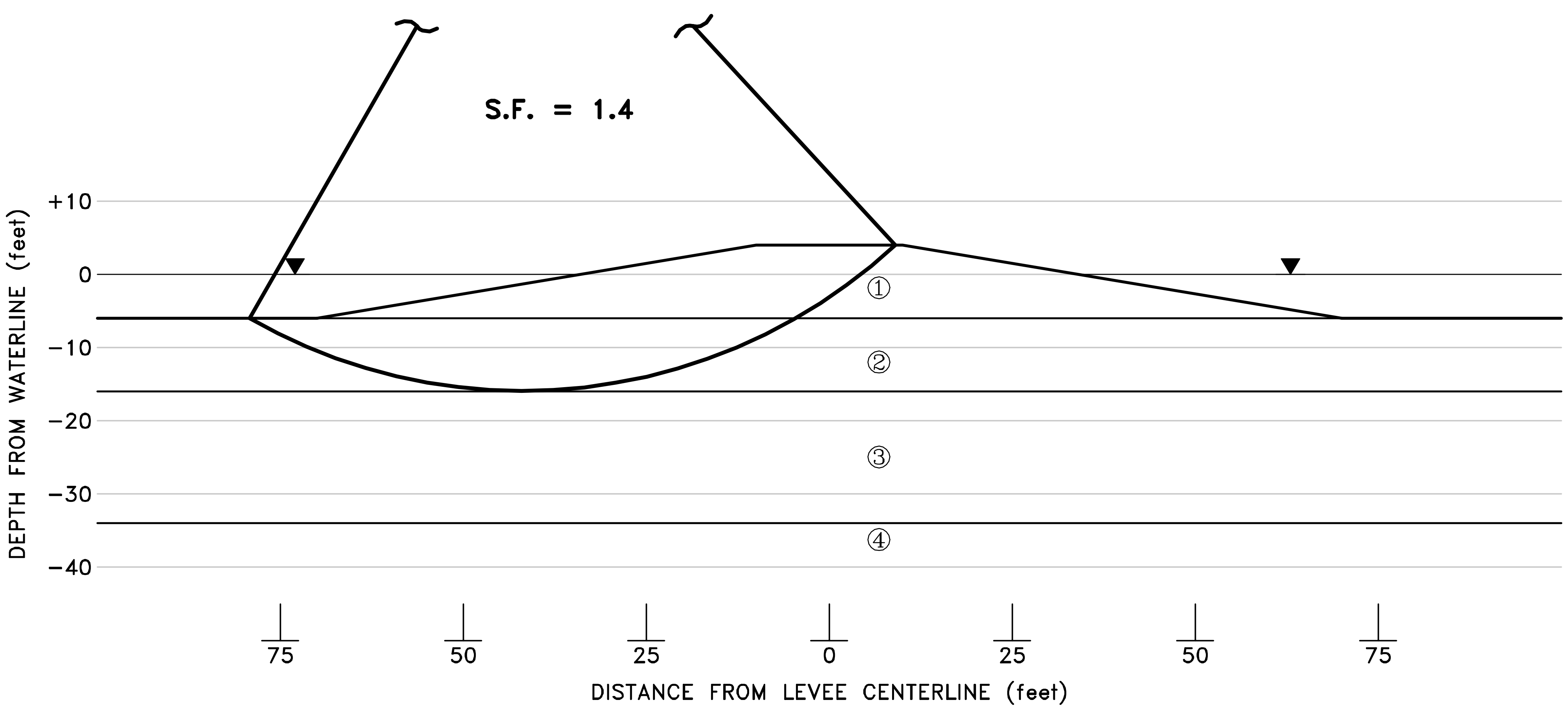
Title: **STABILITY ANALYSES EAST LEVEE**



4 FOOT FREEBOARD, 10 FEET WATER, 1(V):8(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	100	80	0
3	160	84	0
4	100	110	24

a: Analyzed for both fill types.
Lowest SF illustrated.



4 FOOT FREEBOARD, 6 FEET WATER, 1(V):6(H) SLOPES

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C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

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G.P. Boutwell	DMS	
File No.: 03−1114	Date: 10−29−03	Figure No.: **P-7A**

Title: **STABILITY ANALYSES EAST LEVEE**

Oct 29, 2003 − 3:55pm
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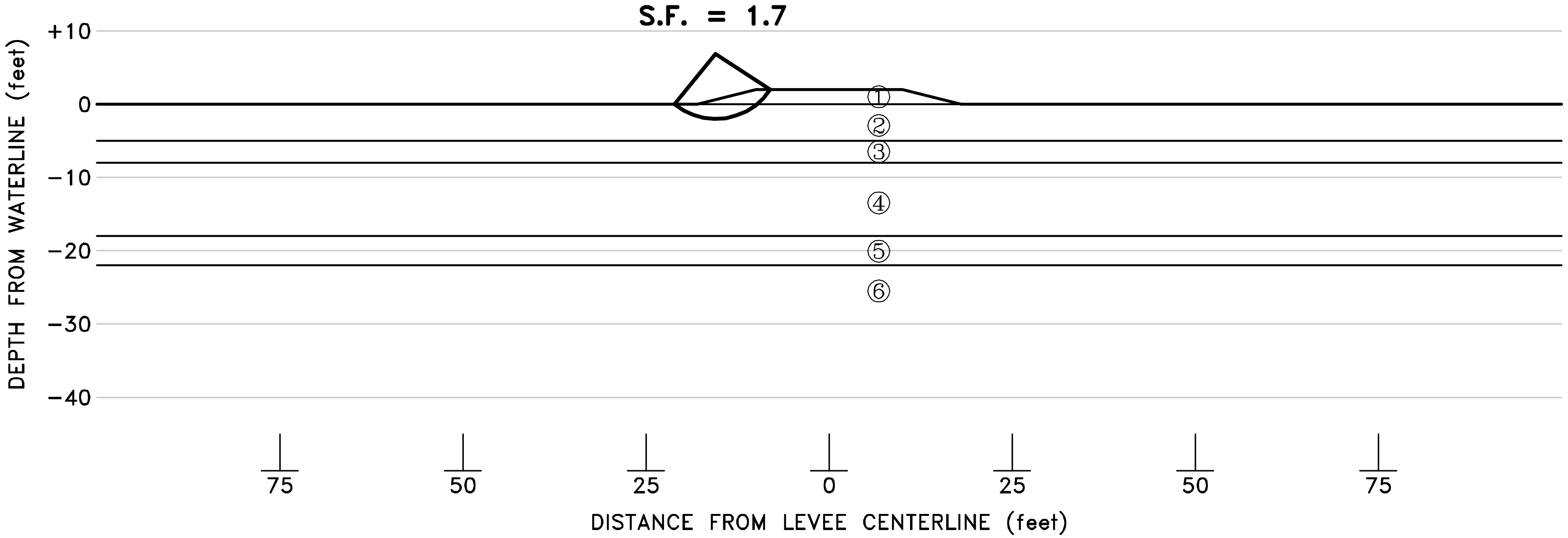
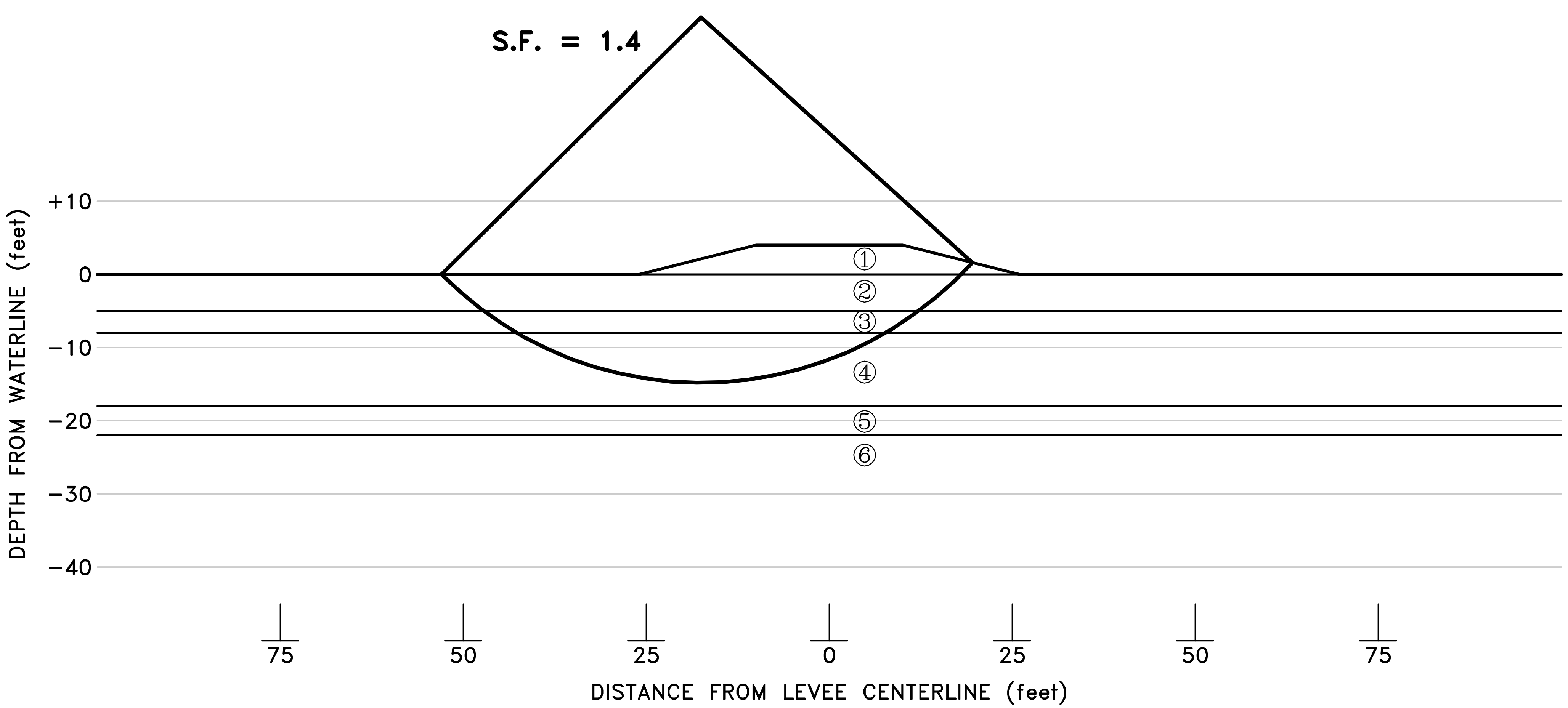


FREEBOARD 2 FEET ABOVE RIDGE, 1(V):4(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	0	110	26
2	0	110	24
3	80	83	0
4	90	84	0
5	100	96	0
6	160	92	0

a: Analyzed for both fill types. Lowest SF illustrated.



FREEBOARD 4 FEET ABOVE RIDGE, 1(V):4(H) SLOPES

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PROJECT BA-38
PLAQUEMINES PARISH, LOUISIANA
for
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
BATON ROUGE, LOUISIANA

C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

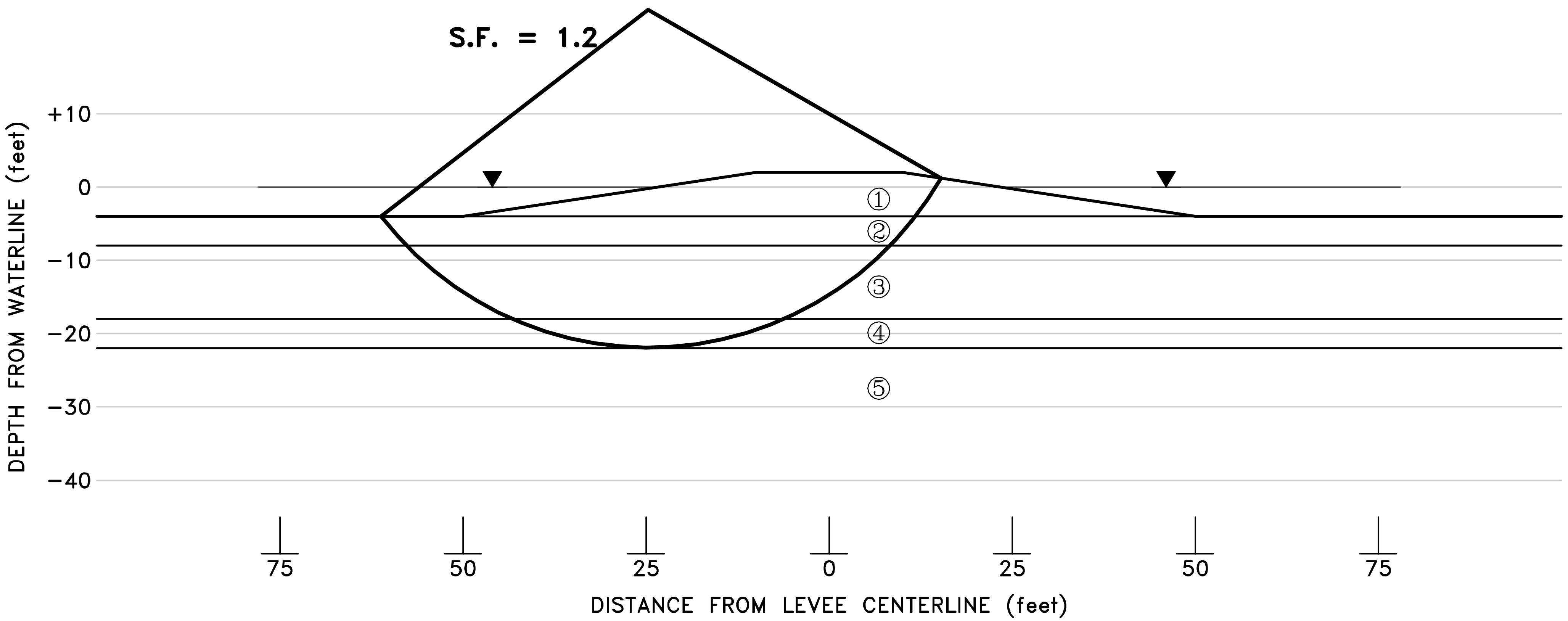
STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03-1114	Date: 10-29-03	Figure No.: **P-8**

Title: **STABILITY ANALYSES SOUTH LEVEE ON BEACH RIDGE**

Oct 29, 2003 - 3:55pm

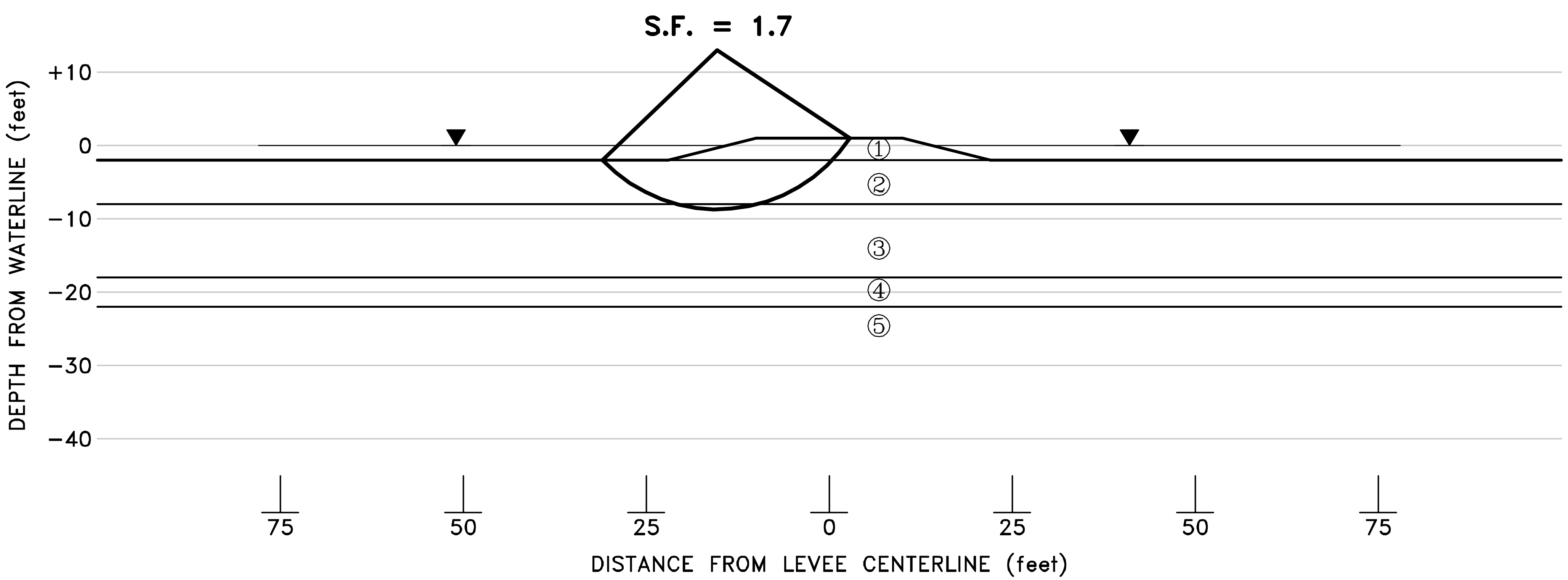
P:\2003\03-1114\CADD\031114-P8 SOUTH LEVEE STABILITY.DWG



1 FOOT FREEBOARD, 4 FEET WATER, 1(V):8(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	80	83	0
3	90	84	0
4	100	96	0
5	160	92	0

a: Analyzed for both fill types. Lowest SF illustrated.



1 FOOT FREEBOARD, 2 FEET WATER, 1(V):4(H) SLOPES

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
(PELICAN HEADLAND)
PROJECT BA-38
PLAQUEMINES PARISH, LOUISIANA

for
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
BATON ROUGE, LOUISIANA

C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

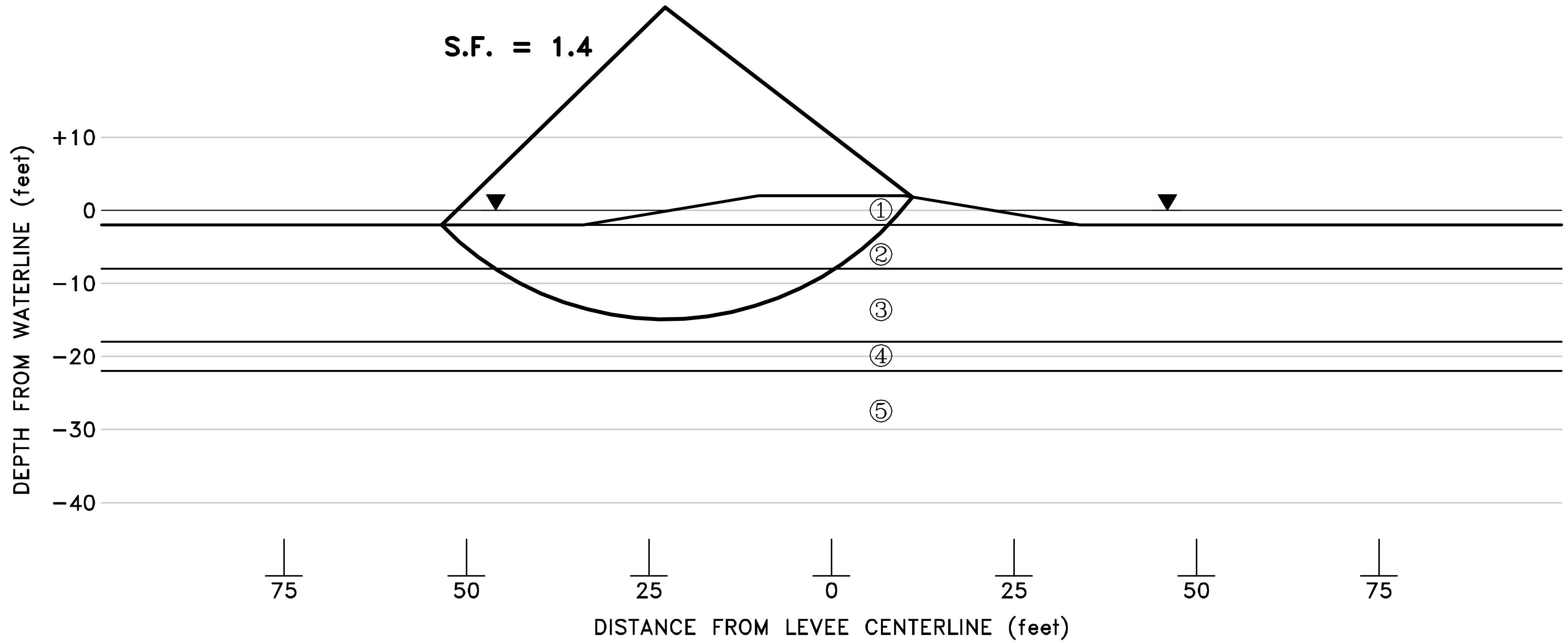
STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03−1114	Date: 10−29−03	Figure No.: **P-9**

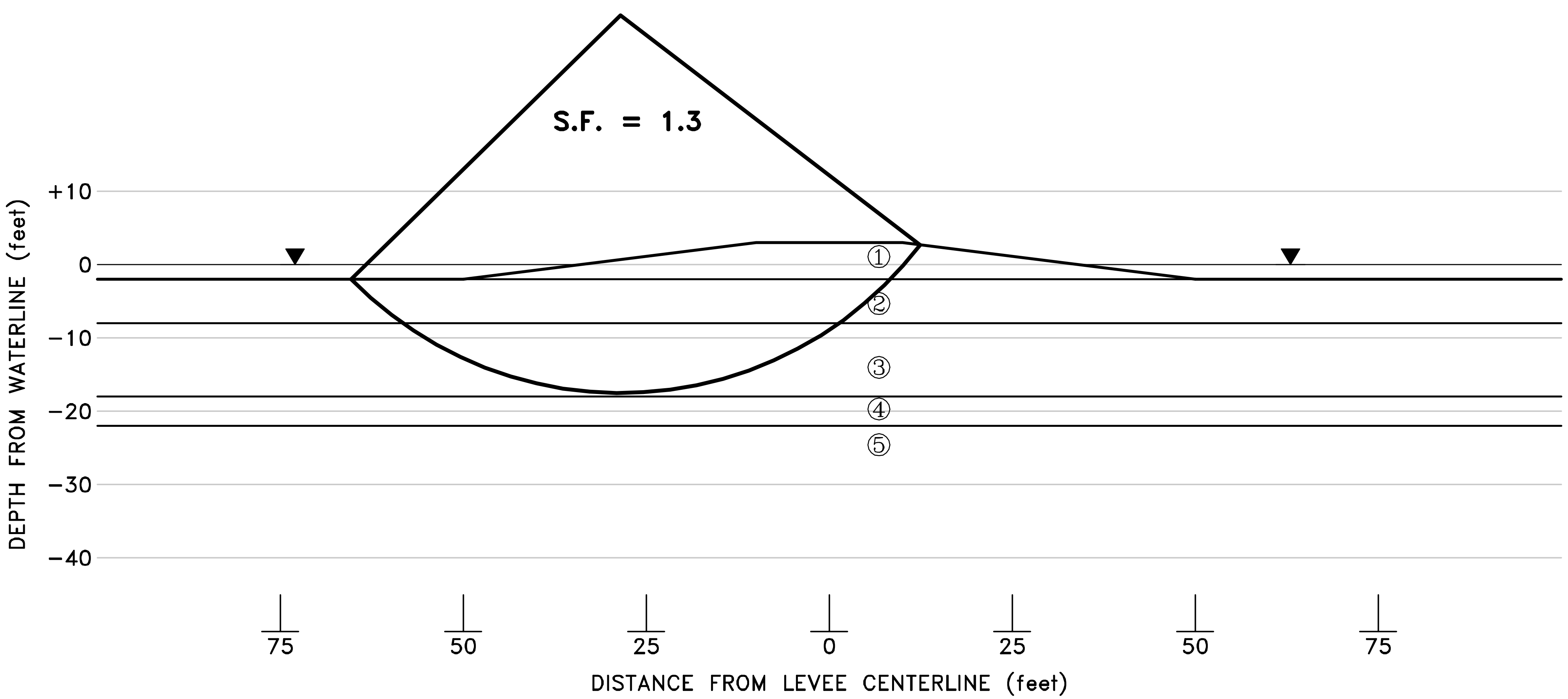
Title: **STABILITY ANALYSES SOUTH LEVEE - OFFSHORE**

Oct 29, 2003 − 3:55pm

P:\2003\03−1114\CADD\031114−P9 SOUTH LEVEE STABILITY.DWG



2 FOOT FREEBOARD, 2 FEET WATER, 1(V):6(H) SLOPES



3 FOOT FREEBOARD, 2 FEET WATER, 1(V):8(H) SLOPES

SOIL	COHESION (psf)	UNIT WEIGHT (pcf)	FRICTION ANGLE (degrees)
1[a]	100	100	0
1[a]	50	110	22
2	80	83	0
3	90	84	0
4	100	96	0
5	160	92	0

a: Analyzed for both fill types. Lowest SF illustrated.

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
(PELICAN HEADLAND)
PROJECT BA-38
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ENGINEERS
BATON ROUGE, LOUISIANA

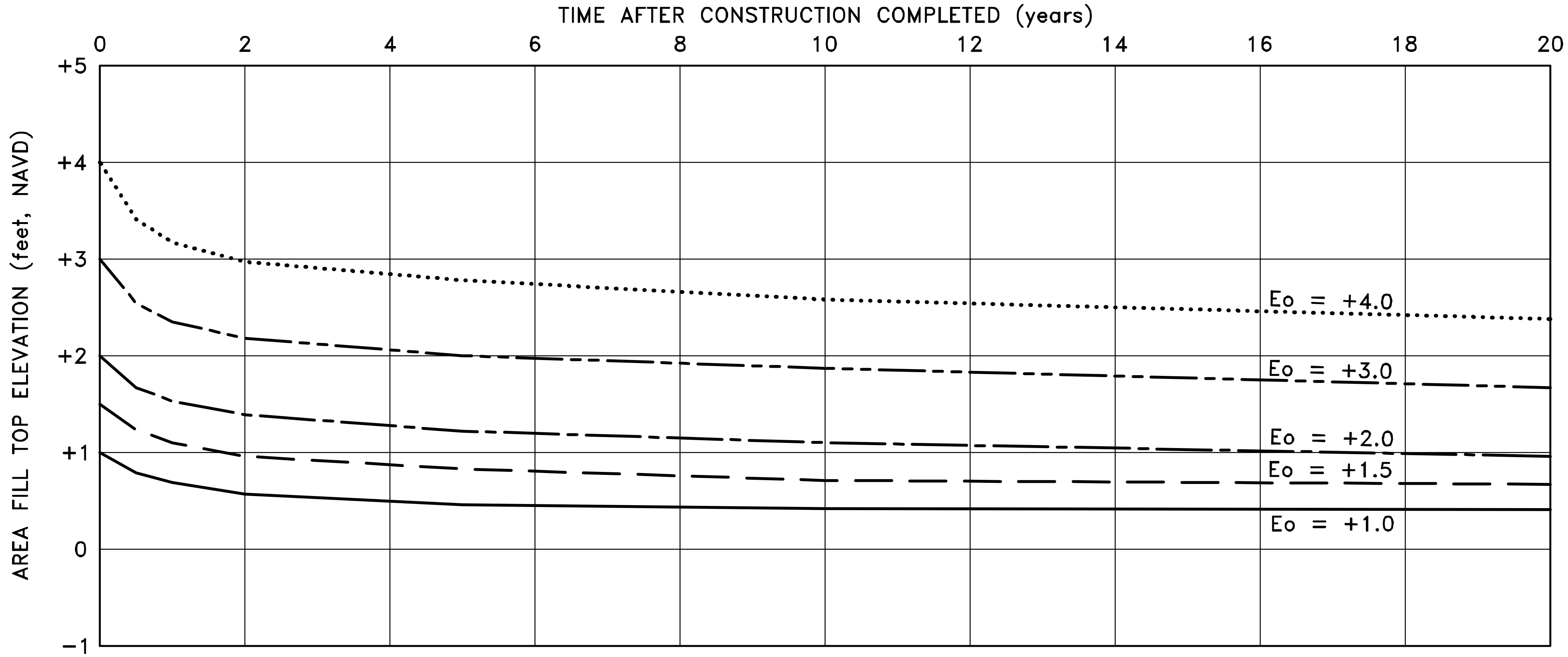
STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03−1114	Date: 10−29−03	Figure No.: **P-9A**

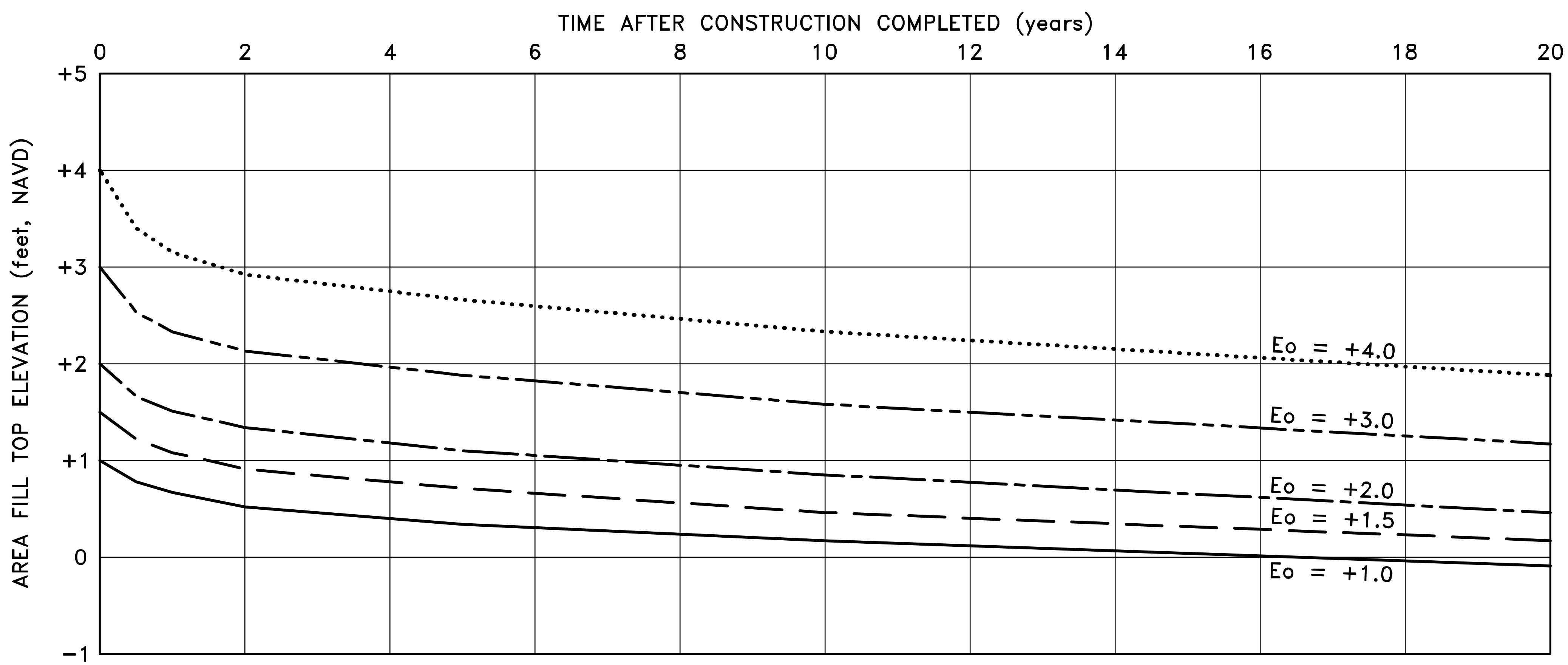
Title: **STABILITY ANALYSES SOUTH LEVEE - OFFSHORE**

Oct 29, 2003 − 3:59pm

P:\2003\03−1114\CADD\031114−P9A SOUTH LEVEE STABILITY.DWG



WITHOUT GEOLOGIC SUBSIDENCE



WITH GEOLOGIC SUBSIDENCE

NOTES:

1. Settlements include both self−weight consolidation and weight−induced settlements in foundation soils.

2. Geologic subsidence rate furnished by LDNR = 0.5 ft./20 yr.

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
(PELICAN HEADLAND)
PROJECT BA-38
PLAQUEMINES PARISH, LOUISIANA
for
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
BATON ROUGE, LOUISIANA

C-K & ASSOCIATES, INC.
ENGINEERS
BATON ROUGE, LOUISIANA

STE
Soil Testing Engineers, Inc.
Baton Rouge, LA Lake Charles, LA Metairie, LA

Project Engineer:	Drawn by:	Checked by:
G.P. Boutwell	DMS	
File No.: 03−1114	Date: 10−29−03	Figure No.: **P-10**

Title: **TIME-SETTLEMENT CURVES: AREA FILL**

Oct 29, 2003 − 3:59pm

P:\2003\03−1114\CADD\031114−P10 TIME SETTLEMENT.DWG

STE
Soil Testing Engineers, Inc.

REPORT OF GEOTECHNICAL INVESTIGATION
BARATARIA BARRIER ISLAND RESTORATION
PROJECT BA-36
PLAQUEMINES PARISH, LOUISIANA

APPENDIX A

FIELD AND LABORATORY PROCEDURES

The following paragraphs describe the field and laboratory procedures used for this investigation Soil Boring Logs are included with this appendix. The boring logs, tables, and figures in this Appendix provide the field and laboratory data collected.

A.1 FIELD EXPLORATION

Twenty-four soil borings were drilled for this project to depths of 22 to 81 feet below water or ground surface. These borings were drilled during the period September 3 through September 26, 2003. The approximate locations of the borings are shown on the Boring Plans, Figures C-1 and P-1. The locations were established by LDNR personnel and physically located by C-K Associates, Inc. and STE. The borings totaled 955 lineal feet, 240 feet of which were continuously sampled. Logs of the borings, corrected to reflect the laboratory test results, are attached to this Appendix.

A.1.1 Sampling Procedures - Undisturbed Samples. In these cohesive and semi-cohesive soils, relatively undisturbed samples were secured using a three-inch diameter, thin wall steel tube sampler, essentially following ASTM D1587. In this sampling procedure, the borehole is advanced to the desired level, and the tube is lowered to the bottom of the boring. It is then pushed about two feet into the undisturbed soil in one continuous stroke. The sample and tube are retrieved from the borehole and detached from the drill string. The tube is then sealed to minimize disturbance and moisture loss, and protected for transportation to the laboratory.

After any laboratory vane shear tests are performed, the samples are extruded in the laboratory by a hydraulic piston onto a rigid sample catcher to minimize disturbance. The sample is then visually classified. The classification includes description of soil color, strength estimates, identification of structural conditions (layering, seams, etc.) and variations (organics, oxide inclusions, etc.). A pocket penetrometer strength test is performed.

A.1.2 Sampling Procedures - Standard Penetration Tests. In the less cohesive materials, standard penetration tests were performed; these tests provide a measure of the in situ characteristics of the soil and secure a disturbed sample. In this test, a 2 inch OD, 1.37ID, heavy-walled "split Spoon" sampler is driven into the undisturbed soil at the bottom of the borehole with a drop hammer weighing 140 pounds and having a stroke of 30 inches. It is first seated 6 inches, then driven an additional two, 6-inch increments. The "Penetration Resistance" is the number of such blows required to drive the spoon the final 12 inches. It is recorded on the boring log in the following manner:

4 b/f
2-2-2

where the figures A-B-C indicate the number of blows required for each 6 inch increment.

A.1.3 Soil Classifications. The soil classifications are given on the attached logs. The materials' strength group, color, and material type are presented. The strength groups are in accordance with normal procedures as given in, e.g., *Mitchell (1993)*. The material type is based on the primary and secondary constituents (gravel, sand, silt, clay). The letters in parentheses represent the Unified Soil Classification (ASTM D2487 supplemented by ASTM D2488).

A.1.4 Grouting. Each borehole was grouted upon completion. The grout mixture was prepared in its own tub (not the mud tank used for drilling). The typical grout mix was 28 pounds of bentonite and 14 sacks of Portland cement per 100 gallons of water. After the grout was thoroughly mixed, it was pumped to the bottom of the borehole through the drill stem which was placed to the bottom of the hole. The grout mixture was circulated in the borehole to assure that the drilling fluid had been replaced with grout. After the circulation, the drill stem was withdrawn and grout fluid from the tub was used to replace the volume of the drill stem as it was withdrawn.

A.2 LABORATORY TESTING

The various types of laboratory testing performed on samples from the boring program are described below. The samples actually tested were selected by the Project Engineer to provide the information necessary for both evaluation of the soils and design.

A.2.1 Classification Testing - Atterberg Limits. These tests were necessary to determine the actual soil types more accurately than can be done by visual/manual methods. For cohesive soils, only Atterberg Limits Determinations were necessary. These parameters are used in classifying the semi-cohesive and cohesive materials, i.e., SC, ML, CL, CH, OL and OH under ASTM D2487. The actual procedure followed ASTM D4318; it consists of determining the water content corresponding to:

- Liquid Limit (LL) - Where the soil changes behavior from that of a plastic solid to that of a viscous liquid.
- Plastic Limit (PL) - Where the soil changes behavior from that of an elastic (rigid) solid to that of a plastic (deformable) solid.
- Plasticity Index (PI)- The difference between the above limits: PI = LL - PL.

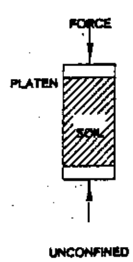
Sixty-four (64) of these tests were performed on the samples. The results are presented in the appropriate columns of the boring logs.

A.2.2 Classification - Particle Size Analyses. The information from these tests is used in classifying the less cohesive (more granular) soils such as PL and SM types. The test consists of two parts

- Sieve Analyses, where the sample is washed over progressively finer sieves, ending with the #200 (0.074 mm). The dry weight retained above each sieve is determined.
- Hydrometer Analysis, where the sample is suspended in water, and the particle sized are determined using the sedimentation rates and Stokes' Law.

This procedure is given in more detail in ASTM D422. There were thirty (30) such tests. Their results are summarized on the Logs of Borings, and presented graphically on figures, the Grain Size Analysis, all of which are attached to this Appendix A.

A.2.3 Strength Testing. The strength test program consisted of unconsolidated undrained (UU) triaxial compression tests. These tests provided data for slope stability analysis/design. In this test, a cylindrical sample (typically 3 inches in diameter and 6 inches high) is encased in a rubber membrane and then placed between two solid, flat end pieces ("platens"). Lateral pressure is applied to the sample by air pressure acting against the membrane. Stress is applied parallel to the long axis of the sample by advancing the end platens in a strain-controlled manner. Both the stress and corresponding axial strain are measured. The peak strength is the maximum axial stress measured before the axial strain reaches the commonly accepted value of 10%. These procedures conform essentially to ASTM D2850. A diagram for this test is given on the sketch below:



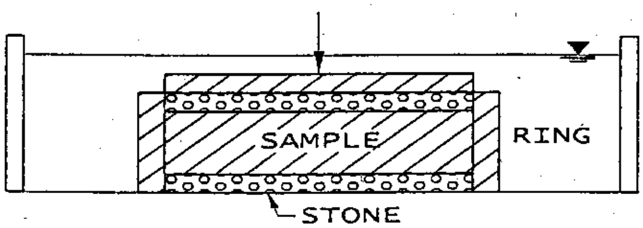
SKETCH A-1 - STRENGTH TESTING

Eighty-four (84) of these tests were performed on the samples.

The results of these tests are presented in the appropriate columns of the attached boring logs.

A.2.4 Laboratory Vane Shear Testing. These tests were performed in the laboratory before the samples were extruded from their Shelby Tubes. The procedures are essentially those described for the field test in Section A.1.3, but a much smaller vane (1 inch blade diameter x 2 inches long) is used. This test conforms to the manufacture's recommendations and essentially to ASTM D4648. A total of 8 such tests was performed; their results are given on the attached Logs of Borings.

A.2.5 Consolidation Testing. These tests provide data on the compressibility and time-rate of settlement characteristics of the natural soils. In this test, a thin (0.8 inch) cylinder of the soil is trimmed into a 2.5 inch diameter, thick-walled ring. The sample and ring are submerged in water, and various one-dimensional vertical loads applied as illustrated in the sketch below.



SKETCH A-2 - CONSOLIDATION TESTING

Each load is maintained until 100% consolidation occurs under that load; the next load is then applied. This procedure conforms essentially to ASTM D2435. The results of the fifteen (15) such tests performed on the samples are presented graphically on the Consolidation Test figures, and are summarized on Table A-2. In addition, Specific Gravity Determinations were made for all samples subjected to Consolidation Testing. The procedures conformed essentially to ASTM D854.

STE Soil Testing Engineers, Inc.

BARATARIA BARRIER ISLAND RESTORATION COMPLEX
PROJECT BA-38
PLAQUEMINE PARISH, LA
DNR CONTRACT NO. 2503-02-29
TABLE A-1
SUMMARY OF CONSOLIDATION TESTS

BORING NO.	DEPTH (feet)	LL (%)	PI (%)	W_o (%)	DD_o (pcf)	p_c (tsf)	C'_c (decimal)	SOIL TYPE
CS-1	34-36	-	NP	30	89	1.30	0.04	ML(S)
CS-2	16-18	28	11	51	68	0.64	0.18	CL
CS-3	10-12	-	NP	38	86	2.20	0.04	ML(S)
CS-4	29-31	74	48	53	62	0.58	0.24	CH
CF-7	8-10	-	NP	25	101	1.50	0.03	SM
CF-7	19-21	63	37	63	57	0.63	0.24	CH
C-9	8-10	-	NP	23	99	0.80	0.03	SM
C-9	41-43	64	36	44	75	0.72	0.18	CH
PS-1	5-7	63	44	45	31	0.39	0.37	OH
PS-2	26-28	33	14	34	84	1.60	0.08	ML(C)
PS-3	24-26	71	47		70	0.51	0.14	CH
PS-3	59-61	73	48	51	67	1.26	0.21	CH
PF-4	18-20	114	80	94	46	0.59	0.27	OH
P-9	29-31	93	63	54	62	0.64	0.27	CH

LL = Liquid Limit (D4318)
PI = Plas. Index (D4318)
W_o = Initial Water Content (D2216)
DD_o = Initial Dry Density (D2937)

p_c = Preconsolidation Pressure (Casagrande Method)
C'_c = Compression Index = $C_c/(1+e_o)$
NP = Non-Plastic

DESCRIPTION OF TERMS AND SYMBOLS USED ON SOIL BORING LOG

STE

Soil Testing Engineers, Inc.

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Other	Soil Type	DESCRIPTION

Description

Classifications are based on visual observations by field & lab representatives as well as results of laboratory data (when available).

Laboratory Data

Compressive Strength

Value based on peak compressive strength. Determined by unconfined compression test unless otherwise noted.

Dry Unit Weight

As determined by method similar to ASTM D-2937.

Water Content

As determined by pertinent portions of ASTM D-2216.

Atterberg Limits

LL : Liquid Limit
PL : Plastic Limit
PI : Plasticity Index
(= Liquid Limit - Plastic Limit)

Other

Results of other tests such as consolidation, permeability, grain size or notes associated with testing program.

Soil Type

Graphical representation of soil type. In accordance with USCS Symbols.

Ground Water Levels

Long-Term Depth

Depth to water after boring is completed (time noted).

Short-Term Depth

Depth to water after initial water encountered prior to proceeding with boring (time noted).

Initially Encountered

Depth where free water was initially encountered during augering.

Sampling/Field Data

3.5 (P)

Undisturbed

3" dia. Tube sample

Pocket Penetrometer (P)

Penetration resistance (tons/sq. ft.).

Torvane (T)

Shearing resistance (tons/sq. ft.)

13 b/f (3-7-6)

Split Spoon

Std. penetration test

Std. Penetration

No. of blows per foot (blows per each six inch increments).

Auger

Disturbed (auger) collected in accordance with ASTM D-1452.

No Recovery

Sampling attempted but no sample retrieved.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Ground Water Level Data	Boring Advancement Method	Notes
	Boring Abandonment Method	

Form LOGTERMS

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/04/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 54.7" Long. 89° 45' 51.4"

Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–8									Water Mudline at 8.0 ft.
8–12		0.10t1	201	26	283	97	186		Very soft gray ORGANIC CLAY (OH) w/peat
12–14			23						Loose gray SILTY SAND (SM)
14–21	26 b/f 8-9-17 33 b/f 11-15-18		30					GS1	Firm to dense gray CLAYEY SAND (SC) w/shells
21–28	3 b/f 1-1-2		54		71	26	45		Soft gray CLAY (CH) w/shells
28–38	0.5 (P) 1.0 (P)	4.00t2	30	82				GS2	Firm gray SANDY SILT (ML) -- w/shells
38–40									Firm gray SILTY SAND (SM) w/shells

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 8 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
8 to 48 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 9.1 psi
GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 76%, Silt = 10%, Clay = 14%
GS2: Gravel = 0%, Sand = 13%, Silt = 79%, Clay = 8%

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/04/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 54.7"
Long. 89° 45' 51.4"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		■			33						SM	Firm gray SILTY SAND (SM) w/trace of clay and shells
	45											
		X	20 b/f 5-6-14		28					GS3		
												Boring completed at 48 ft.
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
8 to 48 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
t: Unconsolidated, Undrained Triaxial Compression Test
t2: Lateral Pressure = 27.3 psi
GS: Particle Size Analysis
GS3: Gravel = <1%, Sand = 84%, Silt = 10%, Clay = 6%

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-2

STE
Soil Testing Engineers, Inc.

Sheet 1 of 2

LELAP Certificate No. 02052

File: 03-1114
Date: 09/23/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 18' 50.5" Long. 89° 45' 04.6"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–2											Water Mudline at 2.0 ft.
	2–4	■	0.25 (P)	0.09t1	63	59	61	18	43			Very soft dark gray CLAY (CH) w/organic matter and 2-inch sand layer
	5	■	0.5 (P)	3.18t2	28	90				GS1		Firm gray SANDY SILT (ML)
		■	0.25 (P)	2.30t3	24	95						
		■	No (P)		23							
	10	■	0.25 (P)	2.26t4	28	93				GS2		-- w/clay pockets at 10 to 12 ft.
	15											Medium gray SILTY CLAY (CL)
		■	0.5 (P)	0.50t5	27	94	28	17	11	0.25 SG		-- w/1-inch sand layer at 17 ft.
	20	■	0.5 (P)		35					0.19		Alternate layers of 4-inches Soft gray SILTY CLAY (CL) and 3-inches Loose gray SILTY SAND (SM)
	25											Firm gray SILTY SAND (SM)
		■	0.5 (P)	0.28t6	22	94				0.19 GS3		-- w/clay pockets at 26 to 28 ft.
	30	☒	14 b/f 12-9-5									
	35											Medium gray SILTY CLAY (CL)
		■	0.75 (P)	0.71t7	42	76				0.33		-- w/sand seams at 36 to 38 ft.
	40											Soft gray SILTY CLAY (CL)

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 2 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
2 to 43 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
Lateral Pressure
t1 = 3.5 psi t2 = 4.9 psi t3 = 6.3 psi
t4 = 9.1 psi t5 = 13.3 psi t6 = 20.3 psi
t7 = 27.3 psi
GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 43%, Silt = 45%, Clay = 12%
GS2: Gravel = 0%, Sand = 44%, Silt = 50%, Clay = 6%
GS3: Gravel = 0%, Sand = 72%, Silt = 22%, Clay = 6%
SG: Specific Gravity = 2.74

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-2

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/23/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 18' 50.5"
Long. 89° 45' 04.6"

Surface Elevation: N/A (ft., NGVD)

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		■	0.25 (P)	0.28t8	35	79						Soft gray SILTY CLAY (CL)
												Boring completed at 43 ft.
	45											
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
2 to 43 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
t: Unconsolidated, Undrained Triaxial Compression Test
t8: Lateral Pressure = 30.8 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-3

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/04/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 41.8" Long. 89° 45' 19.9"

Surface Elevation: N/A (ft., NGVD)

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–6											Water Mudline at 6.0 ft.
	6–8			0.04t1	92	40				GS1		Very loose gray CLAYEY SILT (ML)
	8–12				35 32					GS2		Loose gray SANDY SILT (ML)
	12–17		13 b/f 5-7-6 15 b/f 8-9-6		32							Firm gray SANDY SILT (ML)
	17–28		2 b/f 1-1-1		50		68	29	39			Very soft gray CLAY (CH)
			0.25 (P)	0.17t2	49	79	67	26	41	0.23		
	28–40				28					GS3		Loose to firm gray SILTY SAND (SM)

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 6 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
6 to 46 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 7.7 psi
t2: Lateral Pressure = 20.3 psi
GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 76%, Silt - 10%, Clay = 14%
GS2: Gravel = 0%, Sand = 31%, Silt = 63%, Clay = 6%
GS3: Gravel = <1%, Sand = 84%, Silt = 10%, Clay = 6%

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-3

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/04/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 41.8"
Long. 89° 45' 19.9"

Surface Elevation: N/A (ft., NGVD)

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
			6 b/f 3-3-3									Loose gray SILTY SAND (SM) w/clay pockets
	45		1.0 (P)	0.78t3	36	78						
												Boring completed at 46 ft.
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
6 to 46 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
t: Unconsolidated, Undrained Triaxial Compression Test
t3: Lateral Pressure = 34.3 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-4

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/05/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 45.2" Long. 89° 44' 47.8"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–6									Water
	6.0									Mudline at 6.0 ft.
	7		1.67t1	29	87				GS1	Firm gray SILTY SAND (SM) -- w/organic matter at 6 to 8 ft.
	11			36						
	13	25 b/f 10-12-13								-- w/trace of clay at 12 to 14 ft.
	15	6 b/f 3-3-3		57					GS2	Medium gray SILTY CLAY (CL)
	20	10 b/f 6-7-3								
	22									Soft gray CLAY (CH)
	30		0.35t2	47	65	74	26	48	CS	
	35	0.75 (P) 0.5 (P)	0.38t3	38 42	80					-- w/shell fragments at 34 to 36 ft.
	37									Loose gray VERY CLAYEY SILT (ML-CL)

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 6 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
6 to 46 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 7.7 psi
t2: Lateral Pressure = 23.8 psi
t3: Lateral Pressure = 27.3 psi
GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 84%, Silt = 12%, Clay = 4%
GS2: Gravel = 0%, Sand = <1%, Silt = 44%, Clay = 55%
CS: See Consolidation Curve

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CS-4

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/05/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 45.2"
Long. 89° 44' 47.8"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		■	0.75 (P)							GS3		Loose gray VERY CLAYEY SILT (ML-CL)
	45	■		1.25t4	33	82				GS4		Firm gray SANDY SILT (ML)
												Boring completed at 46 ft.
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
6 to 46 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
GS: Particle Size Analysis
GS3: Gravel = 0%, Sand = 8%, Silt = 70%, Clay = 22%
GS4: Gravel = 0%, Sand = 43%, Silt = 49%, Clay = 7%
t: Unconsolidated, Undrained Triaxial Compression Test
t4: Lateral Pressure = 34.3 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CF-5

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/22/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 14' 00.2"
Long. 89° 47' 00.2"

Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–2									Water Mudline at 2.0 ft.
2–4	0.25 (P)	0.18t1	38	73				0.21 GS1	Very loose dark gray SILTY SAND (SM) w/grass and clay
4–6 (5)	0.25 (P)		48					0.15	Very soft dark gray SILTY CLAY (CL) w/grass roots
6–8	0.25 (P)	0.37t2	51	73				GS2	Soft gray SANDY CLAY (CL) w/peat pockets
8–10	0.25 (P)		63					0.44	
10–15	9 b/f 4-6-3								Loose gray SILTY SAND (SM)
15–20	0.75 (P)	2.09t3	30	84					Firm gray CLAYEY SAND (SC)
20–23	0.25 (P)		55					0.21	Soft gray CLAY (CH)
23									Boring completed at 23 ft.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 2 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
2 to 23 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 3.5 psi
t2: Lateral Pressure = 6.3 psi
t3: Lateral Pressure = 13.3 psi
GS: Particle Size Analysis
GS1: Gravel = <1%, Sand = 72%, Silt = 17%, Clay = 11%
GS2: Gravel = 0%, Sand = 42%, Silt = 30%, Clay = 28%

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CF-6

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/05/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 34.5"
Long. 89° 44' 57.0"

Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
0–6											Water Mudline at 6.0 ft.
6–10	Shelby tube			37						SM	Loose gray SILTY SAND (SM) w/trace of clay and organic matter
10–17	Shelby tube; split spoon at 14.5–16	32 b/f 11-15-17	3.17T1	25	82				GS1	SP	Dense gray SAND (SP)
17–22	Split spoon at 19.5–21	22 b/f 9-11-11		27					GS2	ML	Firm gray SANDY SILT (ML)
22–26	Shelby tube at 24–26	0.25 (P) 0.5 (P)		45		90	20	70	0.26	CH	Soft gray CLAY (CH) w/trace of sand
26											Boring completed at 26 ft.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 6 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
6 to 26 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 10.5 PSI
GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 93%, Silt = 6%, Clay = 1%
GS2: Gravel = 0%, Sand = 40%, Silt = 57%, Clay = 3%

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CF-7

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/04/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 58.3" Long. 89° 46' 48.0"
Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–4									Water Mudline at 4.0 ft.
5		0.07t1	46	72				GS1	Very soft gray SANDY CLAY (CL) -- w/shell fragments at 4 to 6 ft.
8–10	17 b/f 11-8-9	2.78t2	28	84				GS2 SG	Firm gray SILTY SAND (SM)
12	3 b/f 1-1-2		42		55	21	34		Soft gray CLAY (CH)
20	1.0 (P) 0.5 (P)		61		63	26	37	0.25	
24–26									Loose gray SILTY SAND (SM)
26									Boring completed at 26 ft.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 4 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
4 to 26 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 6.3 psi
t2: Lateral Pressure = 9.1 psi
GS: Particle Size Analysis
GS1: Gravel = 7%, Sand = 40%, Silt = 28%, Clay = 25%
GS2: Gravel = 0 %, Sand = 56%, Silt = 39%, Clay = 5%
SG: Specific Gravity = 2.64

Strata Boundaries May Not Be Exact

03-1114 LOG01 BARATARIA LDNR 9-16-2003 031114C.GPJ LOG01.GDT 10/29/03

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING CF-8

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/05/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 37.1" Long. 89° 44' 24.1"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–6											Water Mudline at 6.0 ft.
	6–8				46					GS1		Very loose gray SILTY SAND (SM) w/shell fragments and peat
	8–12		WOH		64							Very soft gray SANDY CLAY (CL) w/shell fragments and organic matter
	12–14		6 b/f 1-3-3		38		29	18	11			Medium gray SANDY CLAY (CL) w/shell fragments
	14–26		14 b/f 6-7-7 11 b/f 3-4-7 7 b/f 6-4-3		30					GS2		Firm gray SANDY SILT (ML) -- loose below 24 ft.
	26											Boring completed at 26 ft.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 6 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
6 to 26 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 82%, Silt = 11%, Clay = 7%
GS2: Gravel = 0%, Sand = 43%, Silt = 50%, Clay = 7%
WOH: Weight of Hammer

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING C-9

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/22/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 18' 53.2" Long. 89° 41' 19.6"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–2									Water Mudline at 2.0 ft.
		0.25 (P)		265						Very soft dark gray PEAT (PT)
	5	0.25 (P)	1.54t1	33	85				GS1	Firm gray SILTY SAND (SM)
		0.75 (P)		23						
		1.5 (P)	4.49t2 m	26	100				SG1 GS2	Dense gray SILTY SAND (SM) w/trace of clay
	10	1.5 (P)		23						
	15	1.5 (P)	1.07t3	24	96					
	20	0.75 (P)		27						Firm gray CLAYEY SAND (SC)
	25	0.5 (P)	0.81t4	32	89	23	18	5		Medium gray VERY SANDY CLAY (CL-SC)
	30	0.25 (P)	1.21t5	40	76					Stiff gray SANDY CLAY (CL)
	35	1.0 (P)		30						
	40									

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 2 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
2 to 73 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
Lateral Pressure
t1 = 4.9 psi t2 = 7.7 psi t3 = 13.3 psi
t4 = 20.3 psi t5 = 23.8 psi
GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 68%, Silt = 26%, Clay = 6%
GS2: Gravel = 0%, Sand = 54%, Silt = 32%, Clay = 14%
m: Machine Limit
SG: Specific Gravity
SG1 = 2.64

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING C-9

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/22/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 18' 53.2" Long. 89° 41' 19.6"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
										Stiff gray SANDY CLAY (CL)
		0.75 (P)		47		54	18	36	SG2	Soft gray CLAY (CH)
	45	0.5 (P)		41					0.23	
	50	0.5 (P)	0.29t6	52	69	65	18	47	0.25	
	55	0.75 (P)		41					0.17	
	60	0.5 (P)	0.34t7	55	66	86	22	64	0.27	
	65	0.25 (P)		48					0.27	
	70									Very soft gray CLAY (CH)
		0.25 (P)	0.16t8	41	72	57	19	38	0.31	
										Boring completed at 73 ft.
	75									
	80									

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
2 to 73 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
SG: Specific Gravity
SG2 = 2.66
t: Unconsolidated, Undrained Triaxial Compression Test
t6: Lateral Pressure = 37.8 PSI
t7: Lateral Pressure = 44.8 PSI
t8: Lateral Pressure = 51.8 PSI

Strata Boundaries May Not Be Exact

03-1114 LOG01 BARATARIA LDNR 9-16-2003 031114C.GPJ LOG01.GDT 10/29/03

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING C-10

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/22/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 18' 48.0" Long. 89° 46' 47.0"
Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–2									Water Mudline at 2.0 ft.
2–4	0.25 (P)	0.08t1	48	69	30	17	13	0.15	Very soft gray SILTY CLAY (CL) w/shells and organic matter
4–6 (5)	0.25 (P)	0.09t2	41	63				GS	Loose gray CLAYEY SAND (SC)
6–8	0.5 (P)	0.73t3	30	90					Medium gray VERY SILTY CLAY (CL-ML)
8–10	1.0 (P)		38						-- w/shells at 8 to 10 ft.
10–13	10 b/f 6-5-5								Firm gray CLAYEY SAND (SC)
13–17	No (P)		27						Firm gray SILTY SAND (SM)
21–23	1.0 (P)	3.93t4	25	96					-- w/trace of clay at 21 to 23 ft.
23									Boring completed at 23 ft.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 2 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
2 to 23 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 3.5 psi
t2: Lateral Pressure = 4.9 psi
t3: Lateral Pressure = 6.3 psi
41: Lateral Pressure = 16.8 psi
GS: Particle Size Analysis
Gravel = <1%, Sand = 53%, Silt = 30%, Clay = 17%

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING Q-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/03/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 18' 06.2" Long. 89° 49' 30.8"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–14											Water
	14.0											Mudline at 14.0 ft.
	15				35					GS1		Loose gray SANDY SILT (ML) w/shell fragments
			5 b/f 3-2-3		26							
			10 b/f 3-5-5									Firm gray SANDY SILT (ML) w/shell fragments
	20		23 b/f 8-9-14		30					GS2		
			11 b/f 7-6-5									
	25											
	30		24 b/f 8-10-14		36							
	35		14 b/f 8-5-9									
	36											Boring completed at 36 ft.
	40											

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 14 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
4 to 36 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

GS: Particle Size Analysis
GS1: Gravel = 0%, Sand = 46%, Silt = 48%, Clay = 6%
GS2: Gravel = 0%, Sand = 44%, Silt = 48%, Clay = 8%

Strata Boundaries May Not Be Exact

03-1114 LOG01 BARATARIA LDNR 9-16-2003 031114C.GPJ LOG01.GDT 10/29/03

Barataria Barrier Island
Restoration Complex Project
BA-38 (Chaland Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING Q-2

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/03/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 17' 45.4"
Long. 89° 49' 32.5"

Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–11										Water
11										Mudline at 11.0 ft.
11–13	Shelby	0.25 (P) 0.75 (P)	0.15t1	59	62	54	26	28	0.17	Very soft gray CLAY (CH) w/shell fragments
13–15	Shelby	0.25 (P) 1.0 (P)		43						Very soft gray SANDY CLAY (CL) w/shell fragments
15–17	Split spoon	5 b/f 5-3-2								Loose gray SILTY SAND (SM)
17–22	Split spoon	11 b/f 2-3-8		30					GS	Firm gray SILTY SAND (SM) w/trace of clay and shell fragments
	Split spoon	13 b/f 5-7-6								
22–31	Split spoon	6 b/f 2-2-4		47		63	23	40		Medium gray CLAY (CH) w/trace of sand
	Shelby		0.50t2	33	83				0.21	
31										Boring completed at 31 ft.

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 11 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
11 to 31 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

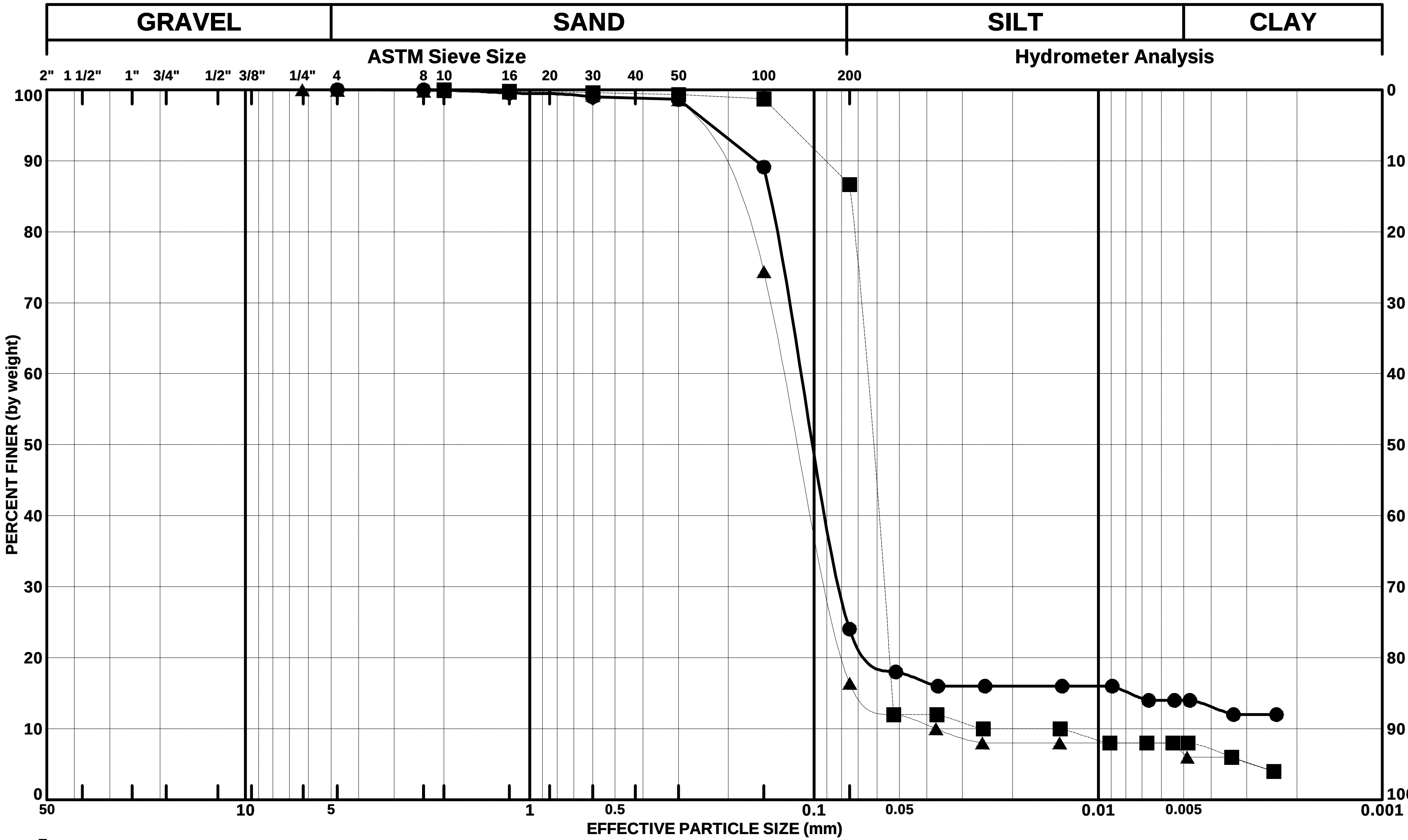
t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 11.2 psi
t2: Lateral Pressure = 23.8 psi
GS: Particle Size Analysis
Gravel = 0%, Sand = 65%, Silt = 25%, Clay = 10%

Strata Boundaries May Not Be Exact

03-1114 LOG01 BARATARIA LDNR 9-16-2003 031114C.GPJ LOG01.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CS-1	28.5 - 30.0	0.0	76.0	10.1	14.0
■ CS-1	46.0 - 48.0	0.0	13.4	78.6	8.0
▲ CS-1	58.5 - 60.0	0.1	83.5	9.9	6.5



ASTM D422

STE
Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

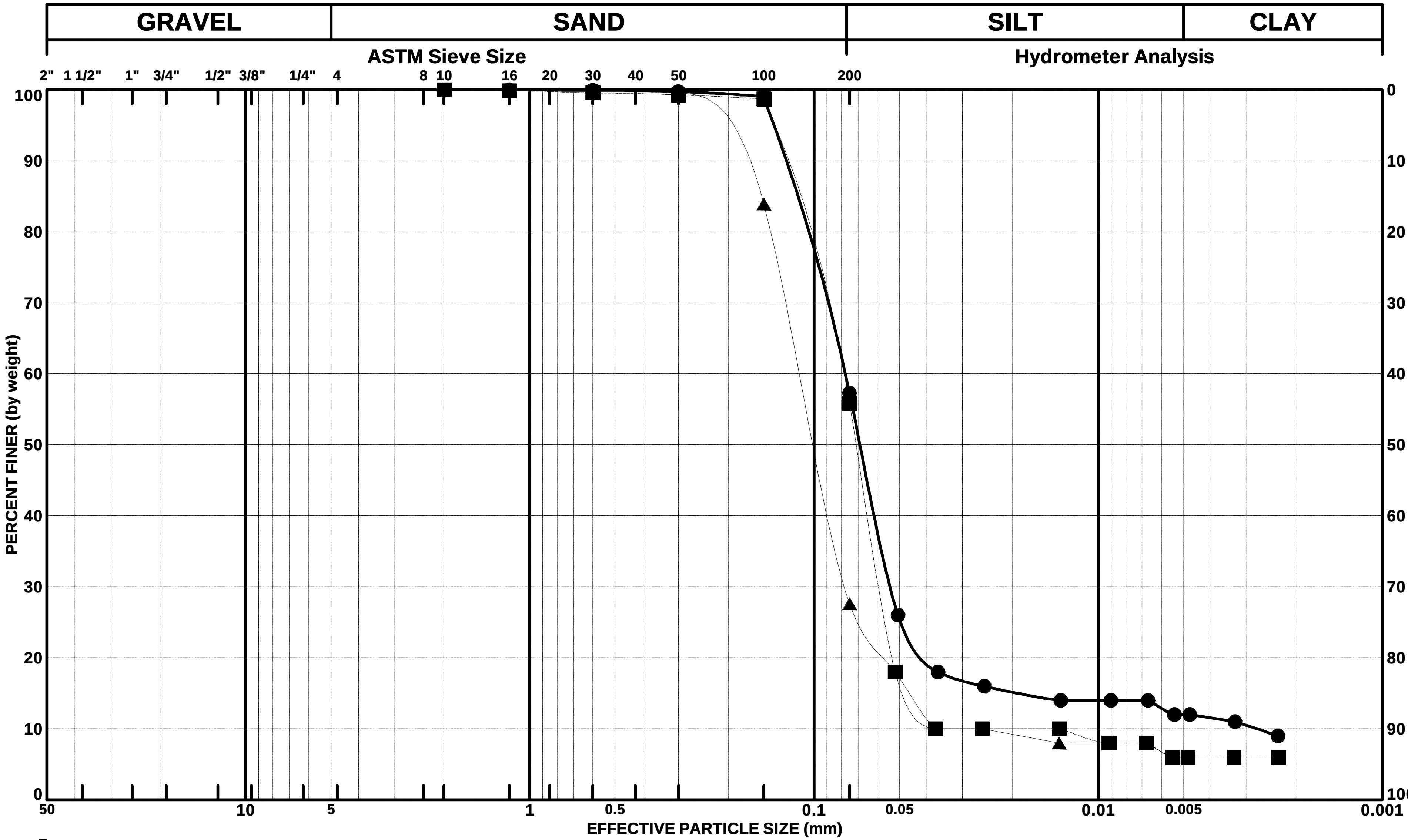
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/11/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CS-2	4.0 - 6.0	0.0	42.7	45.3	12.0
■ CS-2	10.0 - 12.0	0.0	44.2	49.8	6.0
▲ CS-2	26.0 - 28.0	0.0	72.4	21.6	6.0



ASTM D422

STE Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

GRAIN SIZE ANALYSIS

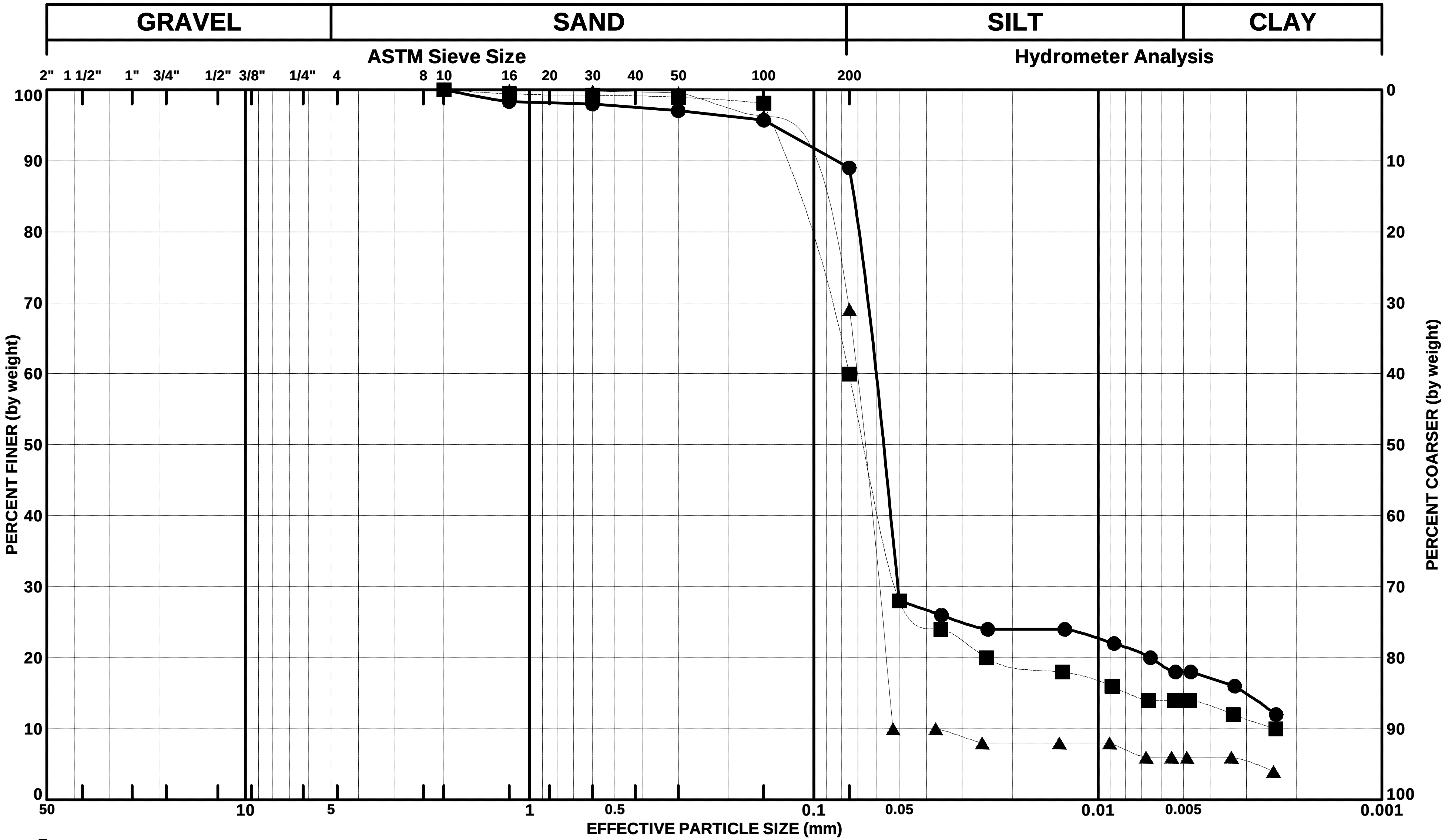
File No.: 03-1114

Date: 09/29/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CS-3	16.0 - 18.0	0.0	11.0	71.0	18.0
■ CS-3	20.0 - 22.0	0.0	40.1	45.9	14.0
▲ CS-3	44.0 - 46.0	0.0	30.9	63.1	6.0



STE Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

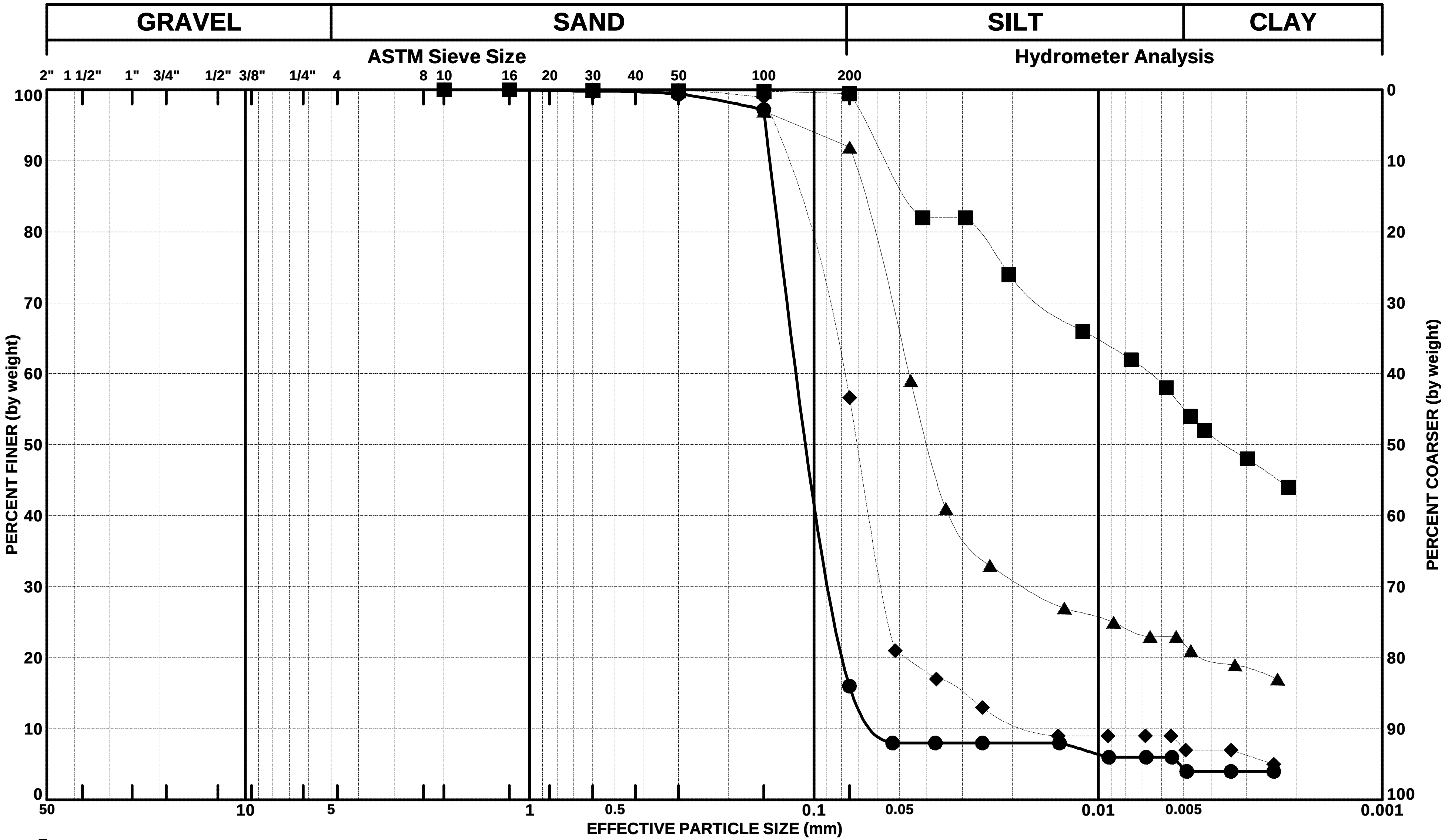
GRAIN SIZE ANALYSIS

File No.: 03-1114

Date: 09/11/2003

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CS-4	16.0 - 18.0	0.0	84.0	11.6	4.4
■ CS-4	24.5 - 26.0	0.0	0.6	44.3	55.1
▲ CS-4	49.0 - 51.0	0.0	8.1	70.0	21.9
◆ CS-4	54.0 - 56.0	0.0	43.4	49.3	7.3

LELAP Certificate No. 02052



ASTM D422

STE
Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

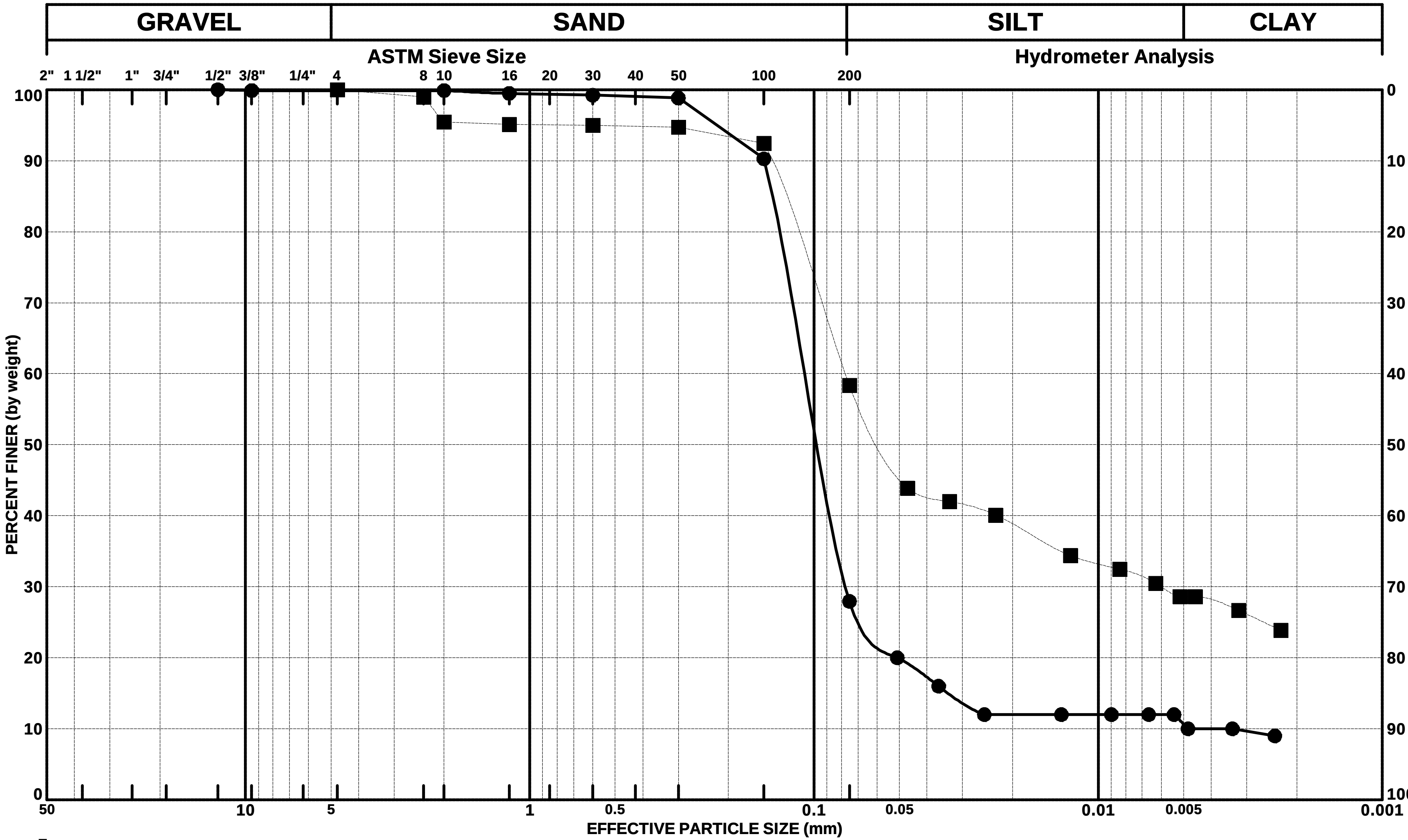
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/12/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CF-5	2.0 - 4.0	0.1	71.9	17.3	10.6
■ CF-5	6.0 - 8.0	0.0	41.7	29.7	28.6



ASTM D422

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Soil Testing Engineers, Inc.

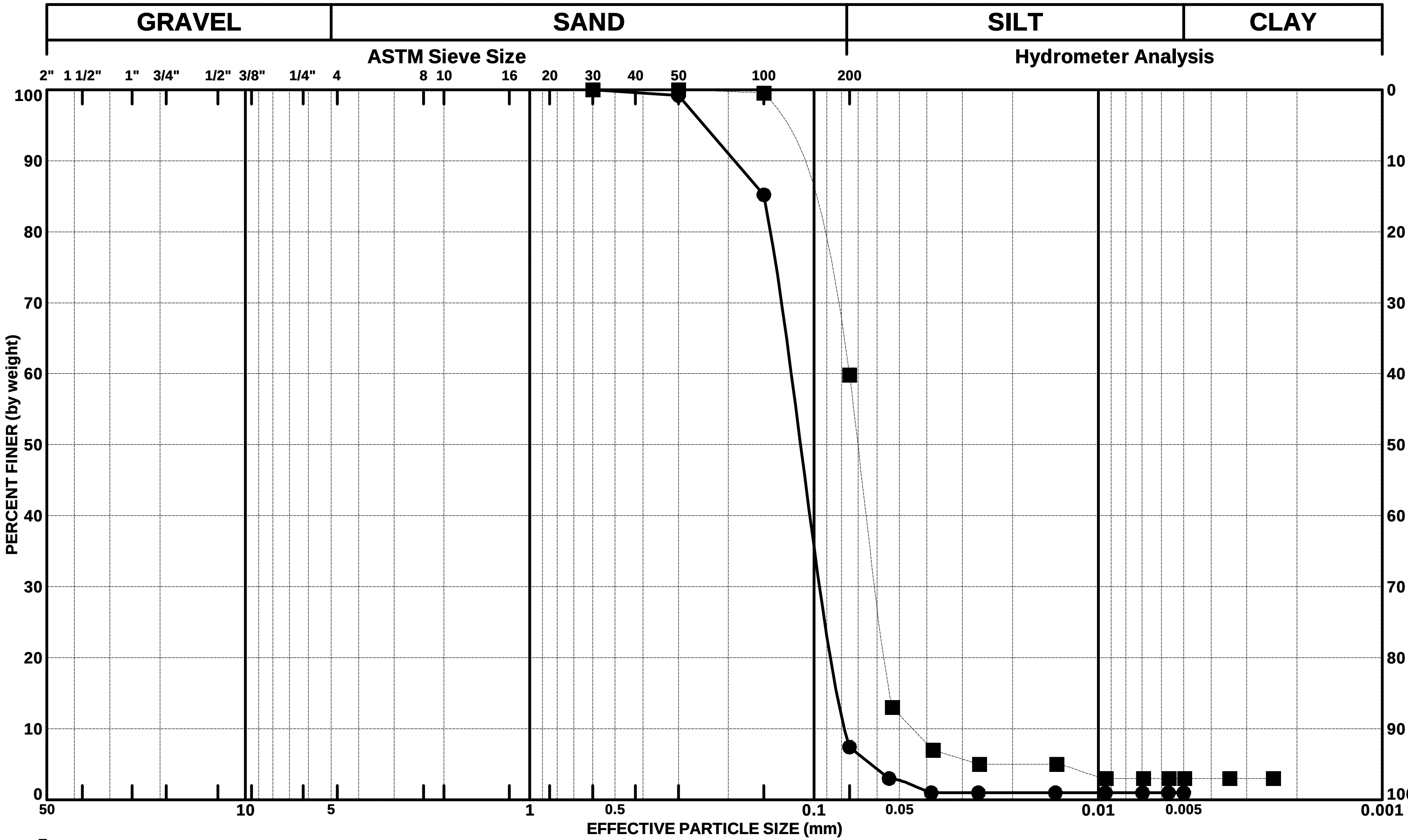
Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 10/01/2003

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CF-6	20.0 - 22.0	0.0	92.6	6.4	1.0
■ CF-6	29.5 - 31.0	0.0	40.2	56.8	3.0

LELAP Certificate No. 02052



ASTM D422

STE Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

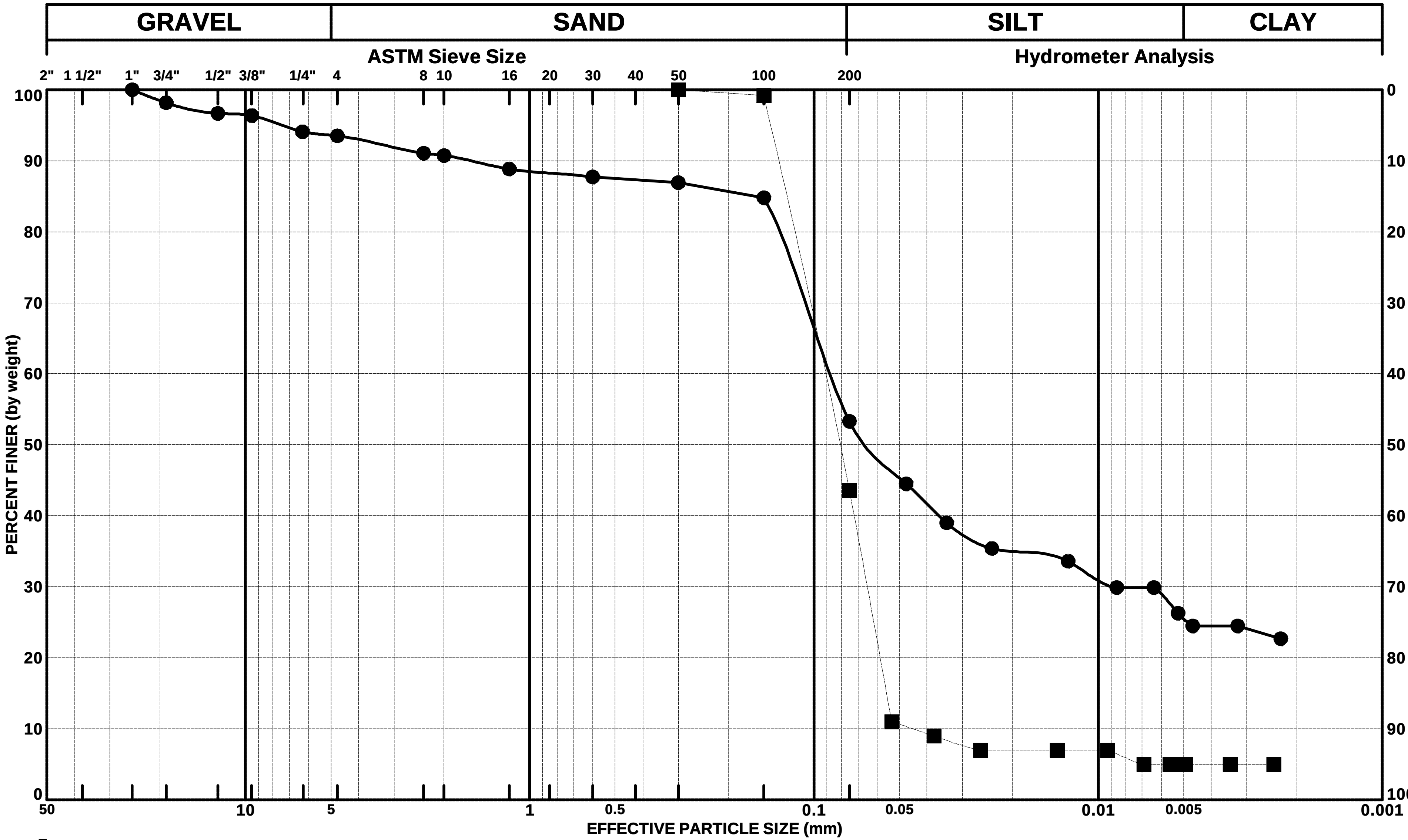
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/12/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CF-7	12.0 - 14.0	6.5	40.2	27.7	25.6
■ CF-7	16.0 - 18.0	0.0	56.4	38.6	5.0



ASTM D422

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Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

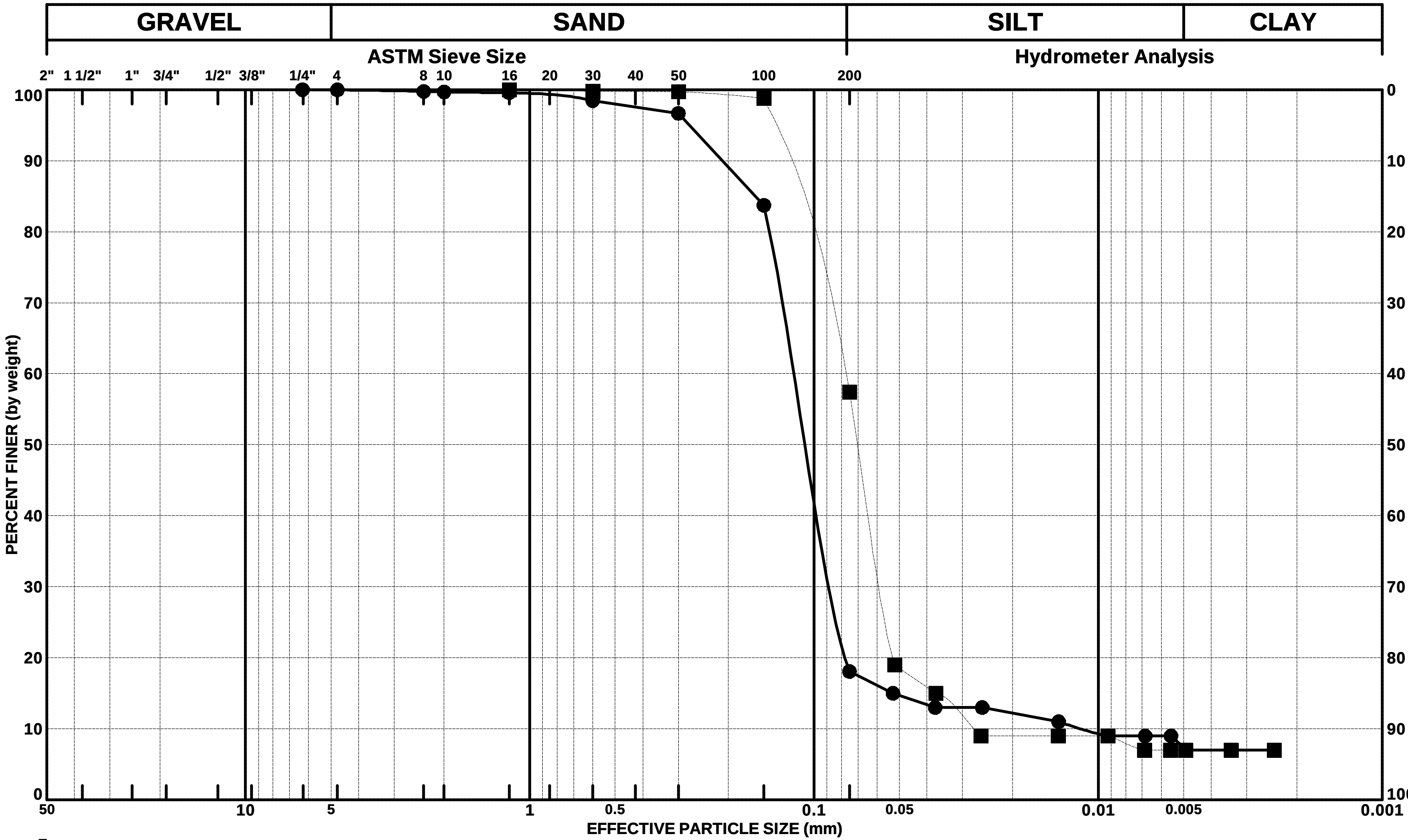
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/12/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● CF-8	16.0 - 18.0	0.0	81.9	10.8	7.3
■ CF-8	29.5 - 31.0	0.0	42.6	50.4	7.0



ASTM D422

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Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

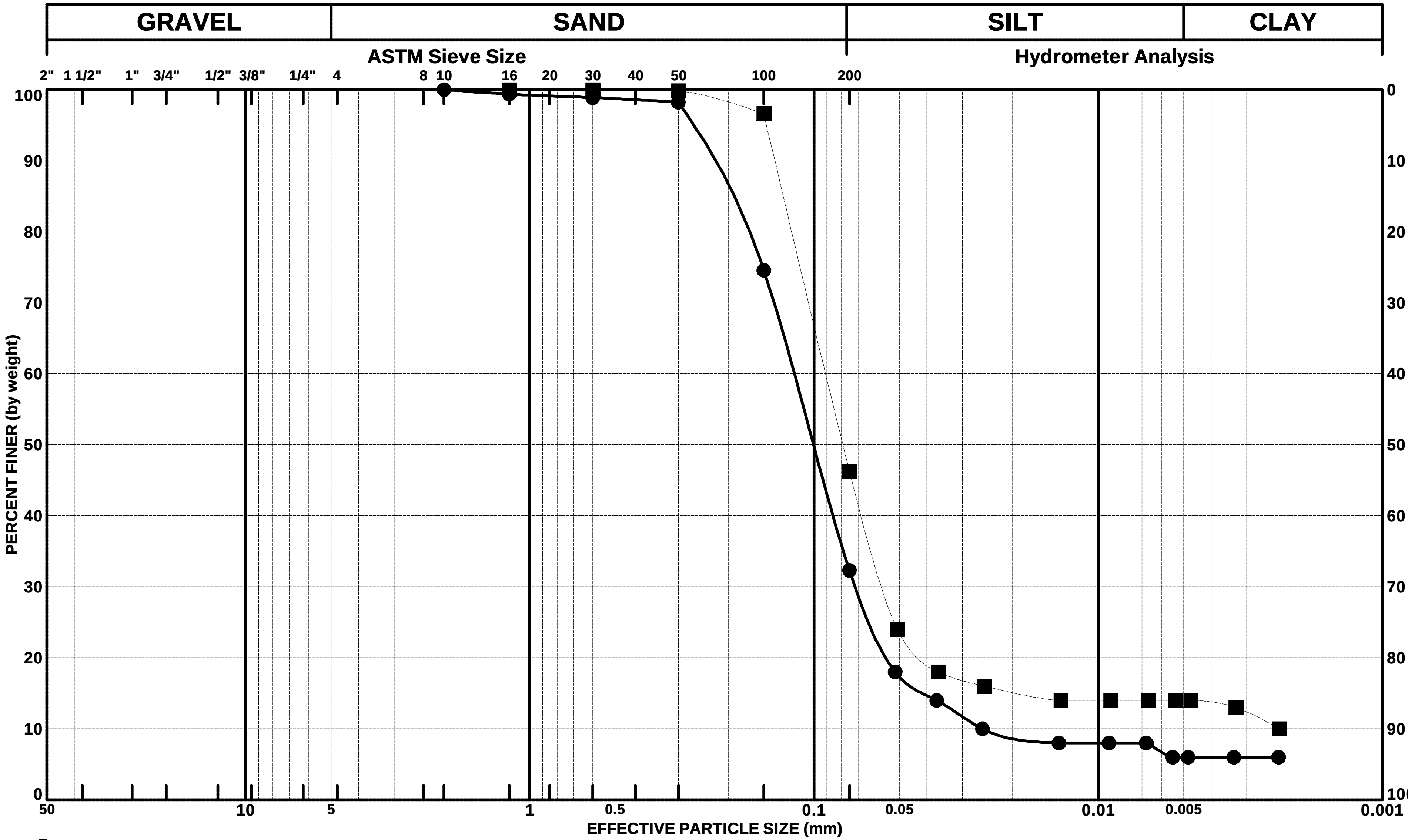
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/12/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● C-9	4.0 - 6.0	0.0	67.7	26.3	6.0
■ C-9	8.0 - 10.0	0.0	53.7	32.3	14.0



STE Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

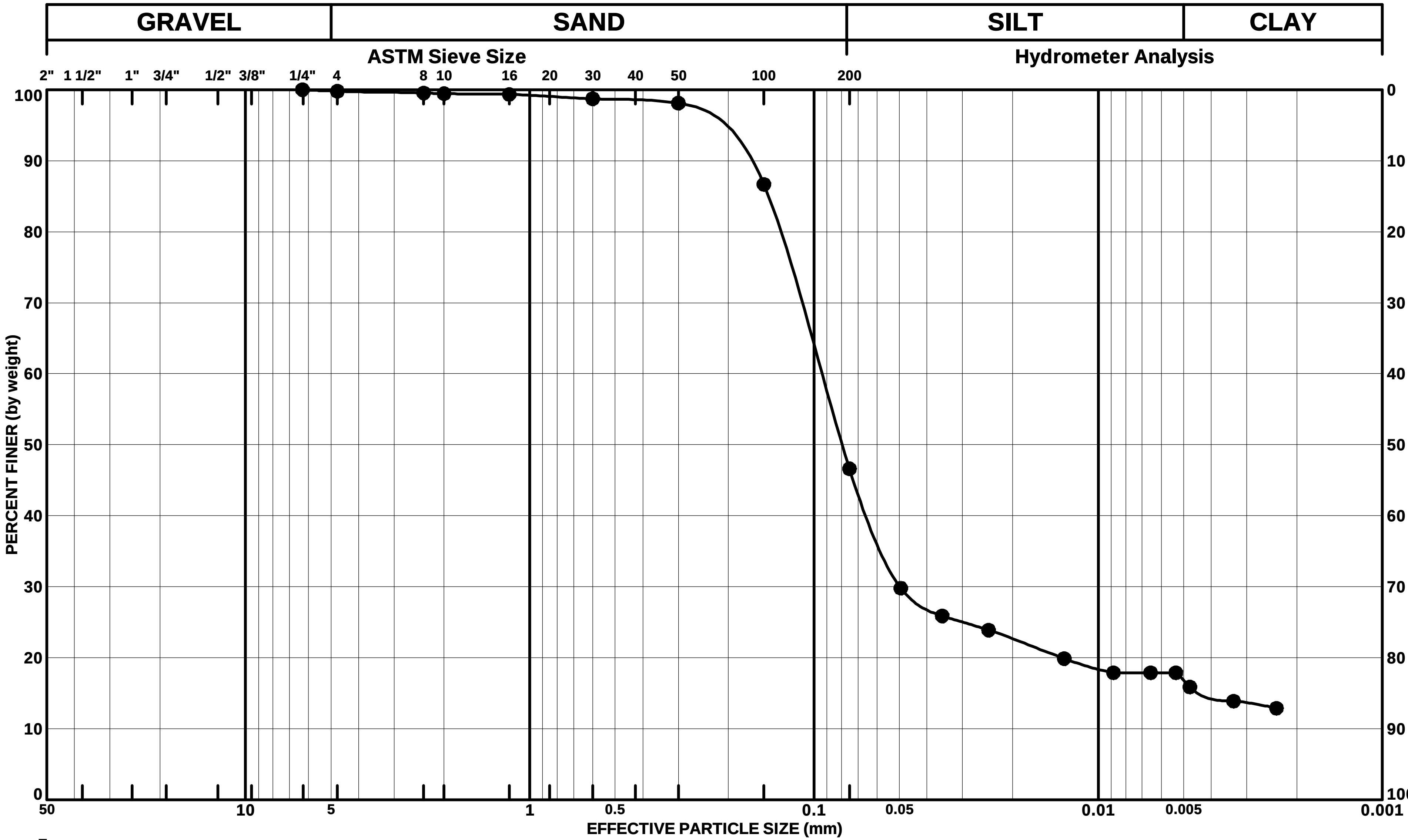
GRAIN SIZE ANALYSIS

File No.: 03-1114

Date: 09/29/2003

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● C-10	4.0 - 6.0	0.2	53.2	29.9	16.8



ASTM D422

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

GRAIN SIZE ANALYSIS

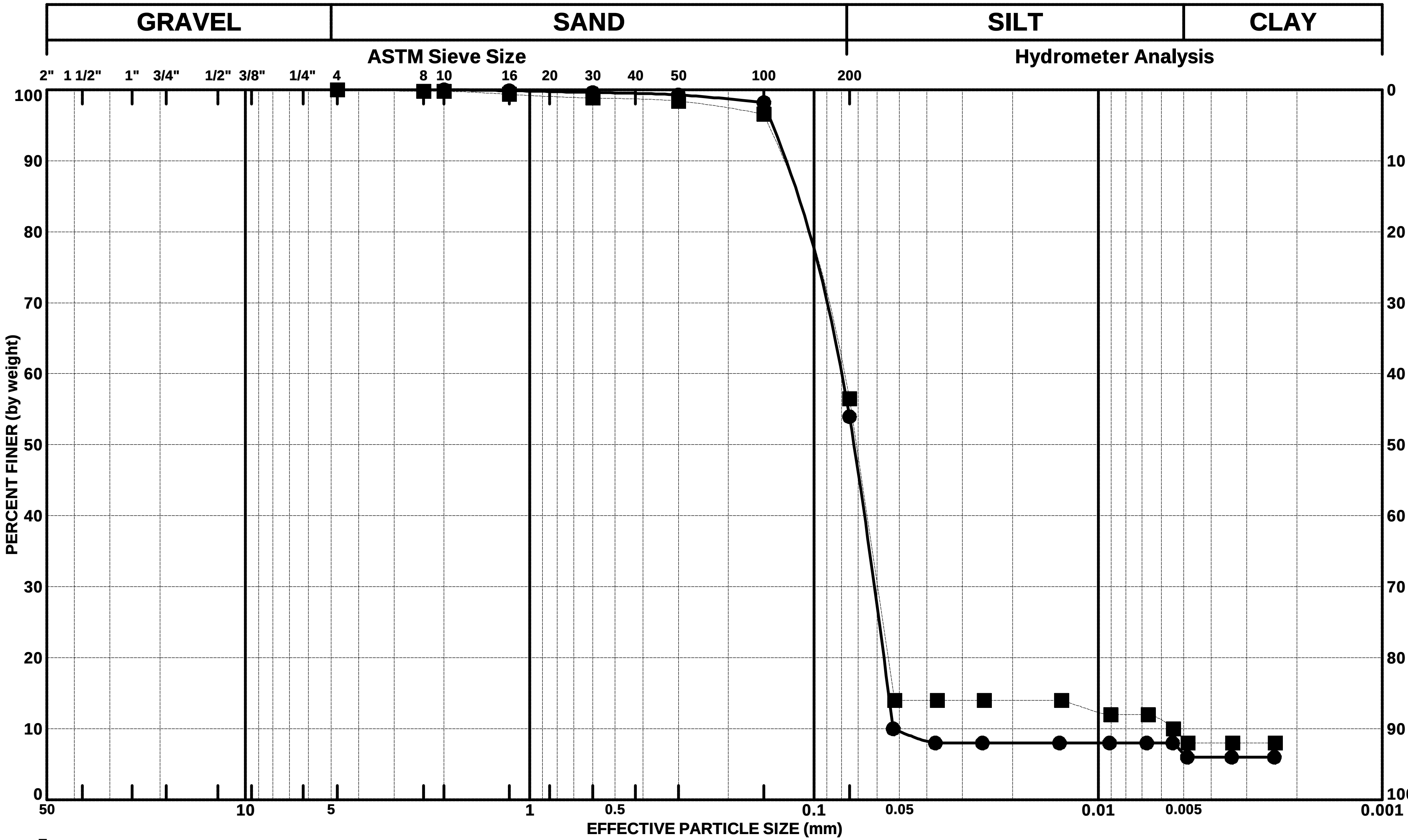
File No.: 03-1114

Date: 10/01/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● Q-1	18.0 - 20.0	0.0	46.1	47.5	6.5
■ Q-1	24.5 - 26.0	0.0	43.5	47.9	8.6



ASTM D422

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Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

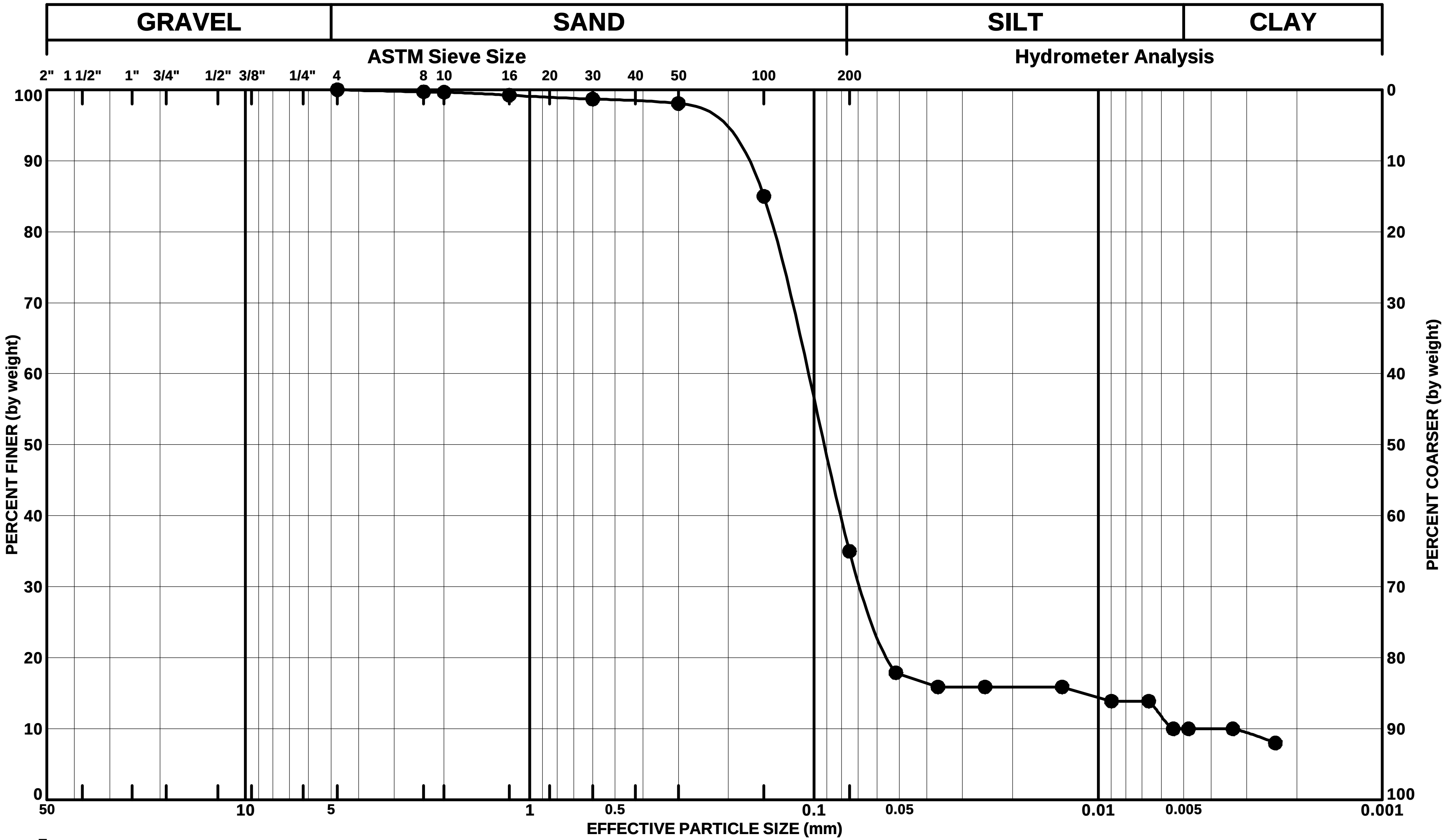
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/11/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● Q-2	21.5 - 23.0	0.0	65.0	25.0	10.0

LELAP Certificate No. 02052



ASTM D422

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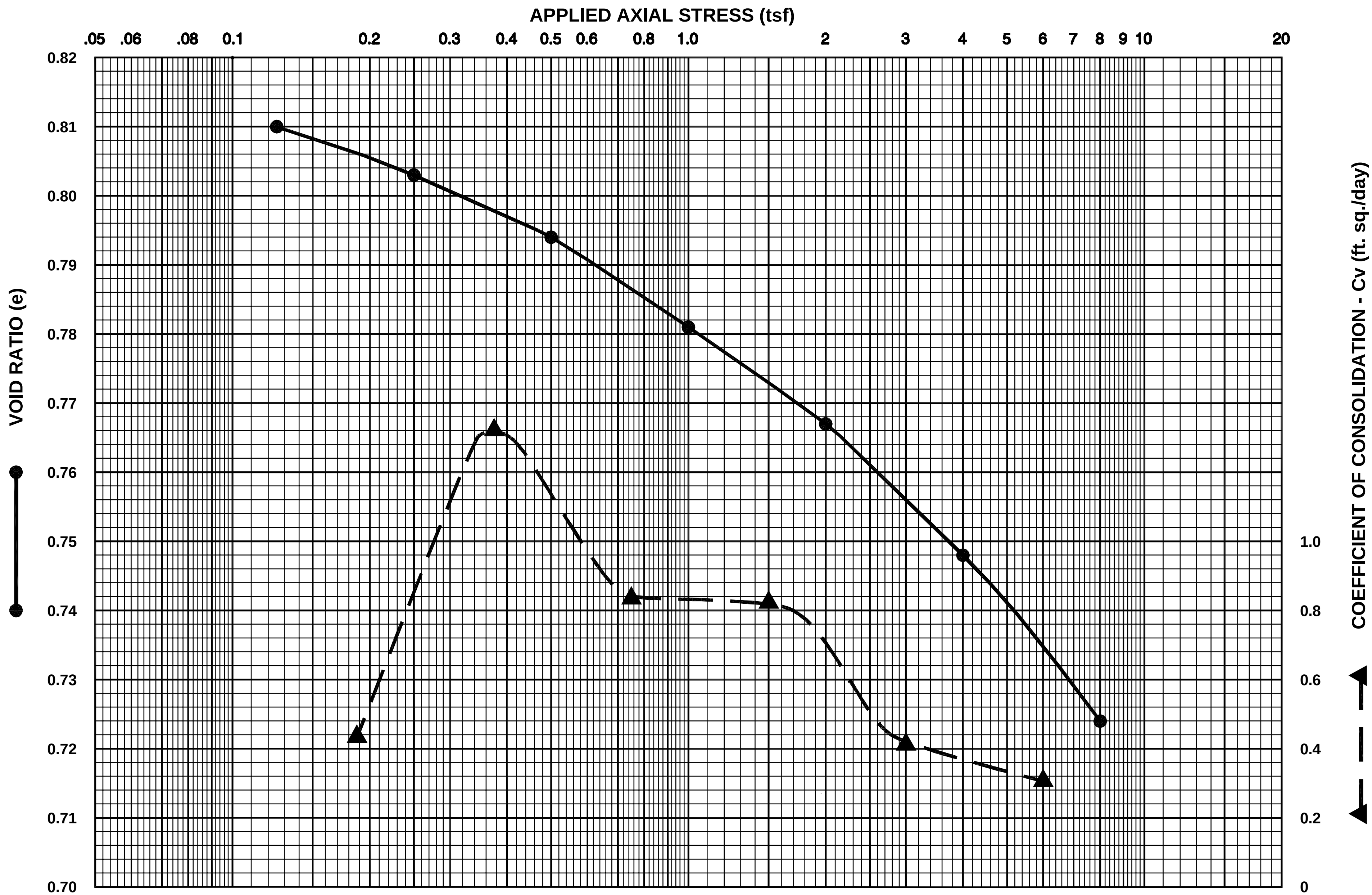
Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Chaland Headland)

GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/11/2003

GRAINSZ 031114C.GPJ GRAINSZ.GDT 10/29/03



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: CS-1
DEPTH (feet): 36-38
MATERIAL: Gray SANDY SILT

FILE NO.: 03-1114

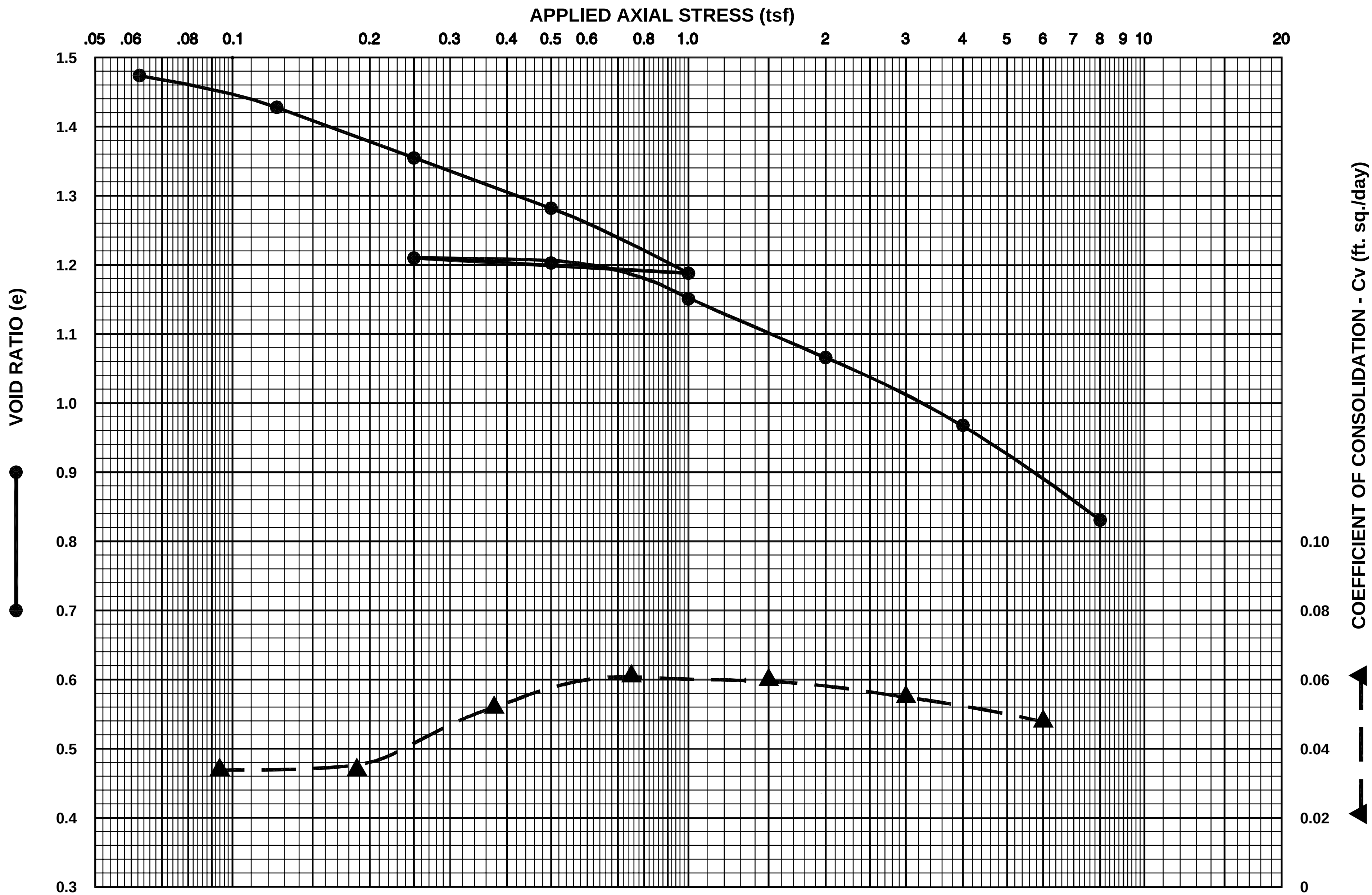
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 30.2
INITIAL DRY DENSITY (lbs./cu.ft.) = 88.7
FINAL MOISTURE CONTENT (%) = 31.9

FIGURE NO.:

Eo = 0.822 Gs = 2.59



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: CS-2
DEPTH (feet): 16-18
MATERIAL: Gray SILTY CLAY

FILE NO.: 03-1114

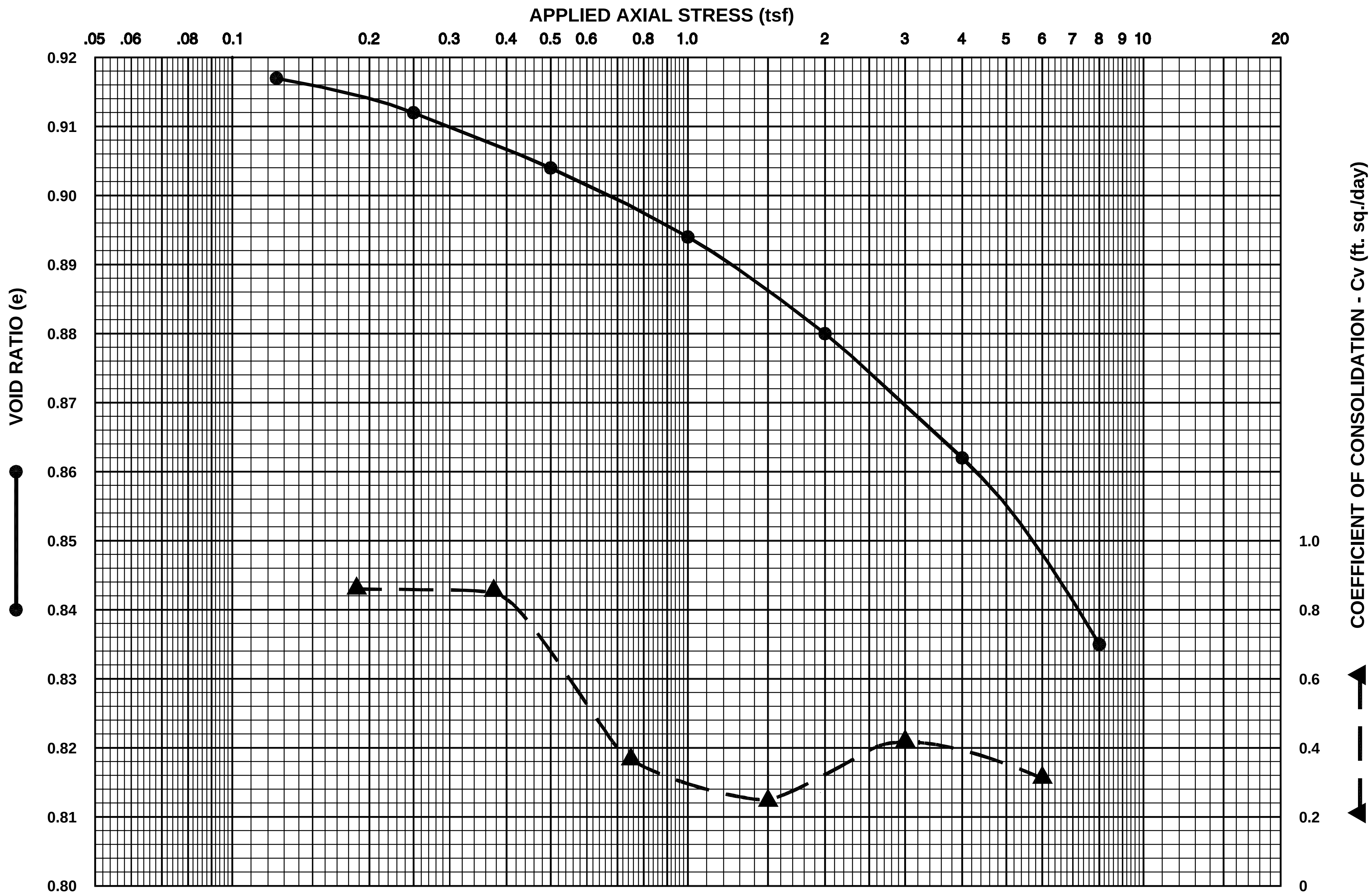
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) =	51.3	LL = 28
INITIAL DRY DENSITY (lbs./cu.ft.) =	68.0	PL = 17
FINAL MOISTURE CONTENT (%) =	33.9	PI = 11

FIGURE NO.:

Eo = 1.217 Gs = 2.66



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: CS-3
DEPTH (feet): 10-12
MATERIAL: Gray SILTY SAND w/clay seams
FILE NO.: 03-1114

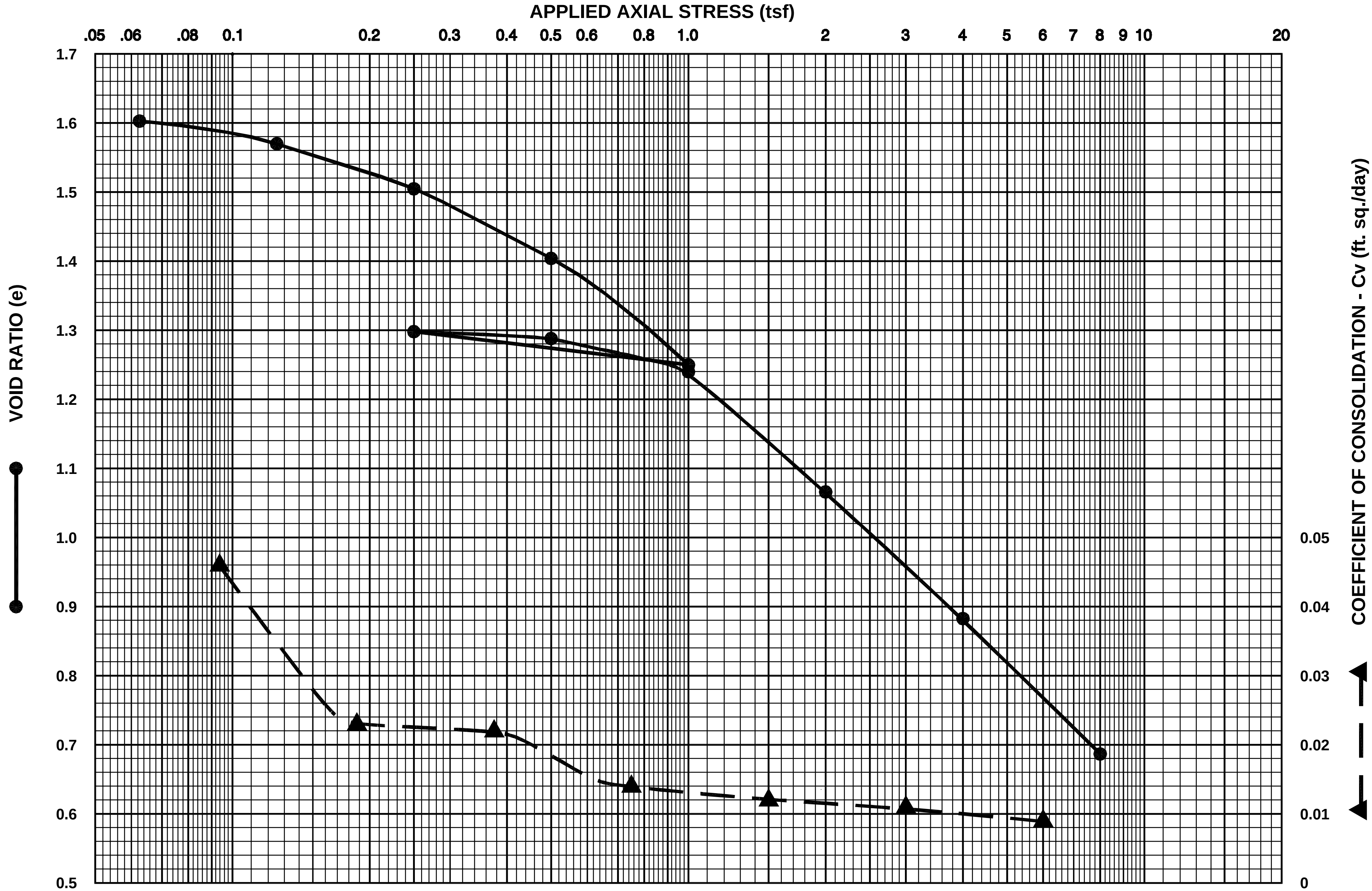
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 37.9
INITIAL DRY DENSITY (lbs./cu.ft.) = 86.1
FINAL MOISTURE CONTENT (%) = 29.8

FIGURE NO.:

Eo = 0.921 Gs = 2.65



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: CS-4
DEPTH (feet): 29-31
MATERIAL: Gray CLAY

FILE NO.: 03-1114

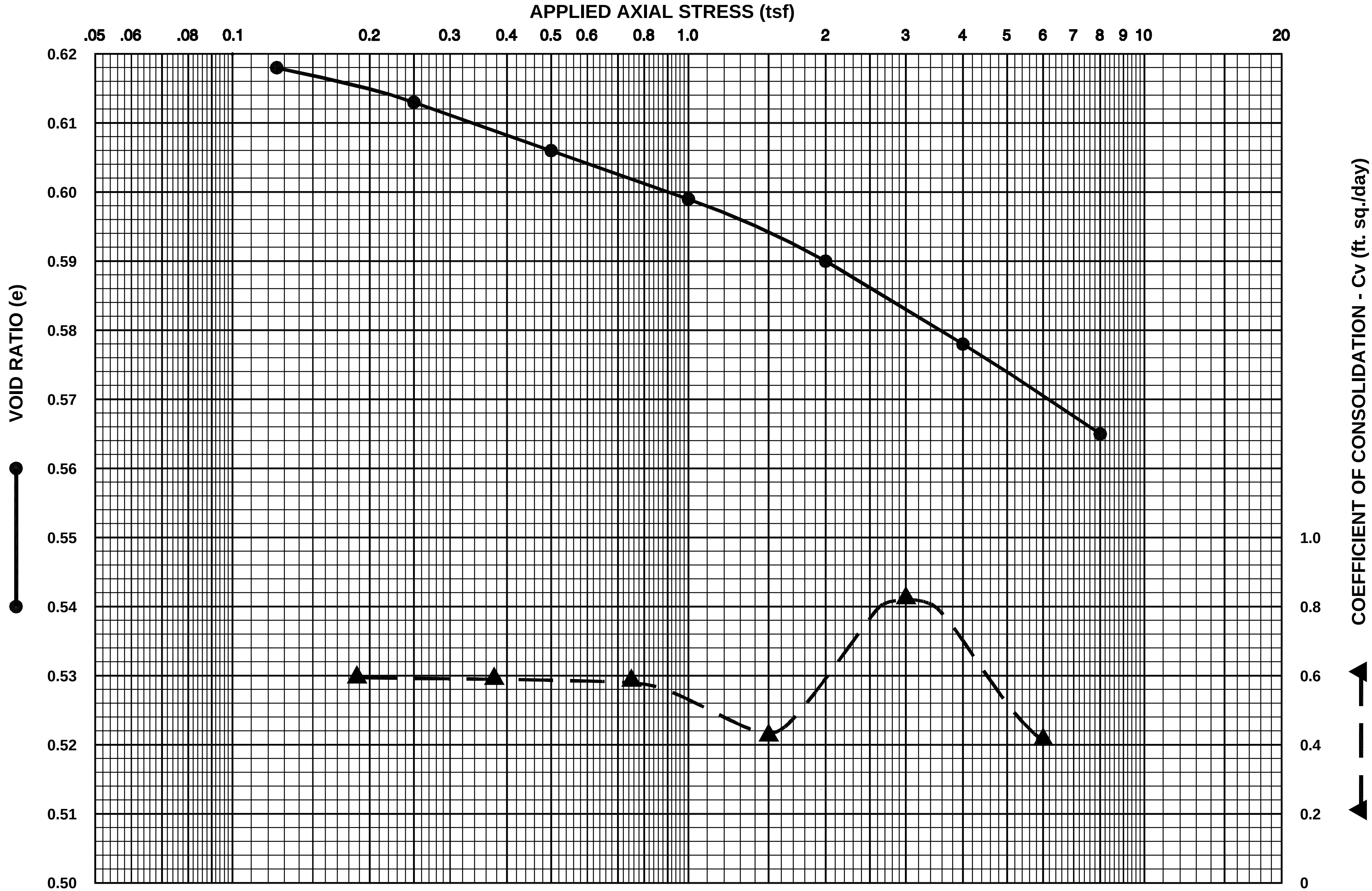
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) =	53.3	LL = 74
INITIAL DRY DENSITY (lbs./cu.ft.) =	61.8	PL = 26
FINAL MOISTURE CONTENT (%) =	40.9	PI = 48

FIGURE NO.:

Eo = 1.625 Gs = 2.6



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: CF-7
DEPTH (feet): 8-10
MATERIAL: Gray SILTY SAND

FILE NO.: 03-1114

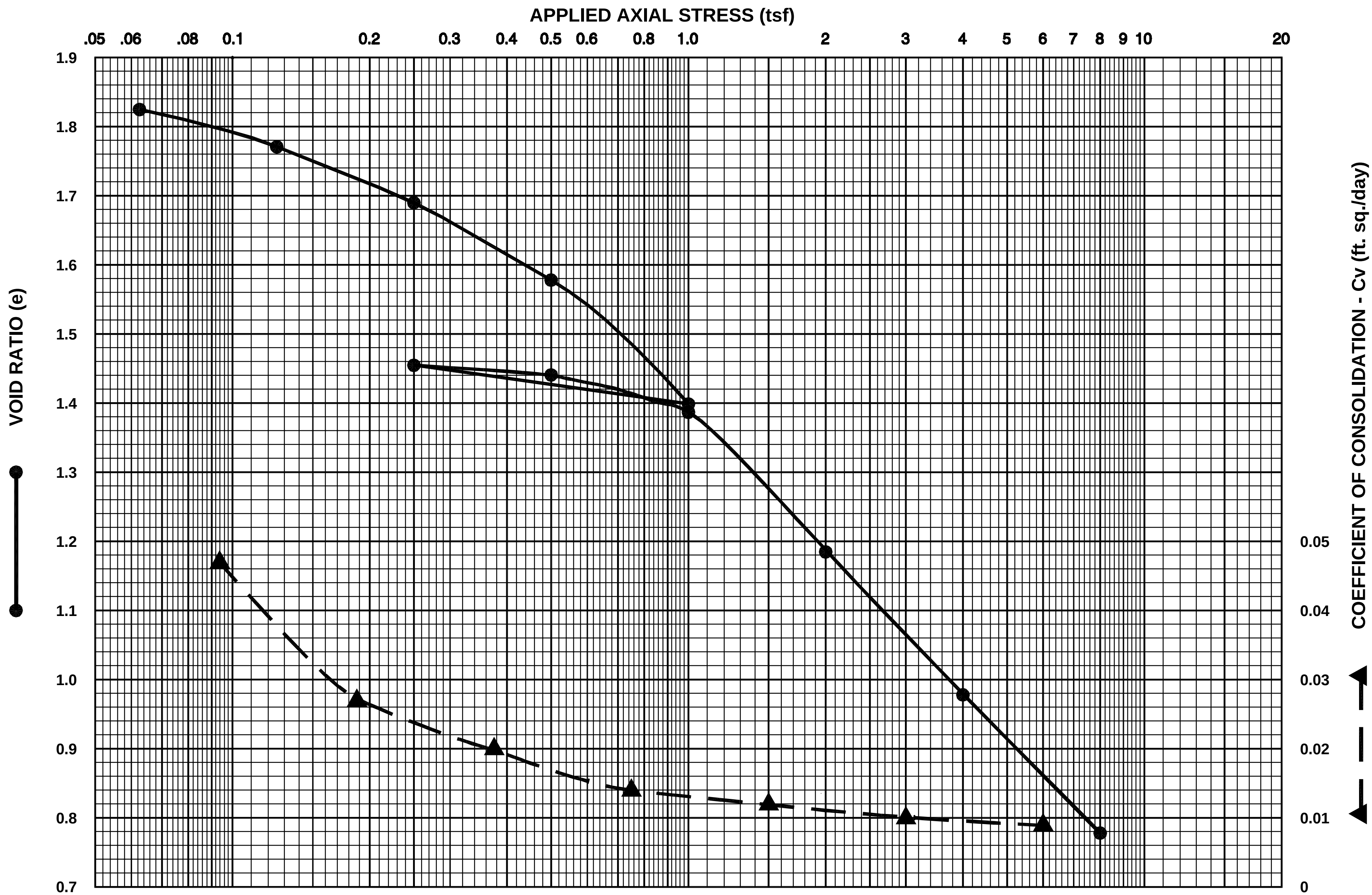
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 24.8
INITIAL DRY DENSITY (lbs./cu.ft.) = 101.4
FINAL MOISTURE CONTENT (%) = 21.8

FIGURE NO.:

Eo = 0.625 Gs = 2.64



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: CF-7
DEPTH (feet): 19-21
MATERIAL: Gray CLAY w/sand seams
FILE NO.: 03-1114

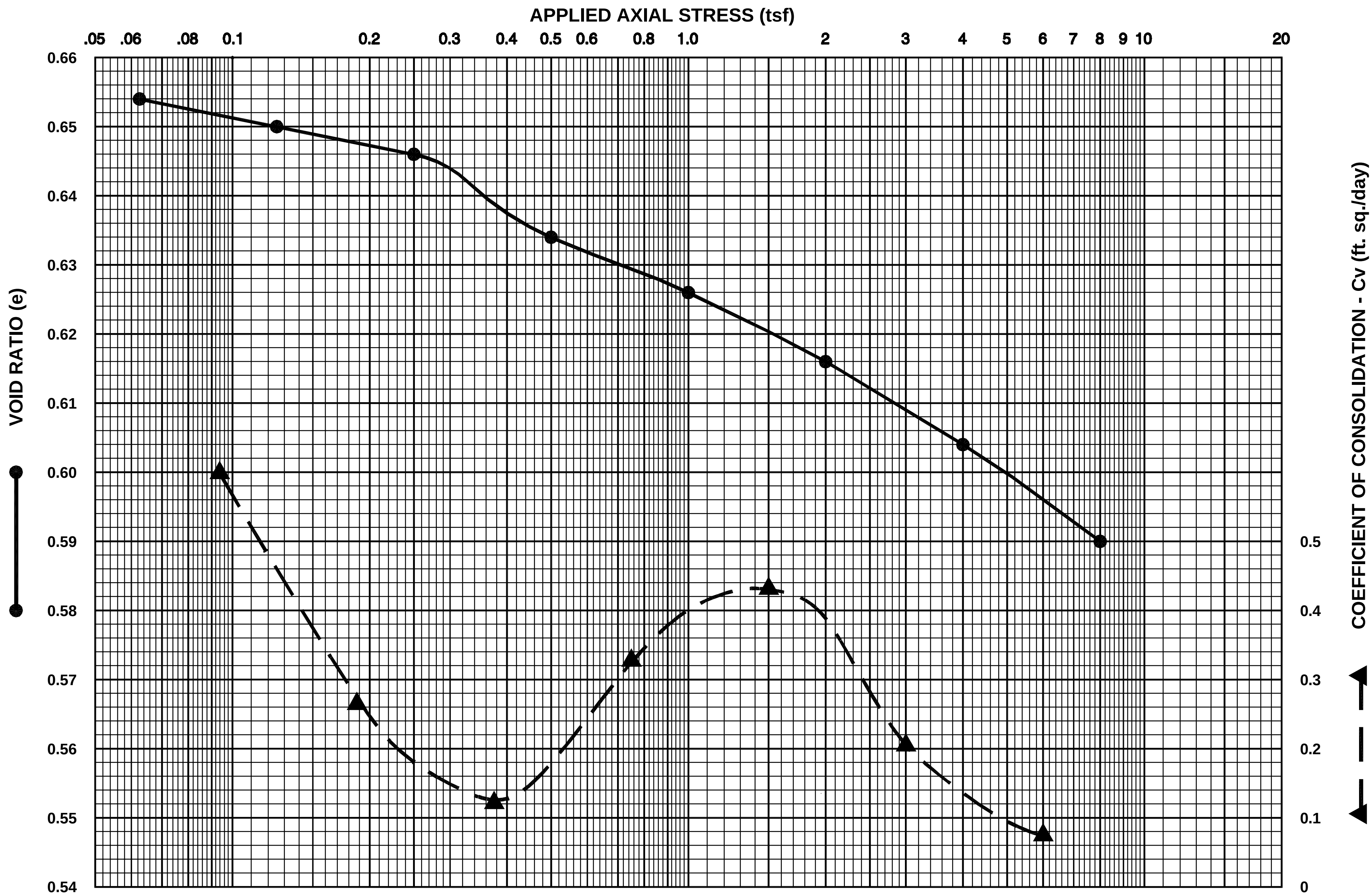
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 63.0 LL = 63
INITIAL DRY DENSITY (lbs./cu.ft.) = 56.7 PL = 26
FINAL MOISTURE CONTENT (%) = 40.9 PI = 37

FIGURE NO.:

Eo = 1.863 Gs = 2.6



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: C-9
DEPTH (feet): 8-10
MATERIAL: Gray SILTY SAND

FILE NO.: 03-1114

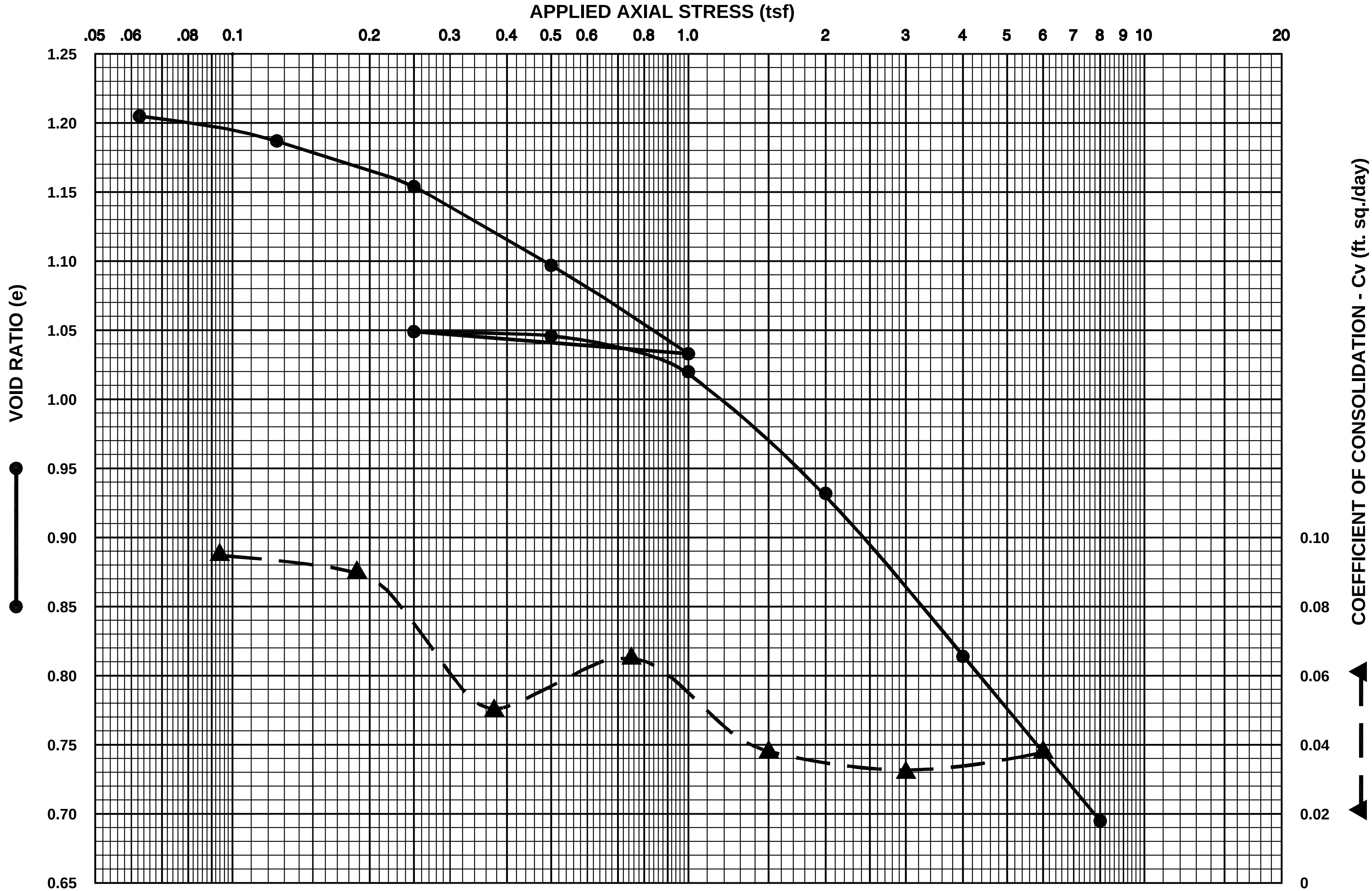
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 23.3
INITIAL DRY DENSITY (lbs./cu.ft.) = 99.4
FINAL MOISTURE CONTENT (%) = 21.6

FIGURE NO.:

Eo = 1.217 Gs = 2.66



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: C-9
DEPTH (feet): 41-43
MATERIAL: Gray SANDY CLAY

FILE NO.: 03-1114

STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) =	44.0	LL = 54
INITIAL DRY DENSITY (lbs./cu.ft.) =	74.9	PL = 18
FINAL MOISTURE CONTENT (%) =	31.9	PI = 36

FIGURE NO.:

Eo = 1.217 Gs = 2.66

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PS-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/24/03
Logged by: K. Moody
Driller: oMNI
Rig: Airboat

Location: Lat. 29° 15' 26.3"
Long. 89° 36' 10.9"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–3									Water Mudline at 3.0 ft.
	3–13	0.25 (P)		137		149	31	118	0.19	Very soft gray ORGANIC CLAY (OH)
	5	0.5 (P)	0.10t1	127	41	63	19	44	0.15 CS,SG	-- w/peat and vertical sand seams at 5 to 7 ft.
		0.25 (P)							0.15	
	10	0.25 (P)	0.08t2	103	41	138	33	105		-- w/sand seams at 9 to 11 ft.
		0.25 (P)								
	13–40									Very soft gray CLAY (CH)
	15									
		0.25 (P)							0.13	
	20									
		0.25 (P)	0.10t3	60	61	65	29	36	0.19	
	25									
		0.25 (P)							0.19	
	30									
		0.25 (P)	0.18t4	62	68				0.21	
	35									
		0.25 (P)							0.21	
	40									

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 3 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
3 to 43 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 5.6 psi
t2: Lateral Pressure = 8.4 psi
t3: Lateral Pressure = 16.8 psi
t4: Lateral Pressure = 23.8 psi
CS: See Consolidation Curve
SG: Specific Gravity = 2.55

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PS-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/24/03
Logged by: K. Moody
Driller: oMNI
Rig: Airboat

Location: Lat. 29° 15' 26.3" Long. 89° 36' 10.9"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		■	0.25 (P)	0.17t5	64	61				0.19		Very soft gray CLAY (CH)
												Boring completed at 43 ft.
	45											
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
3 to 43 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
t: Unconsolidated, Undrained Triaxial Compression Test
t5: Lateral Pressure = 30.8 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PS-2

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/26/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 15' 00.7" Long. 89° 34' 59.5"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–2									Water Mudline at 2.0 ft.
	3	0.25 (P)							0.14	Very soft dark gray ORGANIC CLAY (OH) -- w/peat and shells at 2 to 4 ft.
	5	0.25 (P)	0.07t1	129	36	128	30	98		
	7	0.25 (P)							0.11	
	9	0.25 (P)	0.09t2	93	43	156	46	110	0.31	-- w/peat layer at 9 ft.
	11	0.0 (P)							0.11	
	17	0.0 (P)	0.08t3	102	44				0.13	
	22	0.0 (P)	0.10t4	61	63				0.10	Very soft gray CLAY (CH) w/1-inch silt and sand layers
	27	0.5 (P)		38		33	19	14	0.19 CS,SG	Loose gray CLAYEY SILT (ML)
	32	0.5 (P)							0.21	Very soft gray CLAY (CH) -- w/silt seams at 31 to 33 ft.
	37	0.25 (P)	0.14t5	65	58				0.19	
	40									

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 2 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
2 to 43 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 4.9 psi
t2: Lateral Pressure = 7.7 psi
t3: Lateral Pressure = 13.8 psi
t4: Lateral Pressure = 16.8 psi
t5: Lateral Pressure = 27.3 psi
CS: See Consolidation Curve
SG: Specific Gravity = 2.67

Strata Boundaries May Not Be Exact

03-1114 LOG01 BARATARIA LDNR 9-16-2003 031114P.GPJ LOG01.GDT 10/29/03

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PS-2

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/26/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 15' 00.7"
Long. 89° 34' 59.5"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		■	0.0 (P)		113					0.06		Very soft gray ORGANIC CLAY (OH) w/peat
												Boring completed at 43 ft.
	45											
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
2 to 43 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PS-3

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/10/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 14' 59.3" Long. 89° 33' 59.1"
Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–10									Water; Mudline at 10.0 ft.
10–22	0.0 (P)	0.08t1	128	36	107	30	77	0.06	Very soft dark gray ORGANIC CLAY (OH) w/peat, roots, and shell pockets
	0.0 (P)	0.11t2	138	33	166	40	126	0.08	
	0.0 (P)	0.12t3	138	33	149	40	109	0.10	
	0.0 (P)	0.19t4	198	25	214	43	171	0.18	
	0.0 (P) VS								
22–28	No (P)		61		71	24	47	0.02 SG1,CS	Very soft gray CLAY (CH) w/trace of organic matter
28–33	No (P)		30						Loose gray CLAYEY SILT (ML)
33–38	0.5 (P)	1.96t5	27	92				0.38	Firm gray CLAYEY SAND (SC)
38–40									Loose gray CLAYEY SAND (SC)

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 10 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
10 to 61 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 10.5 psi
t2: Lateral Pressure = 11.9 psi
t3: Lateral Pressure = 13.3 psi
t4: Lateral Pressure = 14.7 psi
t5: Lateral Pressure = 27.3 psi
SG: Specific Gravity
SG1 = 2.71
CS: See Consolidation Curve
WOH: Weight of Hammer

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PS-3

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/10/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 14' 59.3"
Long. 89° 33' 59.1"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
			9 b/f 3-3-6		27							Loose gray CLAYEY SAND (SC)
	45		2 b/f 1-1-1		28							-- very loose below 44 ft.
												Very soft gray SLIGHTLY SILTY CLAY (CL-CH)
	50		0.5 (P)	0.19t6	39	77	49	21	28	0.36		
												Soft gray CLAY (CH)
	55		4 b/f 1-2-2		62							
	60				54		73	25	48	SG2		
												Boring completed at 61 ft.
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
10 to 61 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes
t: Unconsolidated, Undrained Triaxial Compression Test
t6: Lateral Pressure = 37.8 psi
SG: Specific Gravity
SG2 = 2.75

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PF-4

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/09/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 14' 48.6"
Long. 89° 33' 53.9"

Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–14									Water
14									Mudline at 14.0 ft.
15	0.5 (P)	0.26t1	98	44	123	41	82	0.20	Soft gray ORGANIC CLAY (OH) w/wood and roots
	0.75 (P)		89					0.35	
	0.25 (P)	0.21t2	90	48	114	34	80	0.14 SG,CS	Very soft gray ORGANIC CLAY (OH) -- w/roots at 18 to 20 ft.
20	0.25 (P)		85					0.26	-- w/sand pockets and shells at 20 to 22 ft.
	0.5 (P)	0.16t3	102	44	115	32	83	0.67	-- w/wood and shells at 22 to 24 ft.
30	0.5 (P)	0.18t4	102	44				0.52	-- w/wood at 29 to 31 ft.
	0.75 (P)		98		126	31	95	0.25	
35			30						Firm gray SILTY SAND (SM)
36									Boring completed at 36 ft.

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 14 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
14 to 36 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 13.3 psi
t2: Lateral Pressure = 16.1 psi
t3: Lateral Pressure = 18.9 psi
t4: Lateral Pressure = 23.8 psi
SG: Specific Gravity = 2.71
CS: See Consolidation Curve

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PF-5

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/25/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 14' 55.6" Long. 89° 34' 39.9"
Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–2									Water Mudline at 2.0 ft.
	0.25 (P)							0.12	Very soft dark gray ORGANIC CLAY (OH) w/peat
5	0.25 (P)	0.07t1	152	33	86	24	62	0.12	
	0.5 (P)	0.08t2	91	44				0.15	Very soft dark gray CLAY (CH) -- w/silt pockets at 6 to 8 ft.
	0.25 (P)							0.15	
10	0.25 (P)	0.10t3	110	40	132	30	102	0.18	-- w/peat layers at 10 to 12 ft.
15	0.25 (P)								
20	No (P)	0.07t4	66	58	75	19	56		Very soft gray CLAY (CH) w/roots
22									Boring completed at 22 ft.

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 2 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
2 to 22 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 4.9 psi
t2: Lateral Pressure = 6.3 psi
t3: Lateral Pressure = 7.7 psi
t4: Lateral Pressure = 16.8 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING PF-6

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/24/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 15' 18.7" Long. 89° 36' 10.7"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–3									Water Mudline at 3.0 ft.
		0.5 (P)	0.17t1	48	68	77	20	57	0.27	Very soft gray CLAY (CH) -- w/sand pockets at 3 to 5 ft.
	5	0.5 (P)							0.27	
		0.5 (P)	0.11t2	76	56	73	19	54	0.23 SG	-- w/sand seams, wood, and roots at 7 to 9 ft.
	10	0.7 (P)							0.21	
		0.5 (P)	0.13t3	75	54	87	24	63	0.21	-- w/sand pockets at 11 to 13 ft.
	15									
		0.5 (P)							0.15	
	20									Loose gray CLAYEY SILT (ML) w/ 1/2-inch clay layers
		0.4 (P)	0.57t4	41	79				0.29	
	25									Boring completed at 23 ft.
	30									
	35									
	40									

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 3 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
3 to 23 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 4.2 psi
t2: Lateral Pressure = 7.0 psi
t3: Lateral Pressure = 9.8 psi
t4: Lateral Pressure = 16.8 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-7

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/26/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 15' 22.1" Long. 89° 35' 46.5"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–3									Water Mudline at 3.0 ft.
		0.0 (P)	0.05t1	143	32	186	38	148	0.06	Very soft dark gray ORGANIC CLAY (OH) w/peat
	5	0.1 (P)							0.08	
		1.25 (P)	0.16t2	34	79	29	19	10	0.23	Very loose gray CLAYEY SILT (ML)
	10	0.75 (P)							0.14	Loose gray SANDY SILT (ML)
		0.75 (P)	0.41t3	32	86				0.22 GS	-- w/clay seams at 11 to 13 ft.
	15									
		1.0 (P)							0.33	
	20									Very soft gray SILTY CLAY (CL)
		0.5 (P)	0.21t4	39	77				0.13	-- w/sand layer at 21 ft.
	25									Boring completed at 23 ft.
	30									
	35									
	40									

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 3 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
3 to 23 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 4.2 psi
t2: Lateral Pressure = 7.0 psi
t3: Lateral Pressure = 9.8 psi
t4: Lateral Pressure = 16.8 psi
GS: Particle Size Analysis
Gravel = 0%, Sand = 14%, Silt = 72%, Clay = 14%

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-8

STE
Soil Testing Engineers, Inc.

Sheet 1 of 1

LELAP Certificate No. 02052

File: 03-1114
Date: 09/24/03
Logged by: K. Moody
Driller: Omni
Rig: Airboat

Location: Lat. 29° 15' 11.2" Long. 89° 35' 44.9"

Surface Elevation: N/A (ft., NGVD)

Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
0–3									Water Mudline at 3.0 ft.
3–5	0.0 (P)	0.08t1	216	26	83	29	54	0.09	Very soft dark gray PEAT (PT) w/sand pockets
5–11	0.25 (P)							0.10	Very soft gray CLAY (CH)
	0.75 (P)	0.09t2	76	49	98	28	70	0.33 CS,SG	-- w/roots, wood, and peat 7 to 9 ft.
	0.5 (P)								
11–23	0.6 (P)	0.70t3	28	88					Loose gray SILTY SAND (SM) -- w/clay pockets at 11 to 13 ft.
	1.0 (P)								
	1.0 (P)	0.94t4	26	97					-- w/clay seams at 21 to 23 ft.
23									Boring completed at 23 ft.

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 3 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
3 to 23 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 4.2 psi
t2: Lateral Pressure = 7.0 psi
t3: Lateral Pressure = 9.8 psi
t4: Lateral Pressure = 16.8 psi
CS: See Consolidation Curve

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-9

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/11/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 15' 08.9" Long. 89° 35' 09.4"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Description
	0–8									Water
										Mudline at 8.0 ft.
	8–12	0.0 (P)	0.07t1	151	29	156	43	113	0.06	Very soft gray ORGANIC CLAY (OH) -- w/peat at 8 to 10 ft.
		0.0 (P)		90					0.27	
	12–21	VS								Very soft gray CLAY (CH)
		0.5 (P)	0.15t2	54	66	55	25	30	0.27	
		0.0 (P)							0.17	-- w/organic matter at 16 to 18 ft.
	21–27	1.0 (P)		30					0.17	Loose gray SILTY SAND (SM) w/clay seams
	27–40	0.5 (P)	0.37t3	65	58	93	30	63	0.25 SG,CS	Soft gray CLAY (CH)
		0.5 (P)							0.19	-- w/trace of organic matter at 34 to 36 ft.

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 4 ft.
Water to Mudline 8 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
8 to 81 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 9.1 psi
t2: Lateral Pressure = 13.3 psi
t3: Lateral Pressure = 23.8 psi
SG: Specific Gravity = 2.78
CS: See Consolidation Curve

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-9

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/11/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 15' 08.9"
Long. 89° 35' 09.4"

Surface Elevation: N/A (ft., NGVD)

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
			0.5 (P)	0.31t4	49	69				0.19		Soft gray CLAY (CH)
												Loose gray SILTY SAND (SM) w/clay layers
	45		0.0 (P)							0.23		
												Soft gray and brown CLAY (CH)
	50		1.0 (P)	0.46t5	47	71				0.25		
	55		1.0 (P)							0.33		
	60		0.5 (P)	0.26t6	59	61				0.31		
	65		1.0 (P)							0.31		
	70		0.5 (P)	0.28t7	57	61				0.31		
	75		0.5 (P)							0.38		
												Very dense gray SILTY SAND (SM) w/clay pockets
	80											

Continued Next Page

Ground Water Level Data	Boring Advancement Method	Notes
	4" Dia. Rotary Wash: 8 to 81 ft.	t: Unconsolidated, Undrained Triaxial Compression Test t4: Lateral Pressure = 30.8 psi t5: Lateral Pressure = 37.8 psi t6: Lateral Pressure = 44.8 psi t7: Lateral Pressure = 51.8 psi
	Boring Abandonment Method Borehole grouted upon completion	Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-9

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/11/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 15' 08.9"
Long. 89° 35' 09.4"

Surface Elevation: N/A (ft., NGVD)

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		X	60 b/f 27-28-32								SM	Very dense gray SILTY SAND (SM) Boring completed at 81 ft.
	85											
	90											
	95											
	100											
	105											
	110											
	115											
	120											

Ground Water Level Data	Boring Advancement Method	Notes
	4" Dia. Rotary Wash: 8 to 81 ft.	
	Boring Abandonment Method	
	Borehole grouted upon completion	

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-10

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/10/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 15' 02.3"
Long. 89° 34' 40.4"

Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–7											Water
												Mudline at 7.0 ft.
	8		0.0 (P)		167		166	46	120	0.06		Very soft gray ORGANIC CLAY (OH)
	10		0.0 (P)	0.13t1	215	24	189	58	131	0.04		
	12		0.0 (P)		151					0.27		
	14		0.0 (P)							0.10		Very soft gray CLAY (CH) -- w/wood and organic matter at 13 to 17 ft.
	16		0.0 (P)	0.10t2	49	65	61	24	37	0.19		
	22		0.0 (P)							0.33		
	26		1.0 (P)	0.23t3	61	64	69	23	46	0.16		-- w/silt seams at 25 to 27 ft.
	32		No (P)		53					0.33		
	36		No (P)	0.21t4	45	64				0.36		
	40											

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 3 ft.
Water to Mudline 7 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
7 to 47 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

t: Unconsolidated, Undrained Triaxial Compression Test
t1: Lateral Pressure = 9.7 psi
t2: Lateral Pressure = 13.3 psi
t3: Lateral Pressure = 20.3 psi
t4: Lateral Pressure = 27.3 psi

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING P-10

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/10/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 15' 02.3" Long. 89° 34' 40.4"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
		■	No (P)								CH	Very soft gray CLAY (CH)
	45	■	No (P)								CH	
	47											Boring completed at 47 ft.
	50											
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
7 to 47 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING E-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/09/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location:
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–30											Water Mudline at 30.0 ft.
	30		0.5 (P)		51		52	20	32	0.10		Very soft gray CLAY (CH) w/ 1/4-inch sand layers 6-inches apart
			0.5 (P)		63		84	30	54	0.23		
	35		21 b/f 14-11-10							GS		Firm gray SILTY SAND (SM)
			13 b/f 10-7-6		52		36	17	19			Medium gray SILTY CLAY (CL)
	40		4 b/f 2-2-2		40		38	18	20			Soft gray SILTY CLAY (CL)

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 30 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
30 to 53 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

GS: Particle Size Analysis
Gravel = 0%, Sand = 66%, Silt = 30%, Clay = 4%

Strata Boundaries May Not Be Exact

Barataria Barrier Island
Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING E-1

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/09/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location:
Surface Elevation: N/A (ft., NGVD)

FIELD DATA				LABORATORY DATA								
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
												Soft to very soft gray SILTY CLAY (CL)
	45											
		■	1.0 (P)		37		35	19	16	0.25		
	50											
		■	1.0 (P)		35		34	19	15	0.21		
												Boring completed at 53 ft.
	55											
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
30 to 53 ft.

Boring Abandonment Method
Borehole grouted upon completion

Notes

Strata Boundaries May Not Be Exact

03-1114 LOG01 BARATARIA LDNR 9-16-2003 031114P.GPJ LOG01.GDT 10/29/03

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING E-2

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/09/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 13' 50.2" Long. 89° 35' 44.1"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
	0–30											Water
	30											Mudline at 30.0 ft.
			1.5 (P)		36		27	21	6	0.16		Loose gray VERY CLAYEY SILT (ML-CL)
			1.0 (P)		33					0.19 GS		
	35		0.25 (P)		47		39	22	17	0.08		Very soft gray SILTY CLAY (CL) w/sand layers
			0.25 (P)		47					0.06		
			0.5 (P)		52		45	27	18	0.17		
	40											

Continued Next Page

Ground Water Level Data

VS = Vane Shear (ksf)

Deck to Water 2 ft.
Water to Mudline 30 ft.

Boring Advancement Method

4" Dia. Rotary Wash:
30 to 53 ft.

Boring Abandonment Method

Borehole grouted upon completion

Notes

GS: Particle Size Analysis
Gravel = 0%, Sand = 4%, Silt = 83%, Clay = 13%

Strata Boundaries May Not Be Exact

Barataria Barrier Island Restoration Complex Project
BA-38 (Pelican Headland)
Plaquemines Parish, LA
DNR Contract No. 2503-02-29

C-K Associates, Inc.
Baton Rouge, LA

LOG OF SOIL BORING E-2

STE
Soil Testing Engineers, Inc.

LELAP Certificate No. 02052

File: 03-1114
Date: 09/09/03
Logged by: K. Moody
Driller: MASA
Rig: Barge

Location: Lat. 29° 13' 50.2" Long. 89° 35' 44.1"
Surface Elevation: N/A (ft., NGVD)

Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Mini Vane Shear (ksf) / Other	Soil Type	Description
												Very soft gray SILTY CLAY (CL)
	45											Soft gray CLAY (CH)
		■	0.75 (P)		49		72	22	50	0.23		
	50											Very soft gray CLAY (CH)
		■	0.25 (P)		58					0.08		
	55											Boring completed at 53 ft.
	60											
	65											
	70											
	75											
	80											

Ground Water Level Data

Boring Advancement Method
4" Dia. Rotary Wash:
30 to 53 ft.

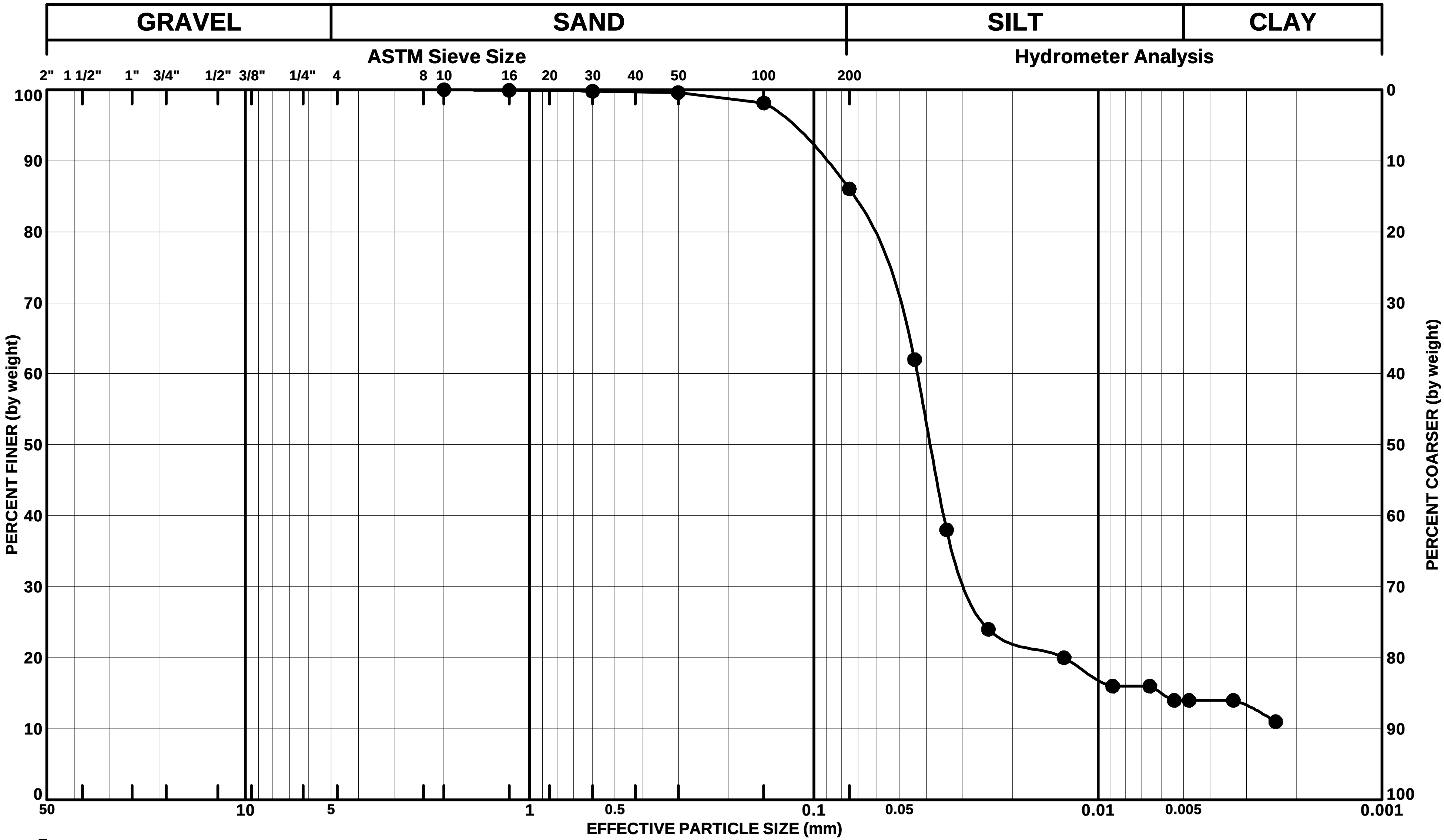
Boring Abandonment Method
Borehole grouted upon completion

Notes

Strata Boundaries May Not Be Exact

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● P-7	11.0 - 13.0	0.0	14.0	72.0	14.0

LELAP Certificate No. 02052



ASTM D422

STE
Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Pelican Headland)

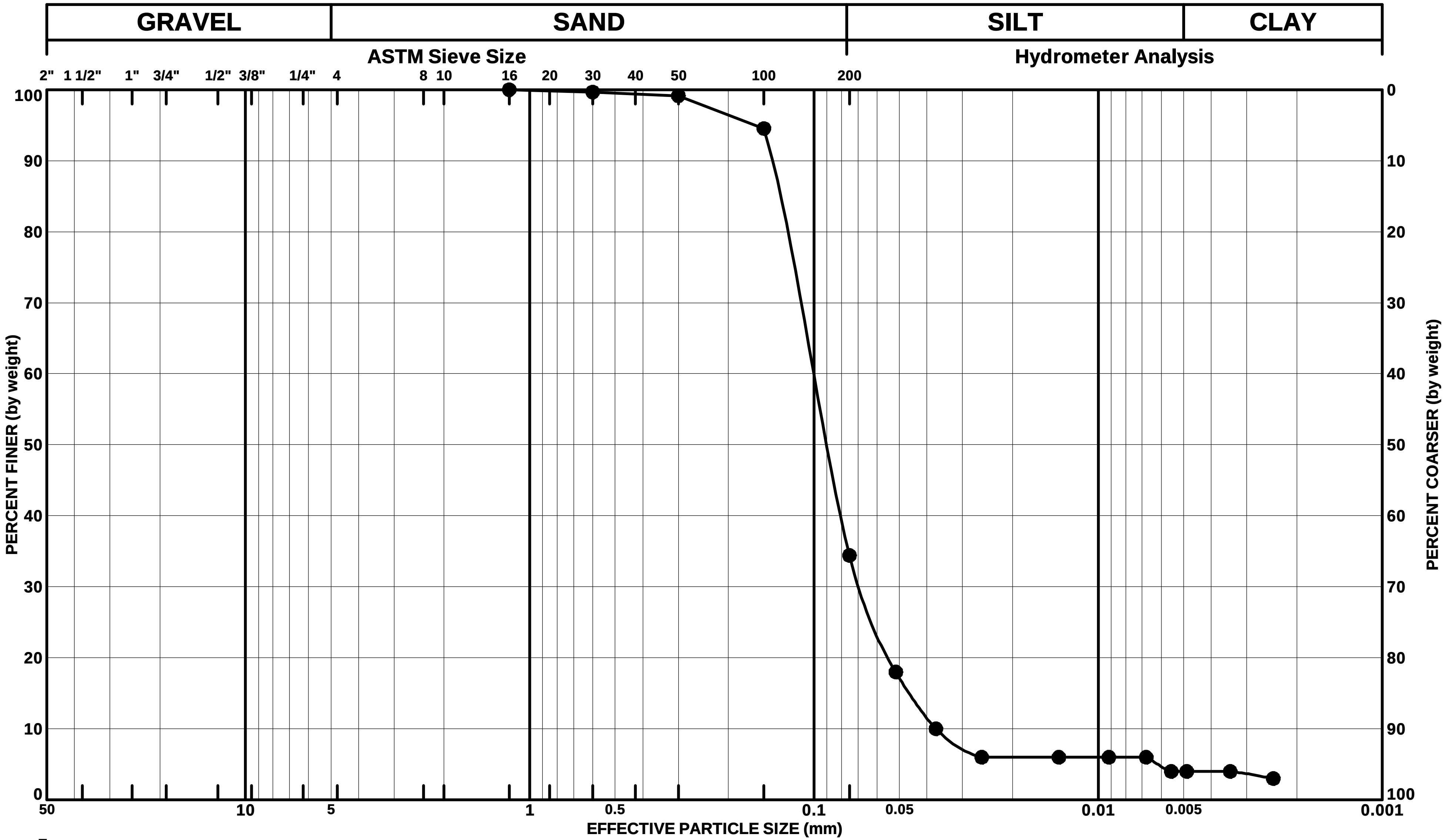
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 10/01/2003

GRAINSZ 031114P.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● E-1	38.5 - 40.0	0.0	65.6	30.4	4.0



ASTM D422

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Barataria Barrier Island Restoration Complex Project BA-38 (Pelican Headland)

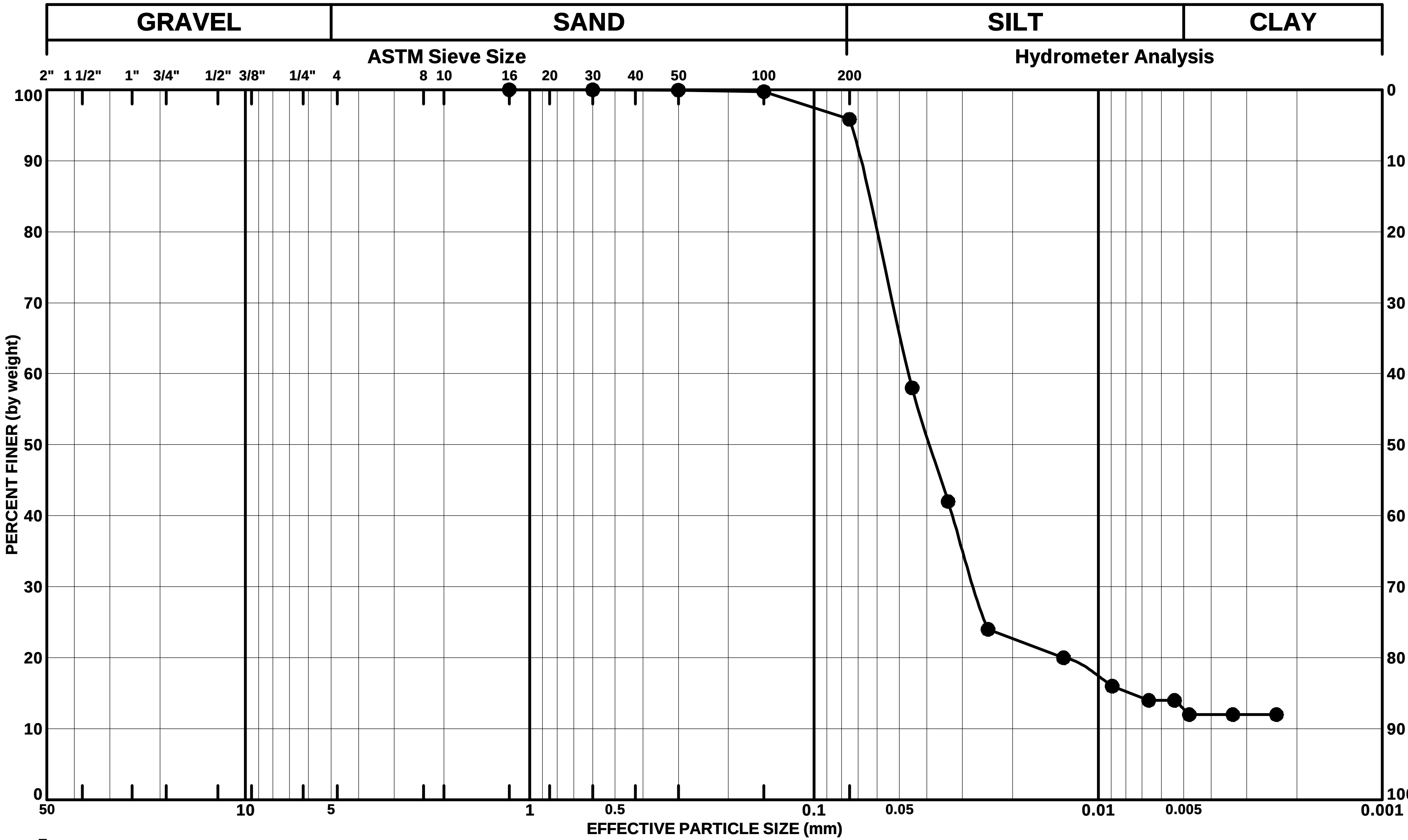
GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/12/2003

GRAINSZ 031114P.GPJ GRAINSZ.GDT 10/29/03

LELAP Certificate No. 02052

Boring No.	Depth (ft.)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● E-2	36.0 - 38.0	0.0	4.2	83.1	12.7



ASTM D422

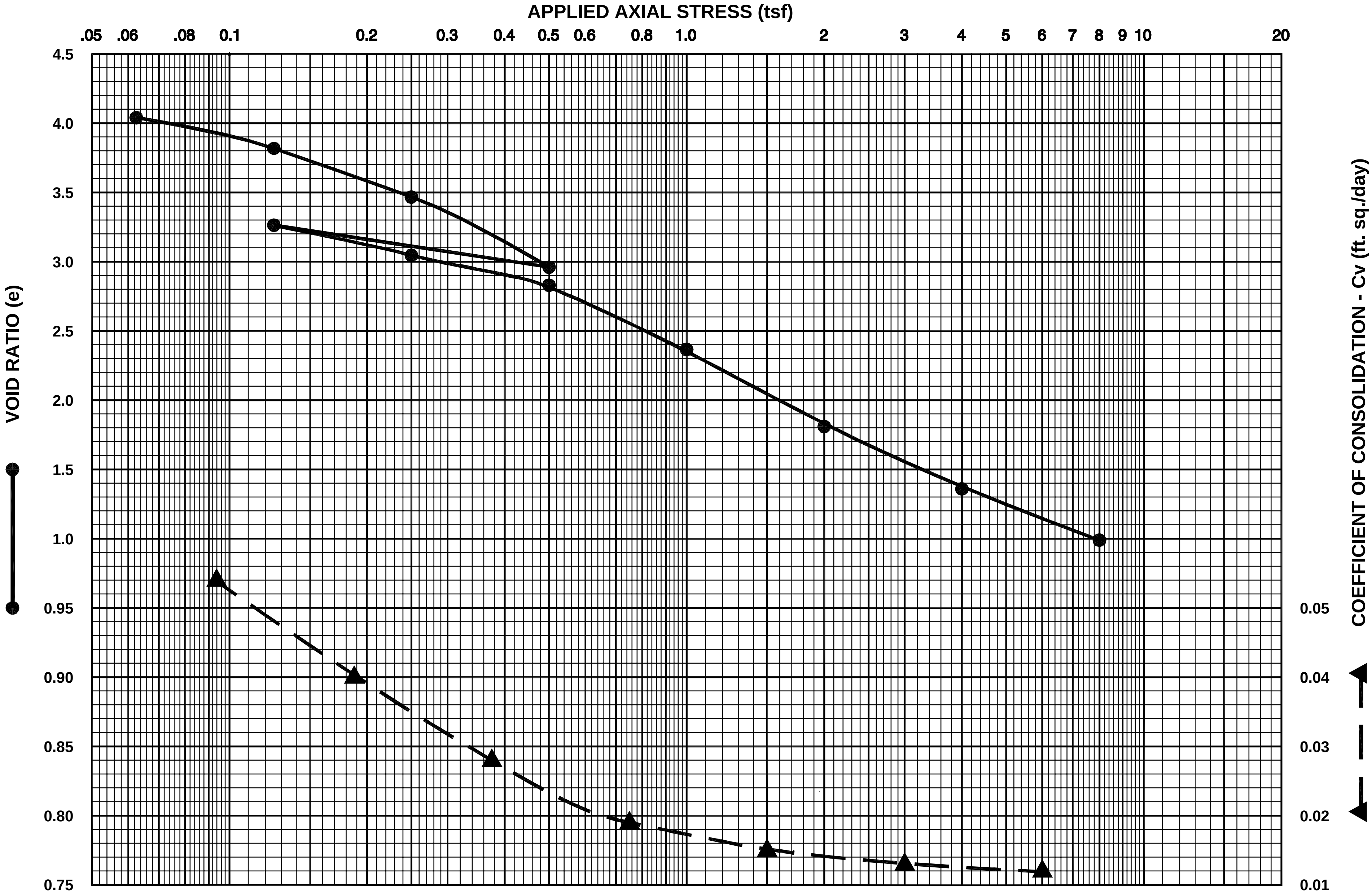
STE
Soil Testing Engineers, Inc.

Barataria Barrier Island Restoration Complex Project BA-38 (Pelican Headland)

GRAIN SIZE ANALYSIS

File No.: 03-1114
Date: 09/12/2003

GRAINSZ 031114P.GPJ GRAINSZ.GDT 10/29/03



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: PS-1

DEPTH (feet): 5-7

MATERIAL: Gray ORGANIC CLAY w/peat

FILE NO.: 03-1114

STE

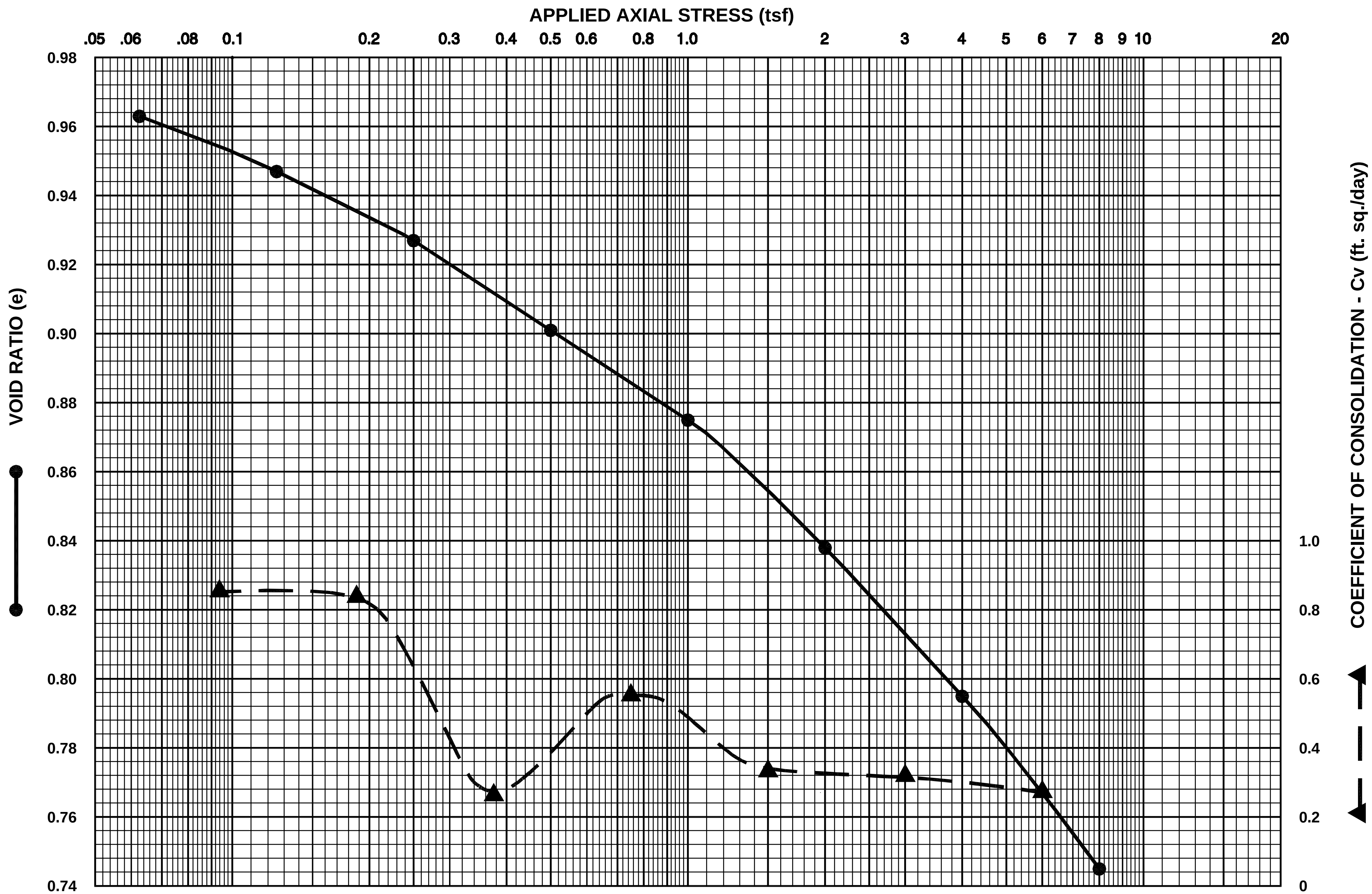
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) =	144.6	LL = 63
INITIAL DRY DENSITY (lbs./cu.ft.) =	30.6	PL = 19
FINAL MOISTURE CONTENT (%) =	63.8	PI = 44

FIGURE NO.:

Eo = 4.203 Gs = 2.55



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: PS-2
DEPTH (feet): 26-28
MATERIAL: Gray CLAYEY SILT w/fine sand
FILE NO.: 03-1114

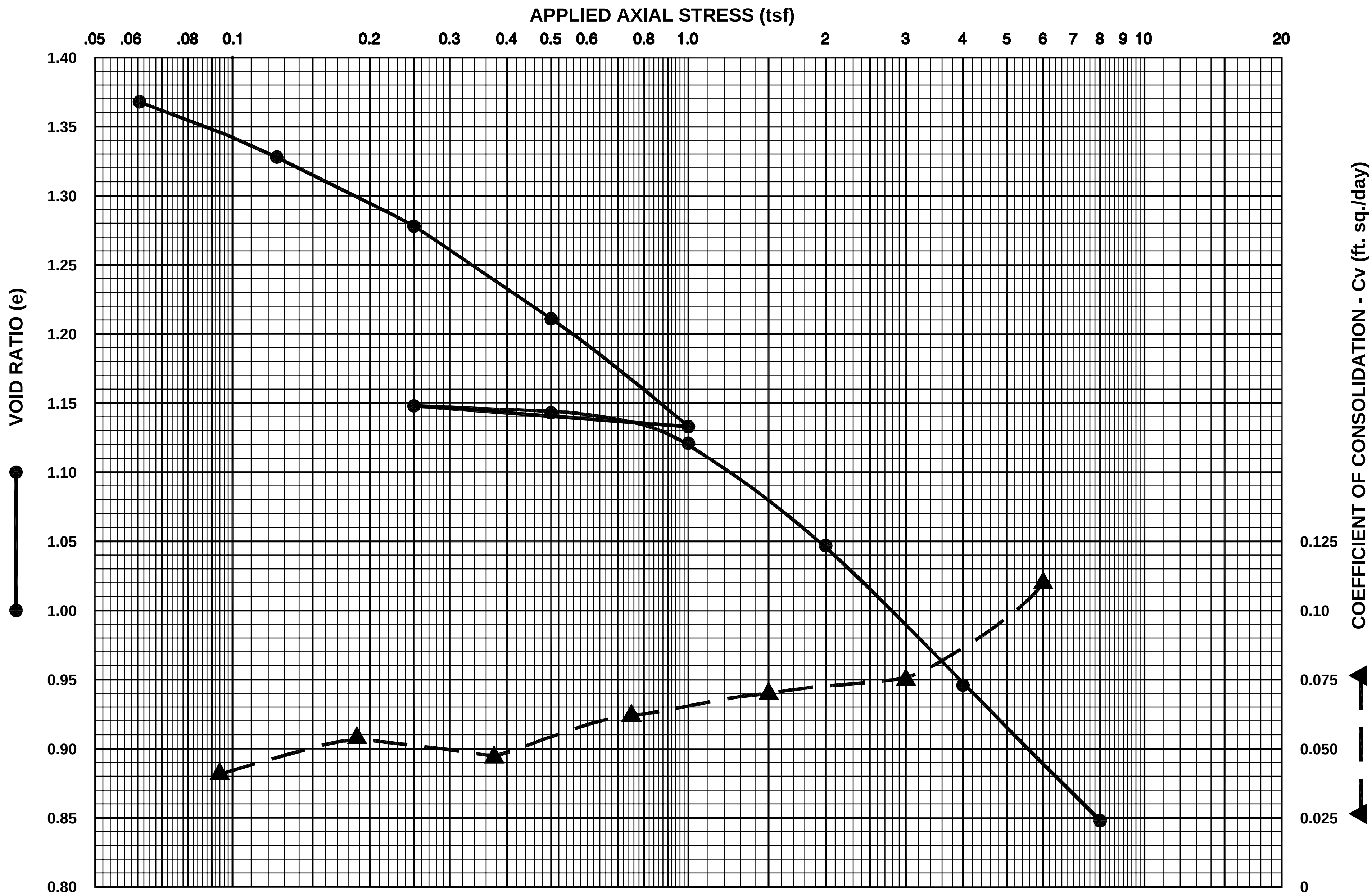
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 33.6
INITIAL DRY DENSITY (lbs./cu.ft.) = 84.5
FINAL MOISTURE CONTENT (%) = 31.3

FIGURE NO.:

Eo = 0.972 Gs = 2.67



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: PS-3
DEPTH (feet): 24-26
MATERIAL: Gray CLAY w/wood
FILE NO.: 03-1114

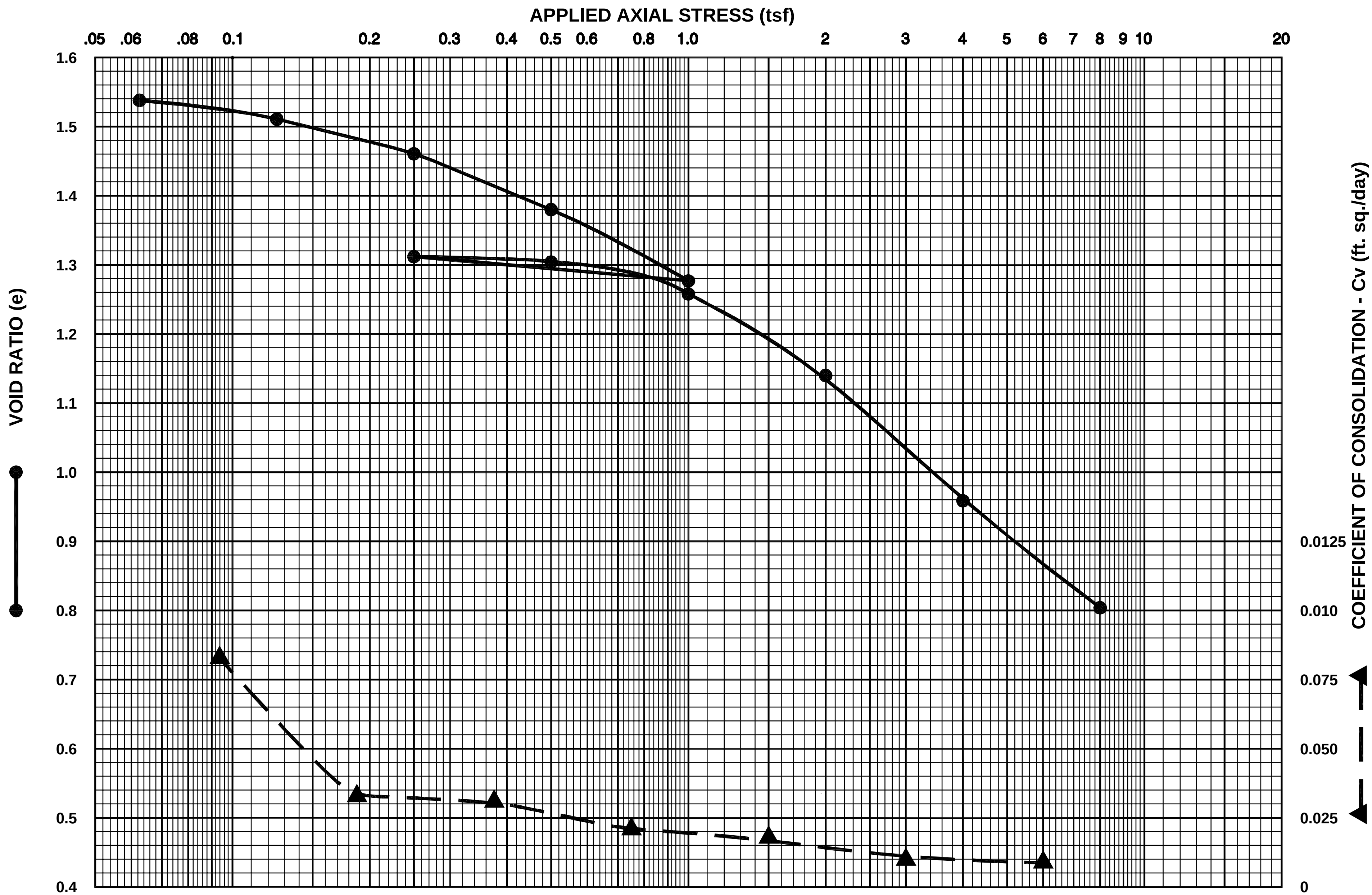
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 28.1 LL = 71
INITIAL DRY DENSITY (lbs./cu.ft.) = 69.9 PL = 24
FINAL MOISTURE CONTENT (%) = 44.0 PI = 47

FIGURE NO.:

Eo = 1.420 Gs = 2.71



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: PS-3
DEPTH (feet): 59-61
MATERIAL: Gray CLAY w/silt seams
FILE NO.: 03-1114

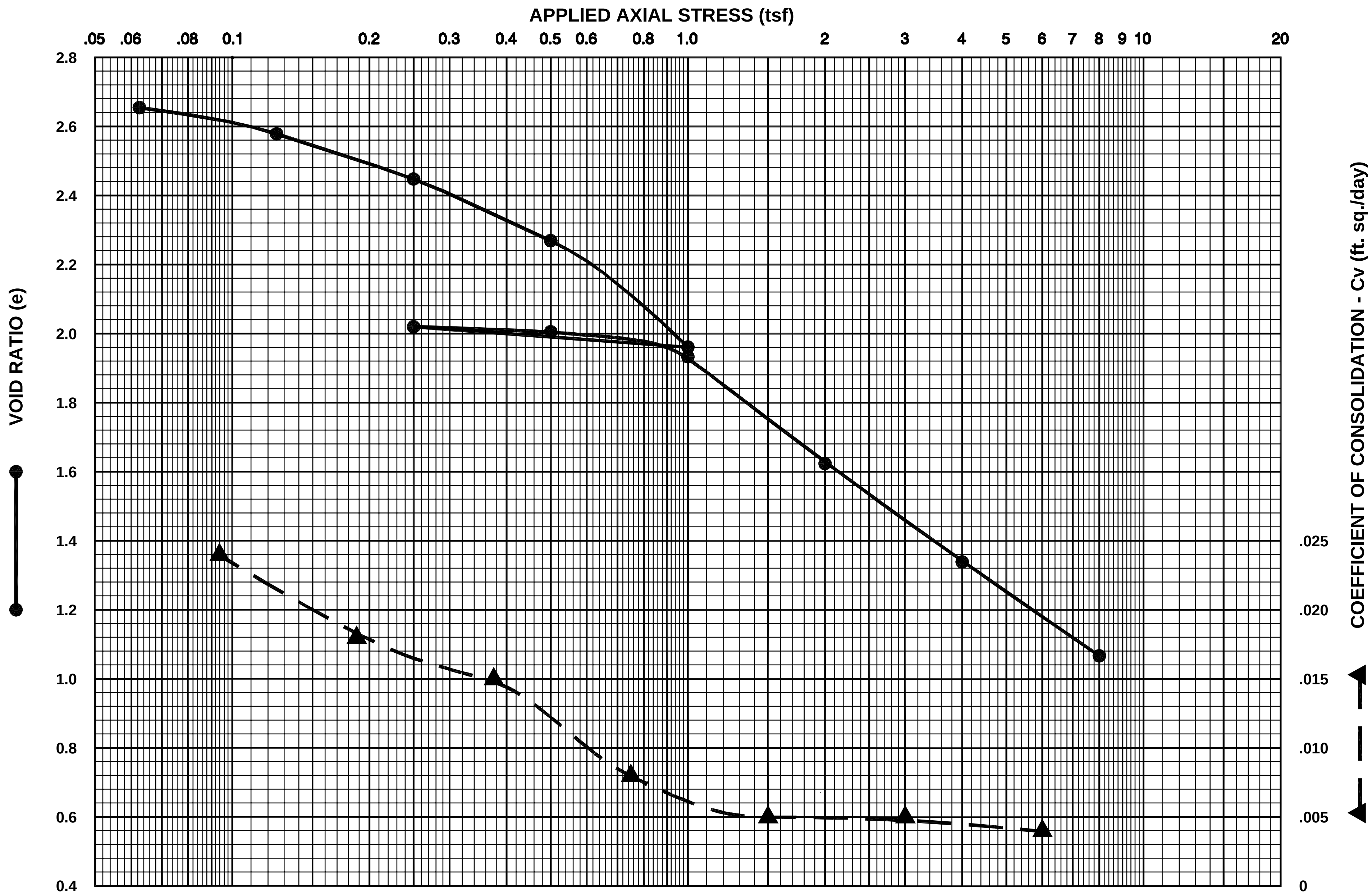
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) =	51.1	LL = 73
INITIAL DRY DENSITY (lbs./cu.ft.) =	67.4	PL = 25
FINAL MOISTURE CONTENT (%) =	34.0	PI = 48

FIGURE NO.:

Eo = 1.863 Gs = 2.6



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: PF-4
DEPTH (feet): 18-20
MATERIAL: Gray CLAY w/peat pockets & sand traces
FILE NO.: 03-1114

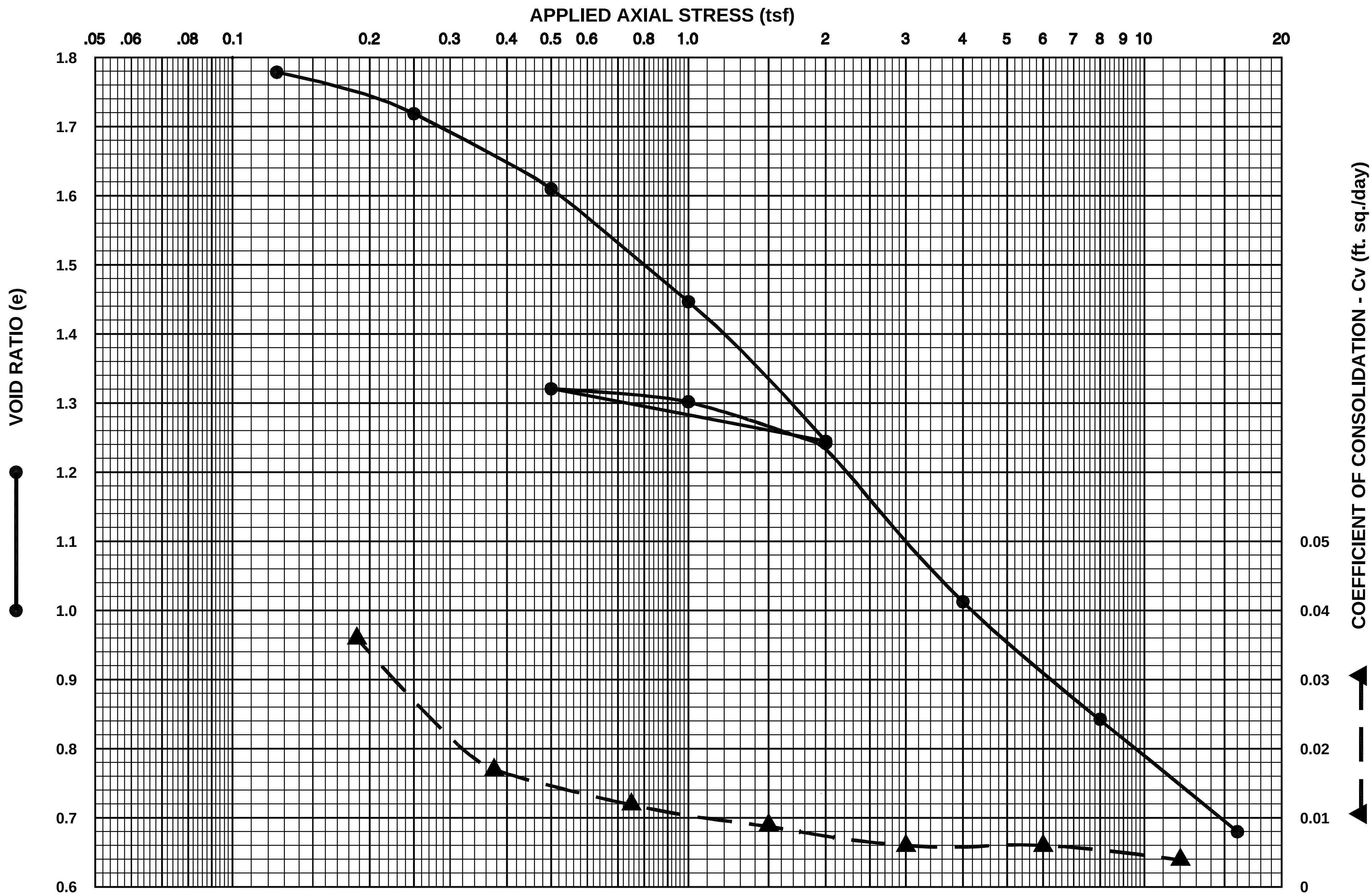
STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) = 94.3 LL = 114
INITIAL DRY DENSITY (lbs./cu.ft.) = 45.5 PL = 34
FINAL MOISTURE CONTENT (%) = 46.5 PI = 80

FIGURE NO.:

Eo = 2.721 Gs = 2.71



CONSOLIDATION TEST

SAMPLE IDENTIFICATION

BORING NO.: P-9
DEPTH (feet): 29-31
MATERIAL: Gray CLAY

FILE NO.: 03-1114

STE
Soil Testing Engineers, Inc.

CLASSIFICATION DATA

INITIAL MOISTURE CONTENT (%) =	54.2	LL = 93
INITIAL DRY DENSITY (lbs./cu.ft.) =	62.0	PL = 30
FINAL MOISTURE CONTENT (%) =	25.1	PI = 63

FIGURE NO.:

Eo = 1.420 Gs = 2.71