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FINAL MARINE GEOTECHNICAL SITE CHARACTERIZATION

SAN FRANCISCO-OAKLAND BAY BRIDGE EAST SPAN SEISMIC SAFETY PROJECT

VOLUME 2A - APPENDICES
(Borings 98-1 through 98-8)

Prepared for

CALIFORNIA DEPARTMENT OF TRANSPORTATION

March 2001

Earth Mechanics

Fugro - Earth Mechanics
A JOINT VENTURE

7700 Edgewater Drive, Suite 848
Oakland, California 94621
Tel: (510) 633-5100
Fax: (510) 633-5101

March 5, 2001
Project No. 98-42-0054

California Department of Transportation
Engineering Service Center
Office of Structural Foundations
5900 Folsom Boulevard
Sacramento, California 95819-0128

Attention: Mr. Mark Willian
Contract Manager

Final Marine Geotechnical Site Characterization
SFOBB East Span Seismic Safety Project

Dear Mr. Willian:

The geologic and geotechnical studies for the San Francisco-Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project are being conducted by Fugro-Earth Mechanics (a joint venture of Fugro West, Inc., and Earth Mechanics, Inc.) under California Department of Transportation (Caltrans) Contract 59A0053. The marine exploration borings were conducted in 1998 as part of the Task 3 preliminary site exploration and testing (Phase 1) and Task 5 final site characterization studies (Phases 2 and 3) of the referenced contract. In addition, two-dimensional (2-D) and three-dimensional (3-D) marine geophysical surveys were conducted as part of Task 1 (initial site characterization, geophysical survey phase) of the referenced contract. Additional exploration (Phase 3) including cone penetration test (CPT) soundings, multi-beam bathymetry, and a supplemental 2-D geophysical survey were conducted in 2000 as part of Task 5.

The interpretation of the site and subsurface characteristics beneath the marine portion of the bridge alignment are provided in Volume 1 of this Final Marine Geotechnical Site Characterization report. The interpretations presented in Volume 1 are based on the field data (including extensive in situ testing, soil sampling, rock coring, and downhole geophysical logging) from the 44 marine borings, 77 CPT soundings, the results of laboratory tests completed in the onshore laboratories, and the integration of those data with prior Caltrans' marine borings and the interpretation of the 2-D and 3-D geophysical surveys.

The Preliminary Marine Geotechnical Site Characterization report containing Phase 1 data and preliminary site characterization information was submitted in June 1998. Volume 1 of the Final Marine Geotechnical Site Characterization Report, which contained revisions to the preliminary interpretations, was provided in draft on February 1, 2000. Volume 2 of the Final Marine Geotechnical Site Characterization Report (including only data from the Phase 2 site investigations) was submitted in draft in 1999. The Phase 3 site investigations were performed in August and September 2000. During the finalization of this report, all pertinent data from the preliminary (Phase 1) and final (Phases 2 and 3) marine site characterization activities were compiled into Volume 2 of this report. This Final Marine Geotechnical Site Characterization report thus completely supersedes the Preliminary Marine Geotechnical Site Characterization report, dated June 1998. The report is a stand-alone submittal that includes all data collected and the most recent interpretations of site characterization in the marine areas of the project.

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California Department of Transportation
March 5, 2001 (Fugro 98-42-0054)

Because of the size of the data set, Volume 2 of this report has been bound into eight volumes, designated as Volumes 2A thorough 2H. Boring logs and data from each of the 44 marine borings are presented in Volumes 2A through 2G. Those data are organized into boring-specific compilations for each of the 14 Phase 1 borings (Volumes 2A and 2B) and 30 Phase 2 borings (Volumes 2C through 2G). Logs of the 77 CPT soundings performed during Phase 3 are presented in Volume 2H.

On behalf of the project team, we appreciate the opportunity to contribute to Caltrans' design of the new bridge to replace the existing SFOBB East Span. Please call if we can answer any questions relative to the information presented in the enclosed report.

Sincerely,

FUGRO-EARTH MECHANICS, A Joint Venture

REGISTERED PROFESSIONAL ENGINEER
ROGER W. A. HOWARD JR.
No. C61002
Exp. 12/31/04
CIVIL
STATE OF CALIFORNIA

Roger Howard, Jr., P.E.
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
M. JACOB CHACKO
NO. 58850
Exp. 06/30/03
CIVIL
STATE OF CALIFORNIA

Jacob Chacko, P.E.
Project Engineer

REGISTERED GEOLOGIST
CRAIG D. PRENTICE
EG NO. 1602
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

Craig D. Prentice, R.G., C.E.G.
Senior Engineering Geologist

REGISTERED PROFESSIONAL ENGINEER
T.W. McNeilan
No. 0583
Exp. 12/31/03
Geotechnical
STATE OF CALIFORNIA

Thomas W. McNeilan, C.E., G.E.
Vice President

Attachment

Copies submitted: Mr. Mark Willian, Caltrans
Mr. Saba Mohan, Caltrans
Mr. Robert Price, Caltrans
Dr. Brian Maroney, Caltrans
Ms. Sharon Naramore, Caltrans
Mr. Gerry Houlahan, TY Lin/M&N
Mr. Sajid Abbas, TY Lin/M&N
Mr. Al Ely, TY Lin/M&N

SAN FRANCISCO-OAKLAND BAY BRIDGE
EAST SPAN SEISMIC SAFETY PROJECT

CALTRANS CONTRACT 59A0053

FINAL MARINE GEOTECHNICAL SITE CHARACTERIZATION

VOLUME 2A - APPENDICES
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MARCH 2001

Prepared For:

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5900 Folsom Boulevard
Sacramento, California 95819-0128

Prepared By:

FUGRO-EARTH MECHANICS
A Joint Venture
7700 Edgewater Drive, Suite 848
Oakland, California 94621

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- Single-Page, Seacalf CPT Logs Include Profiles of:
  - Cone sleeve friction
  - Cone tip resistance
  - Friction ratio
  - Pore water pressure
  - Undrained shear strength

Testing performed

Log provided

No testing performed

No log provided

APPENDIX PLATE NUMBERING REFERENCE GUIDE

VOLUME 2
INDIVIDUAL BORING DATA AND CPT SOUNDING APPENDICES

The San Francisco-Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project marine geotechnical site exploration included 44 borings and 77 Seacalf CPT soundings. The marine drilling was completed using offshore drilling equipment and wire-line sampling, in situ testing, and downhole tools. In addition, 49 tethered Seascout CPT soundings were conducted adjacent to the boring locations to characterize the near-surface materials.

GEOTECHNICAL SITE CHARACTERIZATION SYNOPSIS - VOLUME 1

A general description of Task Order Nos. 3 and 5, the Marine Site Characterization work scope, is provided in Section 1.0 of Volume 1. A description of the marine exploration and subsequent laboratory testing procedures is included in Section 3.0. The locations of the borings are provided on Plate A-1, and a summary of the details of the individual exploration locations and depths is provided in Table 3.1 of Volume 1.

INDIVIDUAL BORING APPENDICES - VOLUMES 2A THROUGH 2G

Individual boring appendices are provided for each of the 44 borings. Each boring appendix includes boring logs and various in situ, downhole, and laboratory data.

Boring Appendices Collation and Plate Number Guide

A table is provided at the end of the Volume 2 Table of Contents that shows the plate titles and numbers included in each boring-specific appendix. The individual appendix plates are numbered with the boring number and a sequential number (e.g., 98-28.4, 98-28.5a, etc.).

Key to Terms and Symbols Used on the Boring Logs

A description of the terms and symbols used on the logs is provided on Plates A-2a and A-2b in Volumes 2A through 2G.

Summary of Field Operations and Location/Depth Information

A description of the progress of the individual borings and a chart showing boring location, coordinates, depths (mudline, top of rock, bottom of borings, etc.), and corresponding elevations (re: Mean Sea Level [MSL] datum, as specified by Caltrans) are included at the beginning of each boring appendix.

Boring Logs

The boring logs for each marine boring provide lithology descriptions, show sampling depths, contain descriptions of the soil and rock characteristics, and provide plotted remote vane, laboratory, and downhole geophysical test data. The appendices include three single-page boring logs (the data for the entire depth of the borings are shown on one page) that show geotechnical test data, CPT data, and downhole geophysical data, respectively. In addition to the single-page logs, multiple-page logs that show geotechnical test data and CPT data are provided at an expanded depth scale. Also included in the marine boring appendices is a geotechnical test data log of the near surface sediments with an expanded undrained shear strength scale.

Geotechnical Test Data Logs. Sampler types are shown on the Key to Terms and Symbols Used on Logs (Plates A-2a and A-2b in Volumes 2A through 2G). The following nomenclature applies to the information in the blow count column of the log: a) "PUSH" denotes thin-wall tube samples pushed with the weight of the drill pipe; b) "WOH" denotes liner samplers advanced by the weight of the down-hole hammer; c) values such as 18 designate either Standard Penetration Test (SPT) N-values or California modified sampler; d) 50/7.5cm is a SPT N-value; and e) 30/60cm is a downhole, wireline hammer blow count. Additional description of the blow count and sampler nomenclature is provided on Plates A-2a and A-2b of Volumes 2A through 2G.

Rock coring data also are tabulated in the Blow Count column. Those data, such as 100-35, provide recovery and Rock Quality Designation (RQD) data for the individual core runs.

The center column of the log provides water content, plastic limit, liquid limit, percent passing the number 200 sieve, and density measurements (presented as submerged unit weights). In addition to the direct measurements of density, the logs also show the theoretical submerged unit weight based on the measured water content, an assumed specific gravity of 2.7, and an assumed 100-percent saturation. In rock intervals, the recovery, RQD, and coring rate are plotted in the center column of the log.

The right-hand column presents the results of the undrained shear strength measurements conducted on samples recovered from the borings as well as the strengths measured in situ using the Halibut and Dolphin remote vane tools. The range of undrained shear strengths that are calculated from CPT cone tip resistances (corrected for unequal end area effects) also are shown based on cone bearing capacity (N_k values) of 12 and 15. Undrained shear strengths measured on remolded samples also are included in the plotted data.

In rock intervals, the unconfined compressive strength measured in unconfined tests and estimated from point load tests are plotted in the right-hand column. Fracture density also is plotted in the rock intervals.

CPT Logs. The in situ CPTs were conducted downhole using the Dolphin system. This downhole in situ tool has a maximum stroke (or test length) of 3 meters. Data are acquired in 3-meter-long increments, or until the CPT meets refusal. The CPT intervals were interspersed with soil sampling. The CPT intervals are shown on the right of the geotechnical test data logs and CPT logs.

The CPT logs for each boring with CPT data provide graphical plots of the data versus depth below mudline (or Bay bottom). Data that are shown include: a) tip resistance in megapascals (MPa), b) sleeve friction in MPa, c) excess pore pressure readings in MPa, and d) friction ratio in percent.

Downhole Geophysical Logs. Downhole geophysical tests were conducted in 41 of the 44 marine borings. That testing included:

a) Compression and shear wave (Vp and Vs, respectively) (except for Borings 98-19, 98-45, and 98-48);

b) Natural gamma (only Borings 98-1 through 98-3 and 98-5 through 98-12);

c) Resistivity (only Borings 98-2, 98-3, and 98-5 through 98-12);

d) Caliper (borehole diameter) (only Borings 98-1 through 98-12 and 98-21 through 98-24); and

e) Acoustic Televiewer (only Borings 98-1 through 98-5 and 98-21 through 98-24).

The Acoustic Televiewer logs are provided under separate covers in Volume 1 of Fugro-EM (1998d) and Volume 1 of Fugro-EM (2001h).

Laboratory Test Results

The offshore and onshore laboratory test results are incorporated in the individual boring appendices. In addition to the test data plotted on the geotechnical test data logs, the appendices include the following information (where relevant):

- Remote vane test data
- Tabulated summary of test results
- Grain size distribution curves
- Plasticity chart showing the Atterberg limit data
- Stress-strain curves from unconsolidated-undrained (UU) triaxial compression tests

- Consolidation test results including axial strain and coefficient of consolidation versus effective vertical stress
- Consolidated-undrained triaxial compression test results including consolidation curves, stress path, stress-strain curves, pore water pressure-strain curves, and obliquity-strain curves
- Consolidated-drained triaxial compression test results including stress-strain curves and Mohr circles

In addition to the laboratory test results presented herein, the results of laboratory tests conducted on rock samples are provided under separate cover in Volume 4 of Fugro-EM (1998d) and Volume 2 of Fugro-EM (2001h). Also, the results of the cyclic tests conducted on samples recovered from the marine borings are provided under separate cover in Volume 3 of Fugro-EM (1998d).

Soil Property Profiles

Where data are available, the following soil properties are plotted versus depth:

- Plasticity Index (Liquid Limit minus Plastic Limit)
- Liquidity Index ([water content minus Plastic Limit] divided by Plasticity Index)
- Soil Sensitivity (undisturbed shear strength divided by remolded shear strength)
- ε_{50} (strain at 50 percent of the failure stress in UU triaxial tests)
- Preconsolidation Pressure - The interpreted preconsolidation pressure profiles show interpreted preconsolidation pressures from consolidation tests and estimated preconsolidation pressures from the in situ CPT data. Also shown on those plots are the calculated effective overburden pressure and isochrones of calculated overconsolidation ratios (OCR).
- Relative Density from CPT test data (marine borings)

CPT DATA APPENDIX - VOLUME 2H

Summary of Field Operations

A description of the progress of the Seacalf CPT operations is presented before the CPT data plots in Volume 2H as Plates A-2a through A-2w.

CPT Sounding Results

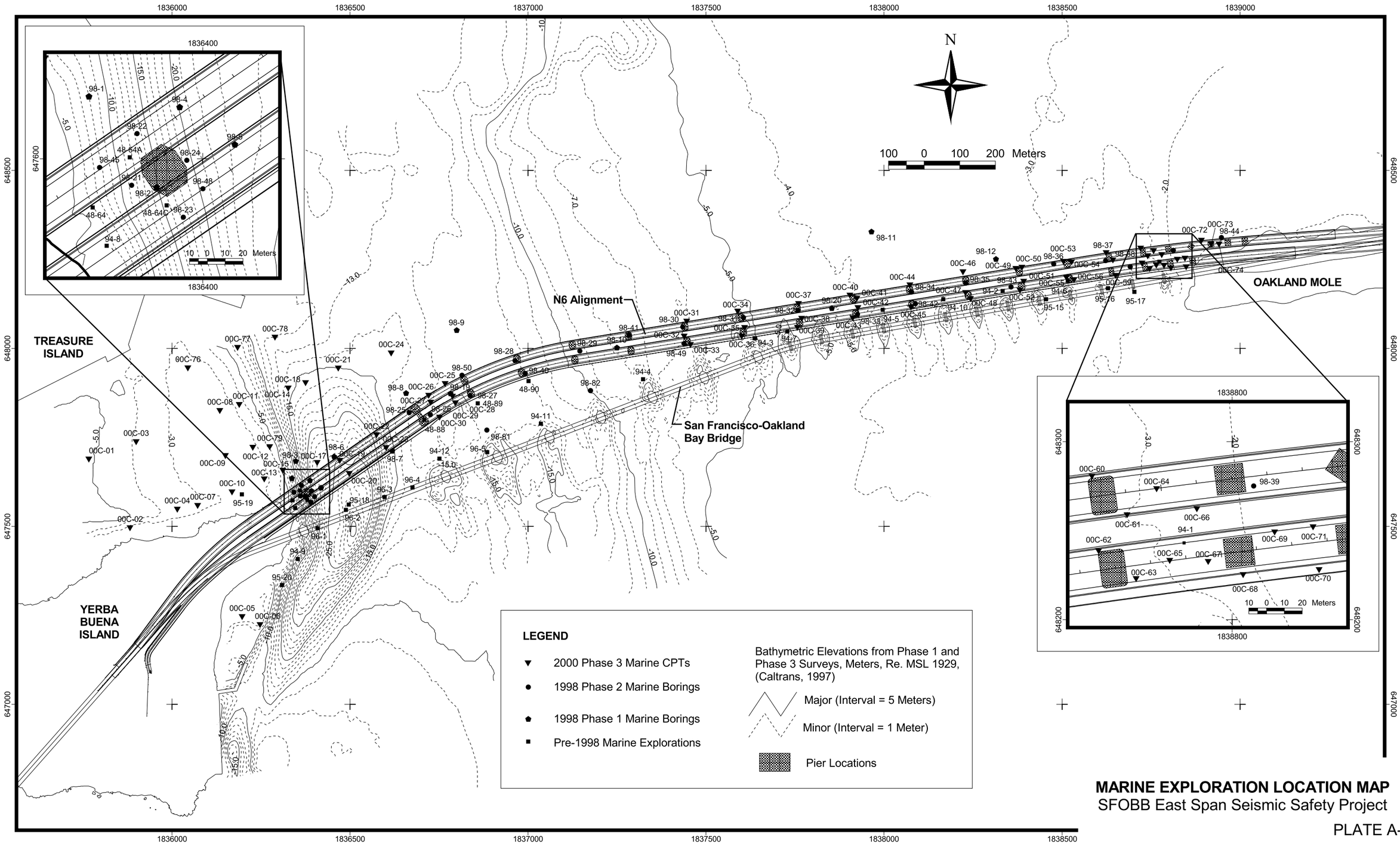
The results of the 77 marine CPT soundings are presented in Volume 2H of this report. The CPT logs provide graphical plots versus depth showing:

- Tip resistance in MPa
- Sleeve friction in MPa
- Friction ratio in percent
- Pore pressure in MPa

In addition, the sounding logs show the range of undrained shear strengths that are calculated from CPT tip resistances (corrected for unequal area effects) based on cone bearing capacity factors (N_k) of 12 and 15.

Earth Mechanics

FUGRO



MARINE EXPLORATION LOCATION MAP
SFOBB East Span Seismic Safety Project

PLATE A-1

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SOIL TYPES

- Well graded GRAVEL (GW)
- Poorly graded GRAVEL (GP)
- GRAVEL with sand (GP or GW)
- Clayey GRAVEL
- Silty GRAVEL
- Well graded SAND (SW)
- Poorly graded SAND (SP)
- SAND with gravel (SP or SW)
- Clayey SAND (SC)
- Silty SAND (SM)
- SAND with silt (SP-SM)
- Fat CLAY(CH)
- Lean CLAY (CL)
- Sandy Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Elastic SILT (MH)
- SILT (ML)
- Sandy SILT (ML)
- Clayey silt (ML/CL)
- Highly plastic ORGANICS (OH)
- Low plasticity ORGANICS (OL)
- SANDSTONE (Rx)
- SILTSTONE (Rx)
- CLAYSTONE (Rx)
- Interbedded Rock Strata
- CONGLOMERATE (Rx)

SAMPLERS

- Thin Walled 3-inch Tube
- 2-1/4-inch Driven Tube
- Liner
- Modified California Liner
- SPT
- Rock Core (Interior symbol represents percent recovery)

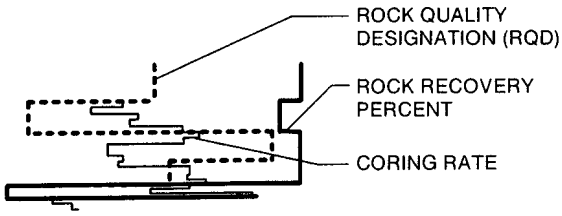
CLASSIFICATION TESTS AND BLOW COUNTS

- ■ PERCENT PASSING #200 SIEVE
- ● WATER CONTENT (%)
- □ SUBMERGED UNIT WEIGHT (KCF)
- ○ THEORETICAL SUBMERGED UNIT WEIGHT (KCF)

PLASTIC LIMIT LIQUID LIMIT
+----------+

- EQUIVALENT SPT BLOW COUNT

ROCK QUALITY AND CORING RATE



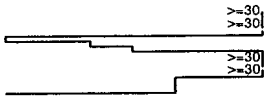
STRENGTH TESTS

- ⊗ POCKET PENETROMETER
- ⊕ TORVANE
- ◇ REMOTE VANE
- ◆ MINIATURE VANE (◇ RESIDUAL VANE)
- ▲ UNCONSOLIDATED UNDRAINED TRIAXIAL
- ▽ SWEDISH FALL CONE
- ▣ UNCONFINED COMPRESSION (SOIL)
- ◎ POINT LOAD TEST (INTACT SPECIMEN)
- ⦶ POINT LOAD TEST (ALONG WEAK PLANE)
- ■ UNCONFINED COMPRESSION (ROCK)

△◇ (Open symbols indicate remolded tests)
+ Strength Exceeds Capacity of Measuring Device

PCPT (Nk = 12 to 15)

FRACTURE DENSITY



KEY TO TERMS AND SYMBOLS USED ON LOGS
SFOBB East Span Seismic Safety Project

TUBE AND LINER SAMPLERS

WOH	Liner sample advanced with the weight of an 80 kg hammer.
PUSH or SAVE	Pushed thin-walled 7.5cm-tube.
15/60cm	Number of blows required to produce the indicated penetration using a 5.7 cm tube sampler. The sampler was driven with an 80 kg downhole hammer dropped approximately 1.5 m.

SPT AND MODIFIED CALIFORNIA LINER SAMPLERS

Samplers were driven with a 63.5 kg above deck hammer dropped approximately 760 mm.

20	Number of blows to produce 30 cm of penetration after the initial 15 cm of seating.
86/28cm	Number of blows required to produce the indicated penetration after an initial 15 cm seating.
Ref/8cm	50 blows produced the indicated penetration during the initial 15 cm interval.

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

8"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS

Consistency	Undrained Shear Strength, kPa
Very Soft	less than 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very Stiff	100 to 200
Hard	greater than 200

DENSITY OF GRANULAR SOILS

Descriptive Term	Relative Density (%)*
Very Loose	less than 15
Loose	15 to 35
Medium Dense	35 to 65
Dense	65 to 85
Very Dense	greater than 85

*Estimated from sampler driving record and PCPT tip resistance.

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along these planes.
Fissured	Containing shrinkage or relief crack, often filled with fine sand or silt, usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 3 mm thick extending through the sample.
Seam	Inclusion 3 mm to 75 mm thick extending through the sample.
Layer	Inclusion greater than 75 mm thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil types.
Interlayered	Soil sample composed of alternating layers of different soil types.
Intermixed	Soil sample composed of pockets of different soil types and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.

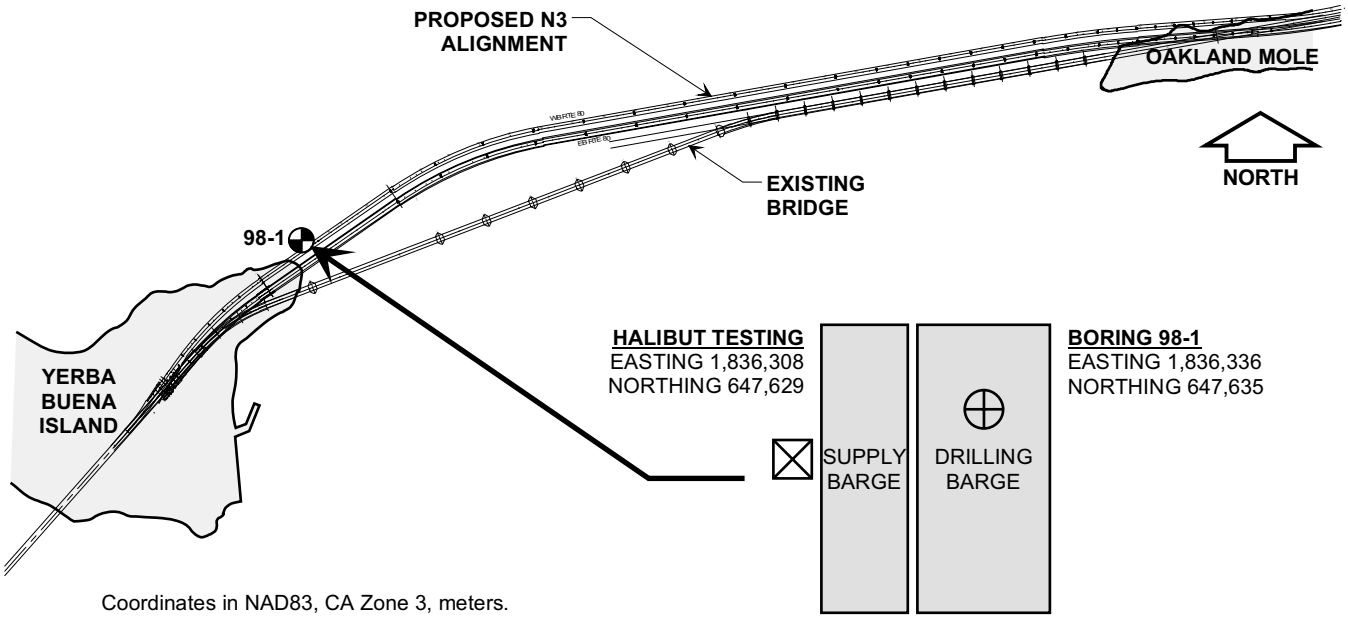
KEY TO TERMS AND SYMBOLS USED ON LOGS

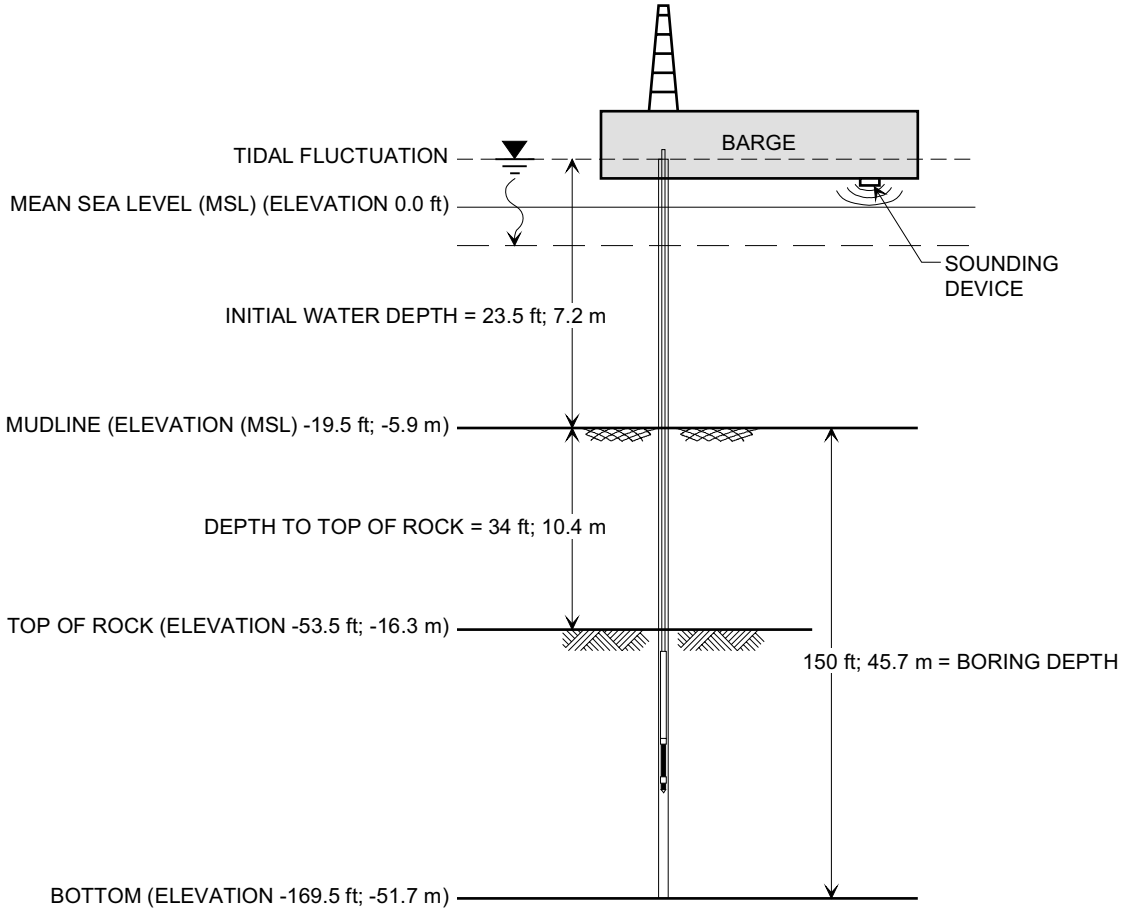
SFOBB East Span Seismic Safety Project

BORING 98-1

Date	Time From	Time To	Description of Activity
March 10, 1998	0420	0600	Pull anchors, position barge on boring location 98-1, north of Pier E2, and set four-point anchor spread.
	0600	0640	Fuel and grease rig.
	0640	0715	Run drill pipe to mudline.
	0715	0730	Measure water depth of 7.2m (23.5 ft) using bottom sensor.
	****	0730	Measure corrected water depth of 7.5m (24.5 ft) using fathometer. Current tide level is approximately +1.5m (+5 ft) MSL. Calculate mudline elevation of -5.9m (-19.5 ft) MSL.
	0730	1050	Drill and sample 0m (0 ft) to 10.4m (34 ft).
	1050	1130	Pull drill pipe. Prepare to set casing.
	1130	1530	Set casing and hammer 0.3m (1 ft) into formation.
	1530	1550	Run drill pipe into hole.
	1550	1615	Set up mud system.
	1615	1645	Wash down hole to 10.4m (34 ft) penetration.
	1645	1745	Drill and sample, 10.4m (34 ft) to 10.7m (35 ft) penetration. Hit apparent bedrock at 10.7m (35 ft) penetration.
	1745	1800	Pull pipe to deck.
	1800	2010	Run 12.7 cm (5 inch) pipe to 10.4m (35 ft) penetration. Prepare Halibut for in situ testing.
	2010	2040	Change bit and run core pipe into hole.
	2040	2400	Rock core, 10.4m (35 ft) to 13.4m (44 ft) penetration. Run Halibut vane tests, 0m (0 ft) to 3.7m (12 ft) penetration.
March 11, 1998	0000	1100	Rock core 13.4m (44 ft) to 28.7m (94 ft).
	0530	0900	Run Halibut vane tests, 4.3m (14 ft) to 5.5m (18 ft) penetration.
	1100	2400	Rock core 28.7m (94 ft) to 45.7m (150 ft).
March 12, 1998	0000	0050	Pull core pipe and prepare for downhole logging.
	0050	0105	Lower caliper down hole. Obstruction at 14.3m (47 ft).
	0105	0145	Lower core pipe down hole to clean out borehole.
	0145	0315	Use drill pipe to drive down casing and secure casing slip joint. Clean out hole for downhole logging.
	0315	0645	Downhole logging.
	0645	0700	Rig maintenance.
	0700	0800	Pull drill pipe and grout borehole.
	0800	1330	Pull casing and move barge to location Boring 98-5.

SUMMARY OF FIELD OPERATIONS
Boring 98-1
SFOBB East Span Seismic Safety Project





BORING 98-1 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-1.2

9842\0035loc2.dsf(1,2)

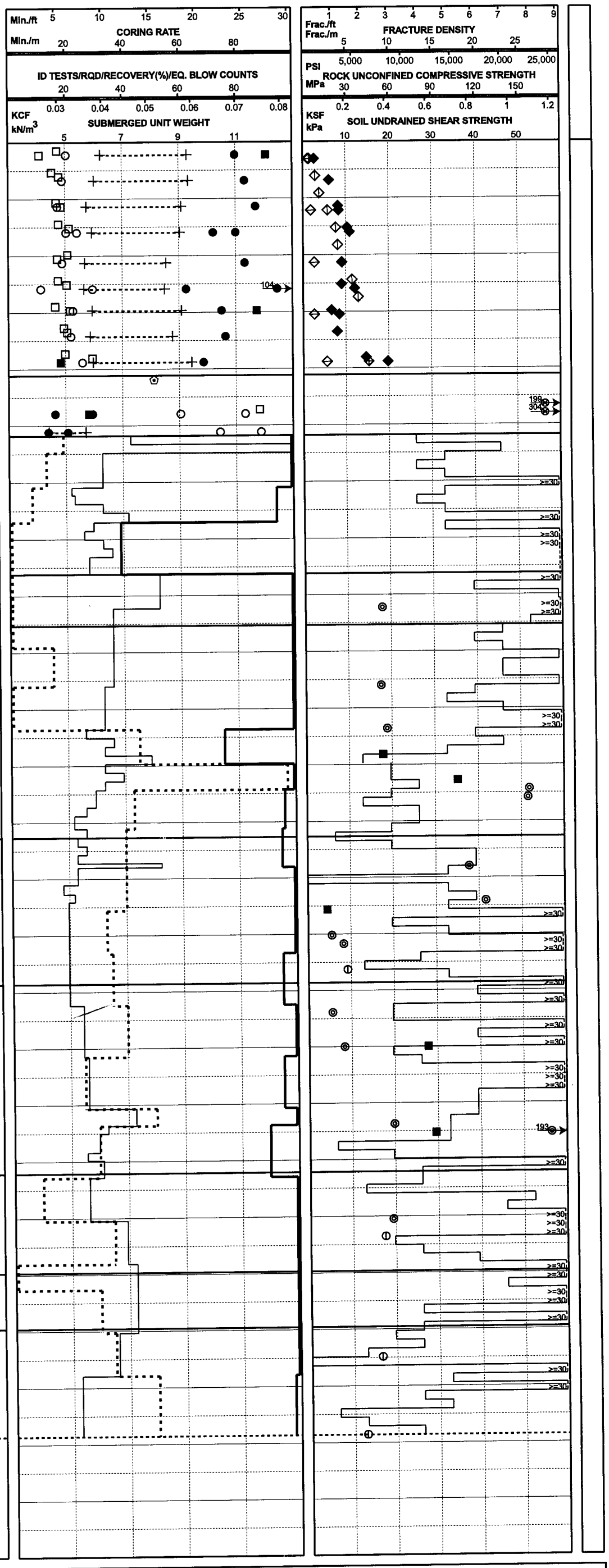
PROJECT NO:	98-42-0035	**START DATE:**	3/10/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-1 (North of Pier E2)	**COMPLETION DATE:**	3/12/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836336 N647635
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -5.9 m (MSL)

Stratum	Material Description	Blow Count
I	Fat CLAY (CH), dark olive gray, very soft to soft -with sandy silt pockets -with an organic odor and mica flakes at 0.3m -with a few shell fragments and mica flakes at 1.2m -with shell fragments at 2.1m -with mica flakes and organic matter pockets at 3.0m -with shell fragments, 3.7m to 6.1m -with an organic odor at 4.0m -with sandy silt seams and an organic odor, at 5.8m -with a few shell fragments, mica flakes, and with olive gray pockets, at 6.7m -with mica flakes at 7.6m (8.2m)	WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH
II	Silty fine SAND (SM), very dense, dark yellowish brown -with light gray clay pockets -olive gray slightly cemented clayey sand layer with fine gravel and iron oxide stains, at 9.4m (10.4m)	51, 25/60cm, NR, 50/5cm, 30/30cm
III	SANDSTONE (Graywacke) (RX), dark yellowish brown, moderately to intensely weathered, hard, fine grained, intensely fractured See Plate 98-1.6 for detailed stratigraphy below 10.4m (15.2m)	100-19, 100-13, 94-8, 39-0
IV	CLAYSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [3:1] (17.1m)	100-0
V	SANDSTONE (Graywacke) (RX), dark gray with very thin olive gray beds, moderately to slightly weathered, moderately hard to hard, moderately fractured -thinly interbedded claystone, dark gray, moderately hard, intensely fractured into 50mm- to 125mm-long pieces, dipping at 20 degrees, 22.6m to 23.2m -moderately fractured, slightly to moderately rough with thin (6mm-thick) calcite/quartz filling, below 23.2m -slickensided claystone layer with vertical flow banding, 23.5m to 24.1m (24.5m)	100-0, 100-15, 100-0, 75-45, 100-97, 96-43
VI	SANDSTONE (Graywacke) (RX) interbedded with CLAYSTONE (RX) [10:1] (29.7m)	95-40, 100-40, 100-33
VII	SANDSTONE (Graywacke) (RX) with thinly to moderately interbedded CLAYSTONE (RX) and SILTSTONE (RX) [4:1:1] (36.4m)	95-35, 100-40, 95-25, 100-50, 90-30
VIII	SANDSTONE (Graywacke) (RX) with interbedded SILTSTONE (RX) [1.5:1], fresh (39.9m)	100-10, 100-35
IX	Interbedded SANDSTONE (Graywacke) (RX), SILTSTONE (RX) and CLAYSTONE (RX) [2:2:1], fresh (41.9m)	100-0, 100-30
X	SANDSTONE (Graywacke) (RX), medium dark gray, fresh, hard, slightly to moderately fractured, fractures dipping at 50 to 80 degrees, moderately rough to rough, with very thin calcite filling	100-35, 98-50

TOTAL DEPTH: 45.7 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-1

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

FUGRO

PLATE 98-1.3

PROJECT NO: 98-42-0035
BORING: 98-1 (North of Pier E2)
START DATE: 3/10/98
COMPLETION DATE: 3/12/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

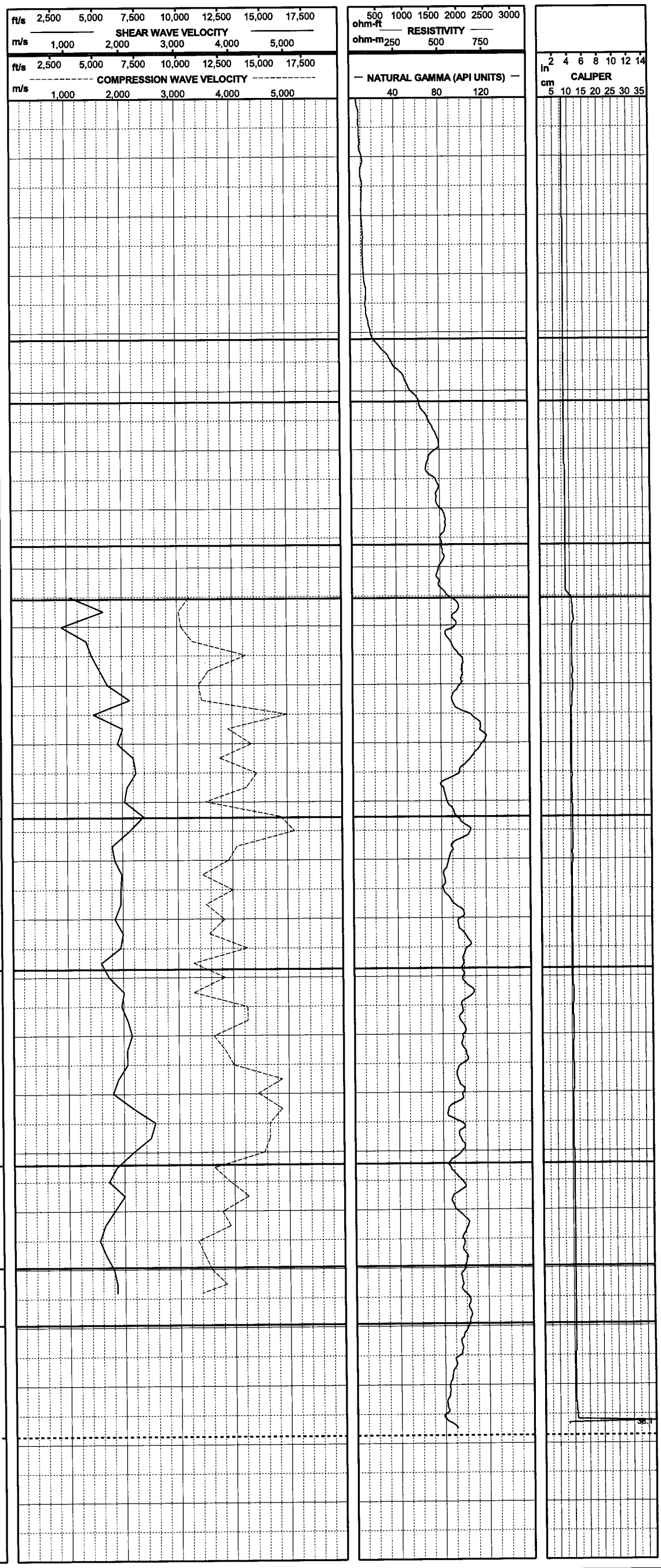
Coordinates: E1836336 N647635
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -5.9 m (MSL)

STRATUM NO.	MATERIAL DESCRIPTION
I	Fat CLAY (CH), dark olive gray, very soft to soft -with sandy silt pockets -with an organic odor and mica flakes at 0.3m -with a few shell fragments and mica flakes at 1.2m -with shell fragments at 2.1m -with mica flakes and organic matter pockets at 3.0m -with shell fragments, 3.7m to 6.1m -with an organic odor at 4.0m -with sandy silt seams and an organic odor, at 5.8m -with a few shell fragments, mica flakes, and with olive gray pockets, at 6.7m -with mica flakes at 7.6m (8.2m)
II	Silty fine SAND (SM), very dense, dark yellowish brown -with light gray clay pockets -olive gray slightly cemented clayey sand layer with fine gravel and iron oxide stains, at 9.4m (10.4m)
III	SANDSTONE (Graywacke) (RX), dark yellowish brown, moderately to intensely weathered, hard, fine grained, intensely fractured (15.2m)
IV	CLAYSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [3:1] (17.1m)
V	SANDSTONE (Graywacke) (RX), dark gray with very thin olive gray beds, moderately to slightly weathered, moderately hard to hard, moderately fractured See Plate 98-1.6 for detailed stratigraphy below 10.4m -thinly interbedded claystone, dark gray, moderately hard, intensely fractured into 50mm- to 125mm-long pieces, dipping at 20 degrees, 22.6m to 23.2m -moderately fractured, slightly to moderately rough with thin (6mm-thick) calcite/quartz filling, below 23.2m -slickensided claystone layer with vertical flow banding, 23.5m to 24.1m (24.5m)
VI	SANDSTONE (Graywacke) (RX) interbedded with CLAYSTONE (RX) [10:1] (29.7m)
VII	SANDSTONE (Graywacke) (RX) with thinly to moderately interbedded CLAYSTONE (RX) and SILTSTONE (RX) [4:1:1] (36.4m)
VIII	SANDSTONE (Graywacke) (RX) with interbedded SILTSTONE (RX) [1.5:1], fresh (39.9m)
IX	Interbedded SANDSTONE (Graywacke) (RX), SILTSTONE (RX) and CLAYSTONE (RX) [2:2:1], fresh (41.9m)
X	SANDSTONE (Graywacke) (RX), medium dark gray, fresh, hard, slightly to moderately fractured, fractures dipping at 50 to 80 degrees, moderately rough to rough, with very thin calcite filling

TOTAL DEPTH: 45.7 m

BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-1

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

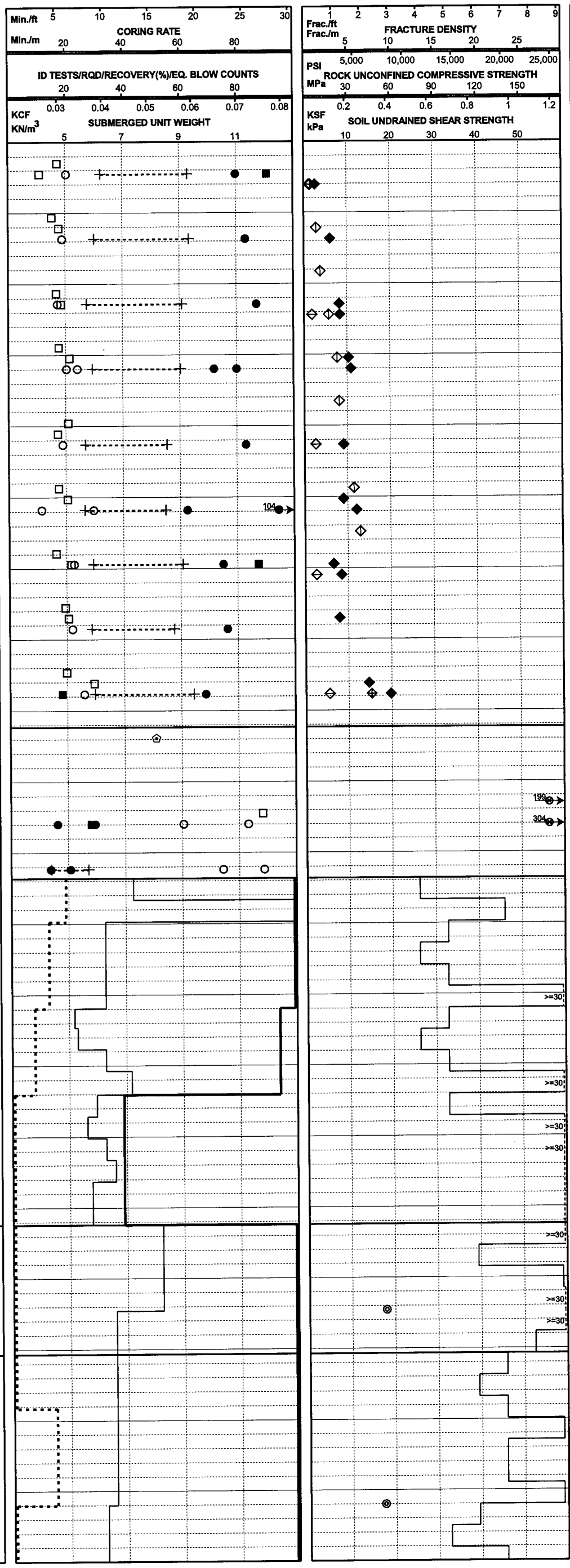
FUGRO

PROJECT NO:	98-42-0035	**START DATE:**	3/10/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-1 (North of Pier E2)	**COMPLETION DATE:**	3/12/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836336 N647635
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -5.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-6		WOH	Fat CLAY (CH), dark olive gray, very soft to soft -with sandy silt pockets -with an organic odor and mica flakes at 0.3m	
-7	1	WOH	-with a few shell fragments and mica flakes at 1.2m	
-8	2	WOH	-with shell fragments at 2.1m	
-9	3	WOH	-with mica flakes and organic matter pockets at 3.0m -with shell fragments, 3.7m to 6.1m	
-10	4	WOH	-with an organic odor at 4.0m	I
-11	5	WOH		
-12	6	WOH	-with sandy silt seams and an organic odor, at 5.8m	
-13	7	WOH	-with a few shell fragments, mica flakes, and with olive gray pockets, at 6.7m	
-14	8	WOH	-with mica flakes at 7.6m (8.2m)	
-15	9	51 25/60cm	Silty fine SAND (SM), very dense, dark yellowish brown -with light gray clay pockets -olive gray slightly cemented clayey sand layer with fine gravel and iron oxide stains, at 9.4m (10.4m)	II
-16	10	NR 30/30cm 50/5cm		
-17	11	100-19 100-13	SANDSTONE (Graywacke) (RX), dark yellowish brown, moderately to intensely weathered, hard, fine grained, intensely fractured -with moderately rough fractures inclined 20 to 70 degrees and moderately thin calcite and clay fracture filling -with a 12mm-thick claystone lens dipping at 35 degrees, and smooth fractures, at 11.0m	
-18	12			
-19	13	94-8	-with a 50mm-thick siltstone bed dipping 45 degrees, at 13.4m -with a very thin dark gray moderately soft claystone layer at 13.6m	III
-20	14	39-0		
-21	15		(15.2m)	
-22	16	100-0	CLAYSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [3:1] -claystone: dark gray, moderately weathered, moderately hard, intensely fractured, with yellowish orange stains on fracture surfaces -sandstone: moderate yellowish brown, moderately weathered, hard, moderately fractured, fractures inclined at 40 to 80 degrees, with iron oxide staining within fractures (17.1m)	IV
-23	17	100-0	SANDSTONE (Graywacke) (RX), dark gray with very thin olive gray beds, moderately to slightly weathered, moderately hard to hard, moderately fractured -very thin calcite/quartz fracture filling and fractures inclined from 35 to 80 degrees, with iron oxide staining within fractures, to 20.7m -with moderately thin (3mm-thick) calcite filling at 17.4m -with a 150mm-thick dark gray claystone bed at 17.7m	
-24	18	100-15	-with very thin calcite filled joints at 18.9m	V
-25	19	100-0	-with near vertical, slightly to moderately rough fractures, 19.5m to 20.1m	



LOG OF BORING AND TEST RESULTS

BORING 98-1

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

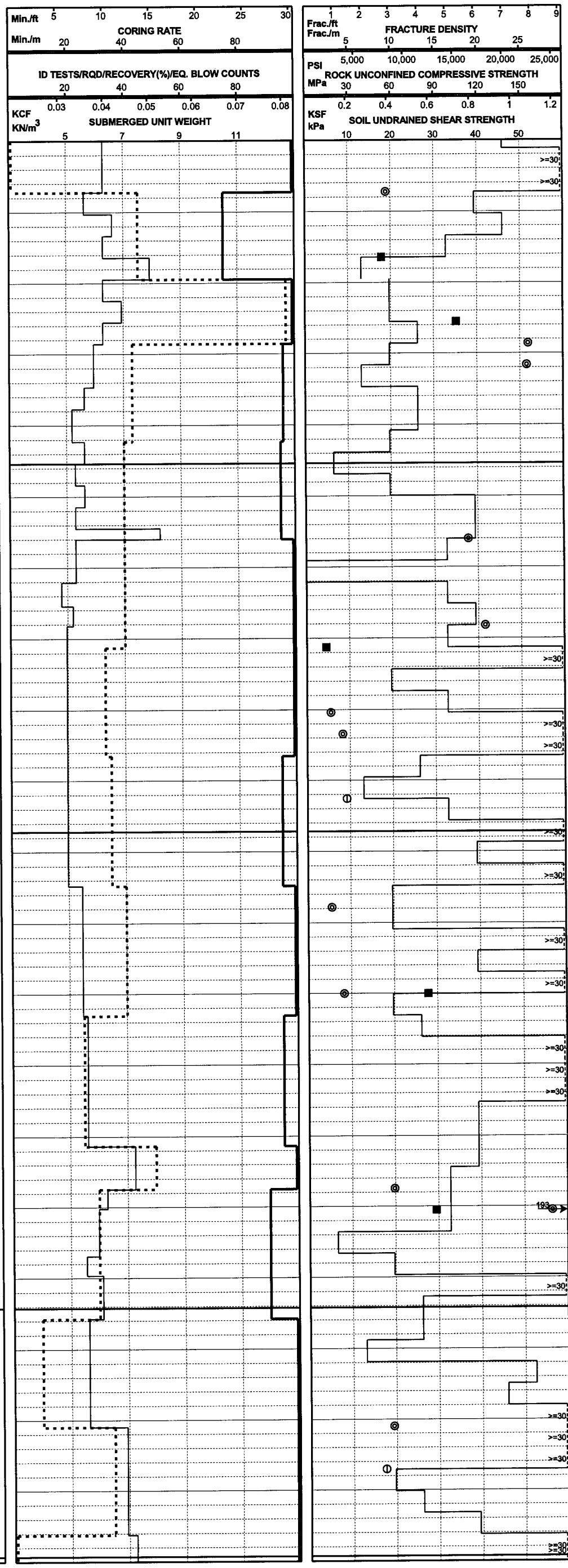
PLATE 98-1.5a

PROJECT NO:	98-42-0035	**START DATE:**	3/10/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-1 (North of Pier E2)	**COMPLETION DATE:**	3/12/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836336 N647635
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -5.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-26		100-0	SANDSTONE (Graywacke) (RX), dark gray with very thin olive gray beds, moderately to slightly weathered, moderately hard to hard, moderately fractured -intensely fractured,20.3m to 20.4m -with 50mm-thick calcite/quartz mineralization zone, at 20.4m -with claystone lenses, 20.7m to 21.9m	
-27	21	75-45		
-28	22	100-97	-thinly interbedded claystone, dark gray, moderately hard, intensely fractured into 50mm- to 125mm-long pieces, dipping at 20 degrees, 22.6m to 23.2m	V
-29	23	96-43	-moderately fractured, slightly to moderately rough with thin (6mm-thick) calcite/quartz filling, below 23.2m -slickensided claystone layer with vertical flow banding, 23.5m to 24.1m	
-30	24		-with a 3mm- to 6mm-thick wavy, undulating, vertical, calcite filled fracture, at 24.4m (24.5m)	
-31	25	95-40	SANDSTONE (Graywacke) (RX) interbedded with CLAYSTONE (RX) [10:1] -sandstone: medium dark gray, slightly weathered, hard, well indurated, moderately fractured -claystone: black, very thinly bedded, intensely fractured, slickensided bedding planes/ fracture surfaces -with moderately thin, well developed calcite striations parallel to the 80 degree fracture surface, at 25.3m -laminated, intensely fractured claystone lenses, 25.6m to 26.5m	
-32	26	100-40		
-33	27		-slightly rough fractures with 1mm- to 12mm-thick calcite filling, at 26.8m -fresh, moderately fractured, with thin, healed calcite filled fractures inclined 40 degrees, below 27.1m -with claystone clasts at 27.4m	VI
-34	28	100-33	-very thin, slightly rough, partially calcite filled fractures, with striations dipping from 60 degrees to dip of fractures, at 28.3m	
-35	29	95-35	(29.7m)	
-36	30		SANDSTONE (Graywacke) (RX) with thinly to moderately interbedded CLAYSTONE (RX) and SILTSTONE (RX) [4:1:1] -sandstone: medium dark gray, fresh, hard, thickly bedded, moderately to intensely fractured, slightly to moderately rough with discontinuous calcite/quartz filling to 2mm-thick. -claystone: black, moderately hard, moderately soft, thinly bedded (100mm- to 300mm-thick), dipping at 20 to 40 degrees, intensely fractured, with smooth, polished bedding plane/ fracture surfaces -siltstone: light gray, hard, very thinly bedded, intensely fractured	
-37	31	100-40		
-38	32			
-39	33	95-25		VII
-40	34	100-50		
-41	35		-150mm-thick dark gray intensely fractured claystone bed at 35.5m	
-42	36	90-30	-claystone with slickensides, and well developed striations inclined at 20 to 30 degrees from horizontal, at 36.3m (36.4m)	
-43	37	100-10	SANDSTONE (Graywacke) (RX) with interbedded SILTSTONE (RX) [1.5:1], fresh -sandstone: medium dark gray, hard, thickly bedded, slightly to moderately fractured -siltstone: medium dark gray, moderately hard to moderately soft, thinly to thickly bedded, slightly to intensely fractured, with smooth bedding-plane/ fracture surfaces, thinly laminated -gradational contact at 36.6m -intensely fractured polished claystone with pyrite flakes, 37.5m to 39.6m	
-44	38			VIII
-45	39	100-35		
		100-0	(39.9m)	IX



LOG OF BORING AND TEST RESULTS

BORING 98-1

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

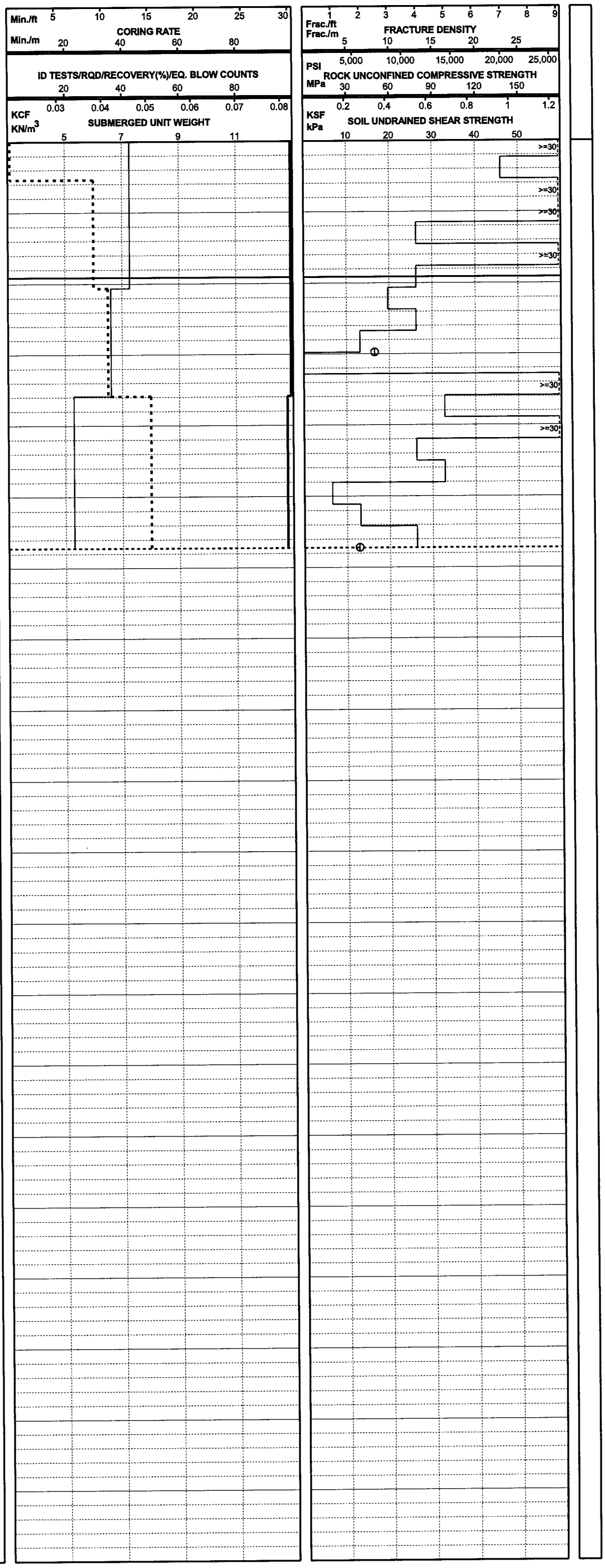
PLATE 98-1.5b

PROJECT NO:	98-42-0035	**START DATE:**	3/10/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-1 (North of Pier E2)	**COMPLETION DATE:**	3/12/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836336 N647635
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -5.9 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-46				100-0	Interbedded SANDSTONE (Graywacke) (RX), SILTSTONE (RX) and CLAYSTONE (RX) [2:2:1], fresh -sandstone: medium dark gray, moderately hard, fine grained, slightly fractured, slightly rough fracture surfaces at 60 degrees with very thin calcite/quartz filling -siltstone and claystone: medium dark gray, moderately soft, intensely fractured, thinly to moderately bedded	IX
-47	41			100-30	(41.9m)	
-48	42			100-35	SANDSTONE (Graywacke) (RX), medium dark gray, fresh, hard, slightly to moderately fractured, fractures dipping at 50 to 80 degrees, moderately rough to rough, with very thin calcite filling	X
-49	43				-175mm-thick claystone bed with polished fractures at 43.4m -thinly interbedded claystone at 43.6m	
-50	44			98-50	-very thinly interbedded claystone at 44.2m	
-51	45				TOTAL DEPTH: 45.7 m BACKFILLED WITH: Cement Grout	
-52	46					
-53	47					
-54	48					
-55	49					
-56	50					
-57	51					
-58	52					
-59	53					
-60	54					
-61	55					
-62	56					
-63	57					
-64	58					
-65	59					



LOG OF BORING AND TEST RESULTS

BORING 98-1

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-1.5c

Earth Mechanics

FUGRO

98-1		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
0.3	1					4.7																							
0.5	2	80	63	32	1.55	4.1	91	3																					H
0.6	3											2.6		1.2															
0.6	400														1.4														
1.1	4					4.5																							
1.2	5					4.8																							
1.2	401														2.9														
1.4	6	83	63	30	1.60							6.1																	
1.8	402														3.8														
2.1	7					4.7																							
2.3	8	87	61	28	1.78	4.8			2.61			8.2																	
2.4	9											8.4		1.9															
2.4	403														5.7														
2.9	10					4.8																							
3.0	11					5.1						10.3																	

Identification Tests
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Fines = % Passing No. 200 Sieve

Strength Tests
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UC = Unconfined Compression
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ϕ = Effective Friction Angle
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H = Hydrometer
C = Consolidation Test
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-1
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/08:41 AM)

Earth Mechanics

FUGRO

98-1		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
3.0	404														7.7														
3.2	12	72	60	29	1.38																								
3.2	12	80										10.9																	
3.7	405														8.1														
4.0	13					5.1																							
4.1	14					4.7																							
4.3	15	83	56	27	1.97			0				9.1		2.6															
4.3	406														9.1														
4.9	16					4.7																							
4.9	407														11.5														
5.0	17					5.0						9.0																	
5.2	18	63	55	27	1.27																								
5.2	18	104										12.1																	
5.5	408														12.9														
5.8	19					4.6																							

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-1
SFOBB East Span Seismic Safety Project

B0035MA(8/12/98/08:41 AM)

Earth Mechanics

FUGRO

98-1		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
5.9	20	75	61	30	1.45	5.2	87					6.7																	H
6.1	21							0				8.5		2.6															
6.6	22					4.9																							
6.7	23					5.1						7.9																	
6.9	24	76	58	29	1.64																								
7.5	25					5.0																							
7.6	26					5.9						14.7																	
7.8	27	69	65	30	1.12		18			15.3		19.8		5.6															
9.3	29										198.6																		
9.4	30					11.8																							
9.6	31	29					28				303.8																		
9.6	31	16																											
10.2	32	21	27	14	0.50																								
10.2	32	14																											
10.8	34a																			12.4	42	18.6	32						

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-1
SFOBB East Span Seismic Safety Project

10035SMA(8/17/98/09:42 AM)

Earth Mechanics

FUGRO

98-1		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
16.5	38																								53.9				
19.2	40																								52.5				
20.7	41																								56.6				
21.6	43b																							53.5		26.7	31.9	0.26	
22.3	43c																			49.6	38	13.8	34						
22.6	43d																							105.6		26.6	47.2	0.34	
22.9	43																								155.7				
23.2	44																								154.7				
25.0	45b																			20.0	36	15.9	28						
25.6	45a																								113.3				
26.2	46b																			44.8	52	8.3	34						
26.5	46c																	1034	46										
26.8	46a																								124.7				
27.1	46d																							13.5		26.2	19.2	0.20	
28.0	47b																								16.6				

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-1
SFOBB East Span Seismic Safety Project

80035SUMA(8/12/98/08:42 AM)

Earth Mechanics

FUGRO

98-1		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
28.3	47a																								24.9				
28.7	48c																			124.8	36	64.8	36						
29.3	48a																								27.6				
30.8	49a																								16.6				
30.9	49c																			0.0	35	44.8	38						
32.0	49d																							83.4		26.4	53.0	0.27	
32.0	49b																								24.9				
34.7	51																								59.4				
35.1	52b																							88.3		26.4	50.0	0.23	
35.1	52a																								193.4				
35.4	52c																			0.0	23	19.3	22						
38.1	53																								58.0				
38.7	54																								52.7				
41.5	56b																			9.7	18	35.2	29						
42.1	57c																	345	53								238.0	0.34	

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-1
SFOBB East Span Seismic Safety Project

10035SUM(8/12/98/08:42 AM)

Earth Mechanics

FUGRO

98-1		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
43.0	57																								49.7				
45.1	58c																			9.0	23	32.4	35						
45.7	58																								38.7				

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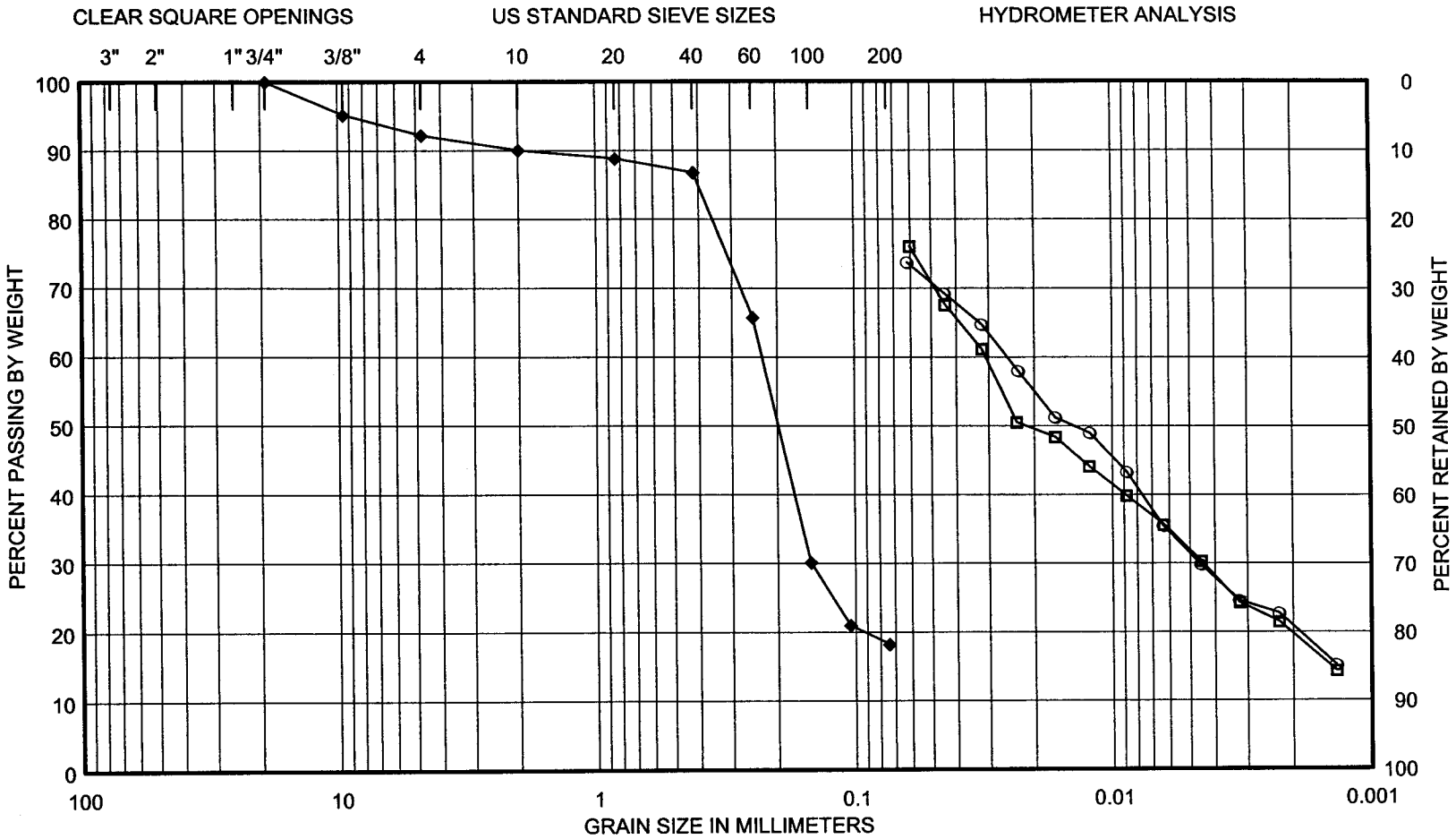
SUMMARY OF LABORATORY TEST RESULTS
BORING 98-1
SFOBB East Span Seismic Safety Project

80035SHA(8/12/98/08:42 AM)



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
2	0.5	○—○	FAT CLAY (CH) with sandy silt pockets
20	5.9	□—□	FAT CLAY (CH) with sandy silt seams
28	8.5	◆—◆	SILTY FINE SAND (SM)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-1

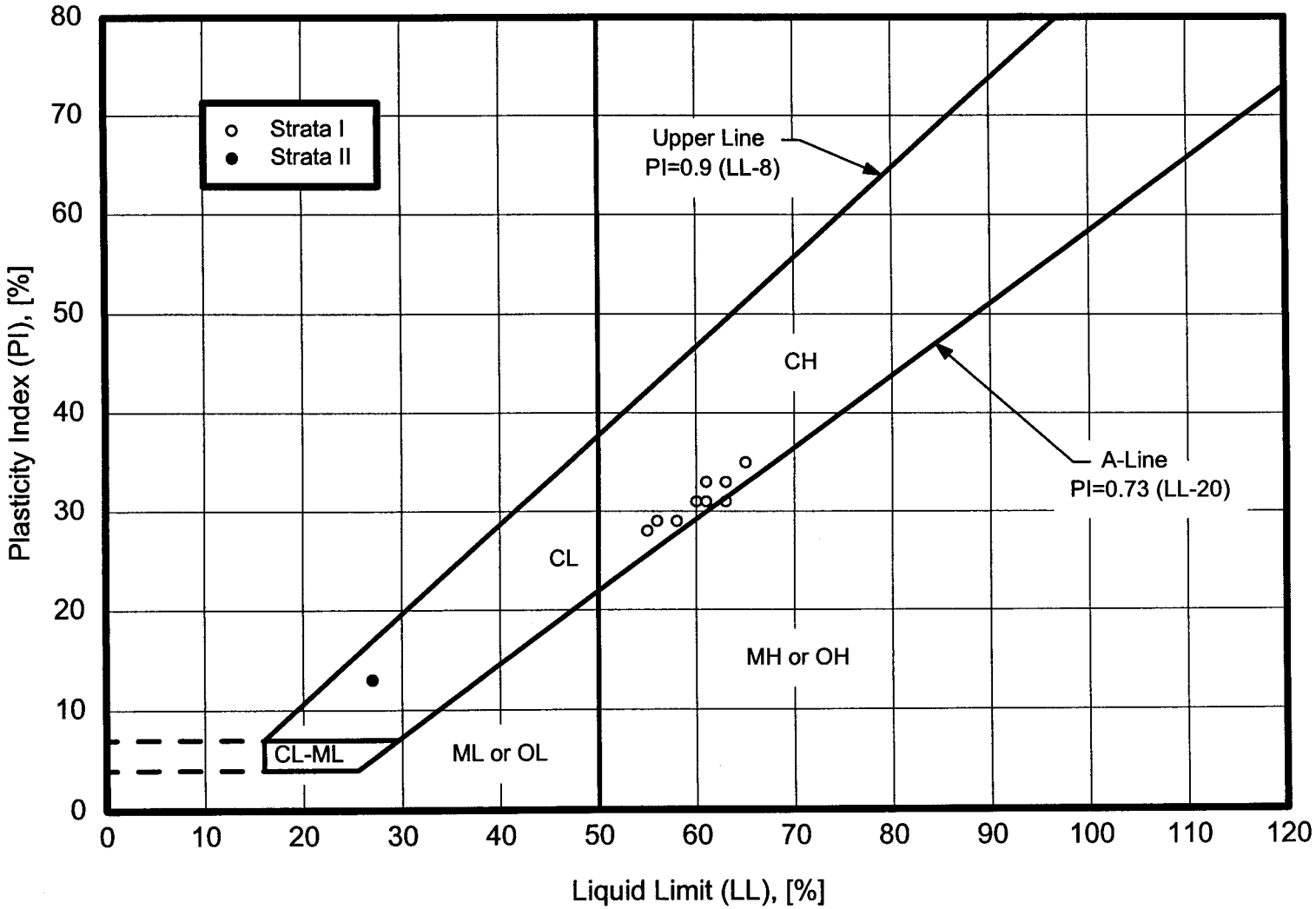
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

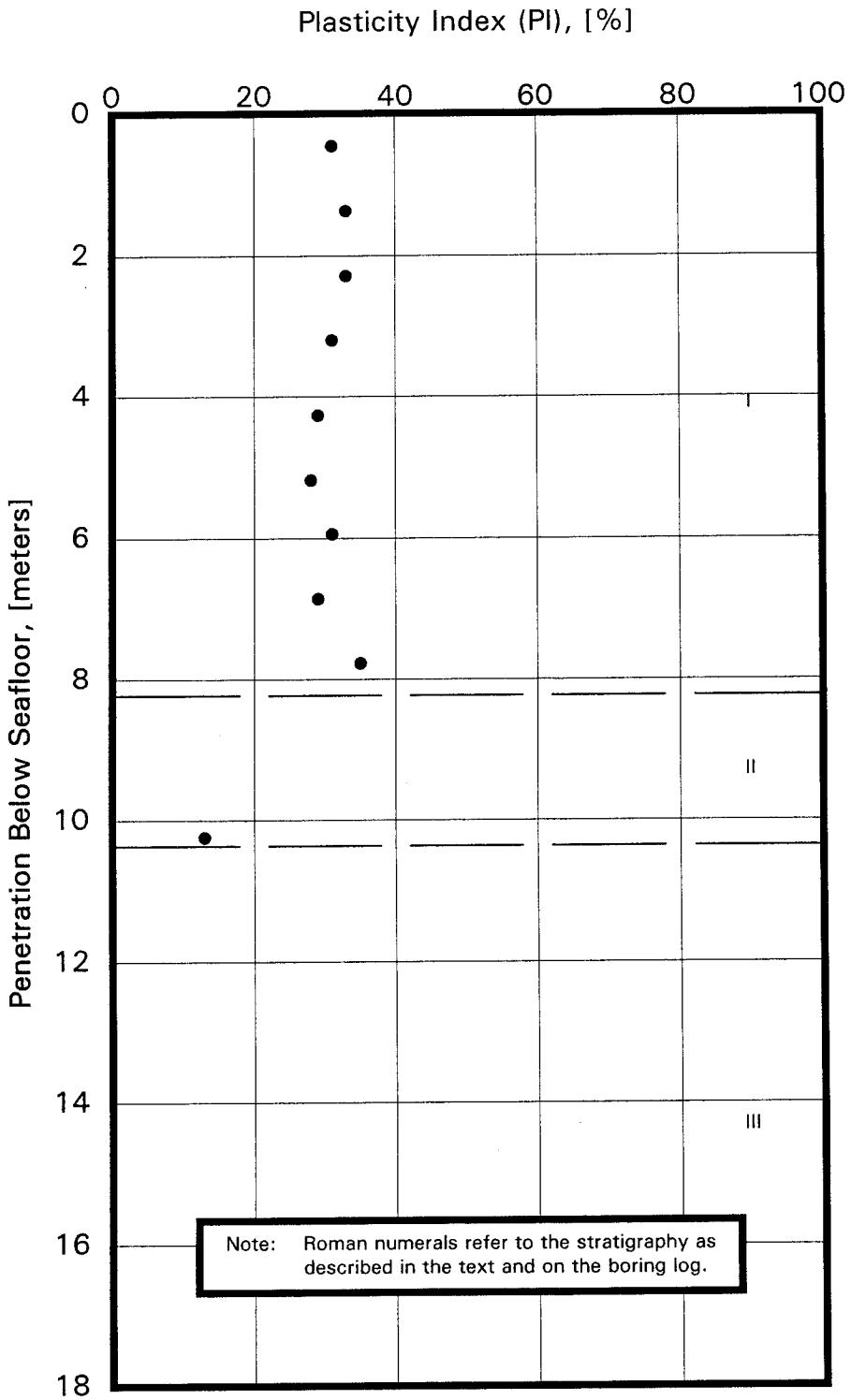
PLATE 98-1.7



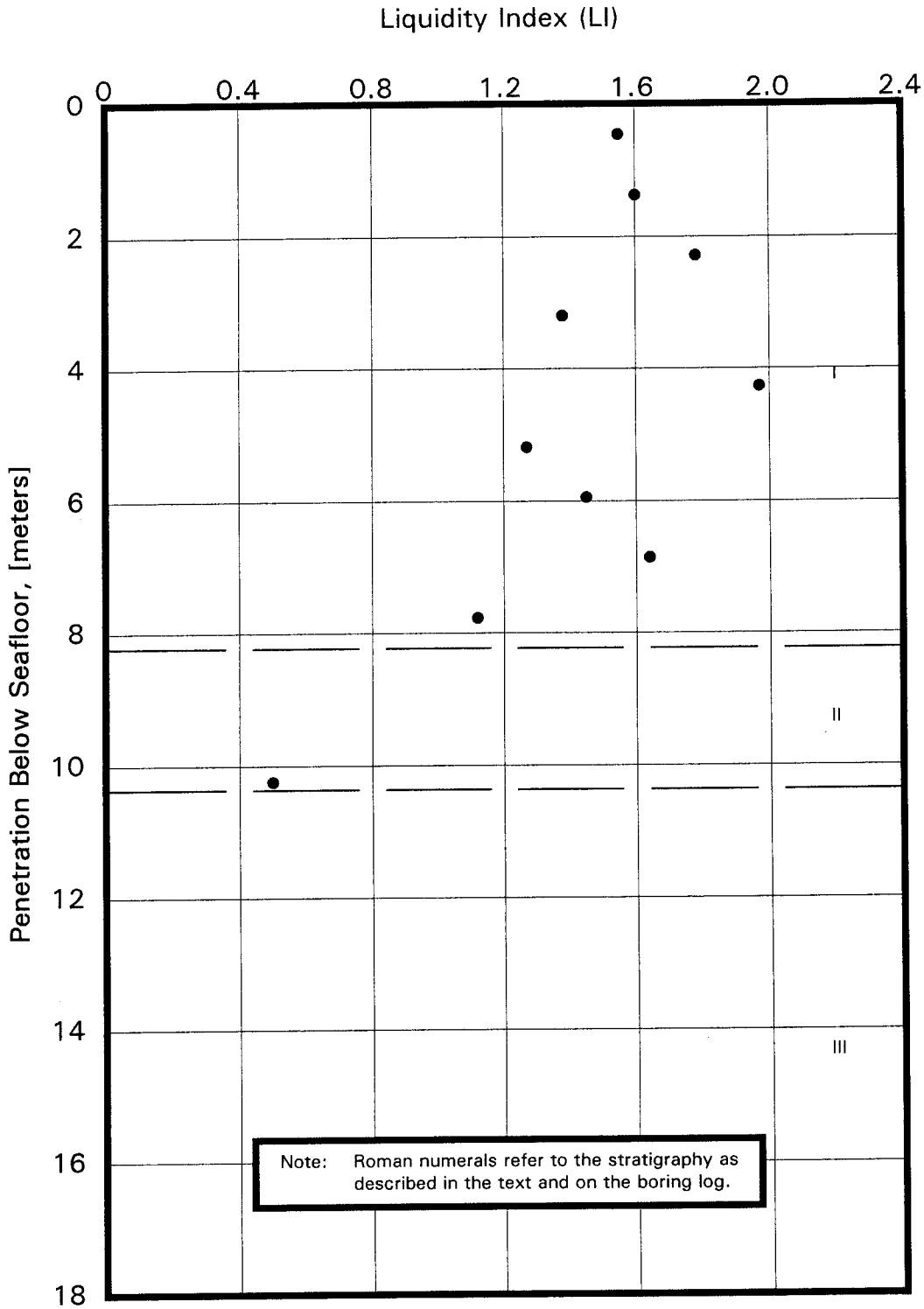
PLASTICITY CHART
Boring 98-1
SFOBB East Span Seismic Safety Project

Earth Mechanics

FUGRO



PLASTICITY INDEX PROFILE
Boring 98-1
SFOBB East Span Seismic Safety Project



LIQUIDITY INDEX PROFILE
Boring 98-1
SFOBB East Span Seismic Safety Project

BORING 98-2

Date	Time From	Time To	Description of Activity
March 15, 1998	0800	0830	Preparing to move barge to location 98-2.
	0830	1000	Pull anchors. Position barge on boring location 98-2, north of Pier E2, and set four-point anchor spread.
	1000	1030	Rig up and lower drill pipe to mudline.
	1030	1045	Measure water depth of 14.9m (49 ft) using bottom sensor. Current tide is approximately 0m (0 ft) MSL. Calculate mudline elevation of -14.9m (49 ft) MSL.
	1045	1130	Drill and sample 0m (0 ft) to 2.0m (6.5 ft).
	1130	1630	Run casing.
	1630	1730	Check slip joint and reassemble.
	1730	1830	Run casing.
	1830	1945	Drive casing.
	1945	2000	Weld casing and build flow.
	2000	2020	Mix mud.
	2020	2040	Run pipe to mudline.
	2040	2115	Drill down to 1.8m (6 ft).
	2115	2130	Sample 1.8m (6 ft) to 2.4m (8 ft).
	2130	2400	Pull drill pipe and prepare for rock coring.
March 16, 1998	0000	0030	Run core pipe to 1.8m (6 ft).
	0030	0830	Rock core 1.8m (6 ft) to 8.2m (27 ft).
	0830	0915	Pull core pipe.
	0915	1045	Run 12.7cm (5-inch) pipe to 7.3m (24 ft).
	1045	1210	Run core pipe to 8.2m (27 ft). Clean out hole.
	1210	1415	Rock core 8.8m (29 ft) to 10m (33 ft).
	1415	1500	Mix mud and pump to stabilize hole.
	1500	1645	Pull HC pipe, remove bit, run HC pipe and follow with NX pipe.
	1645	1835	Rock core 10m (33 ft) to 11.9m (39 ft).
	1835	1915	Retrieve core.
	1915	2000	Lower pressuremeter down hole on A rod.
	2000	2110	Run pressuremeter test at 11.9m (39 ft).
	2110	2200	Run pressuremeter test at 11.3m (37 ft).
	2200	2230	Pull pressuremeter to the surface.
	2230	2400	Pull and run pipe to rock core.
March 17, 1998	0000	0100	Clean out hole 10m (33 ft) to 11.9m (39 ft).
	0100	0515	Rock core 11.9m (39 ft) to 15.8m (52 ft).

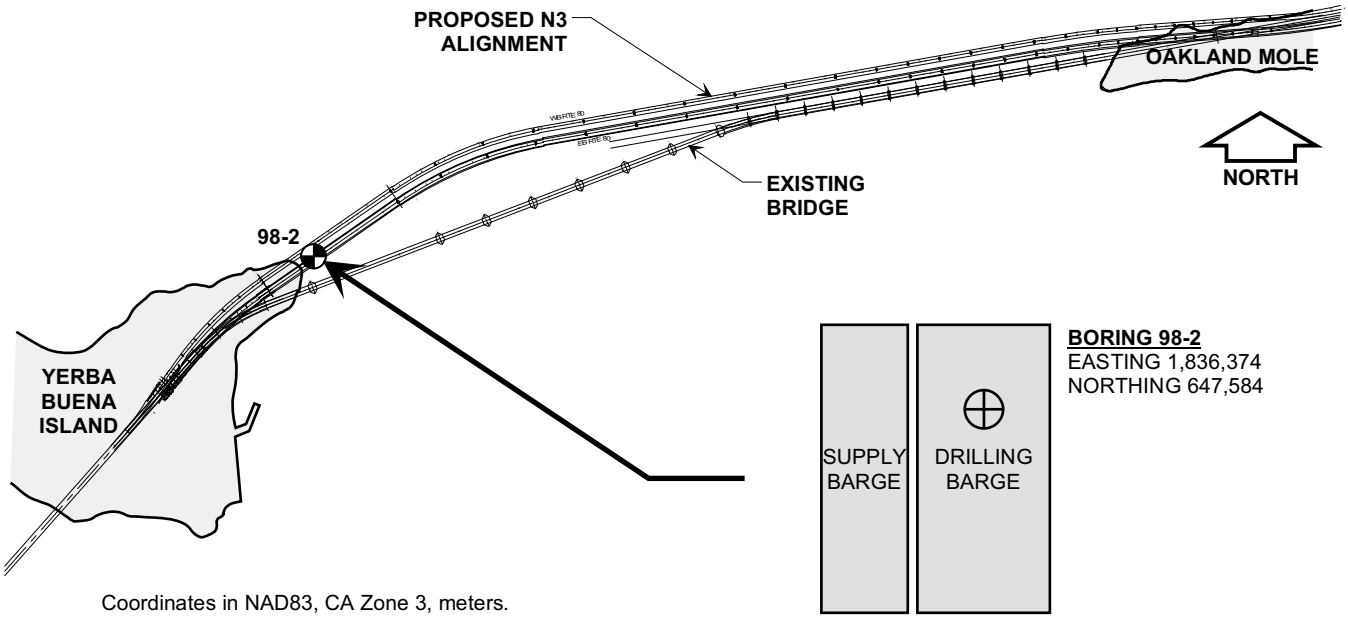
SUMMARY OF FIELD OPERATIONS
Boring 98-2
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
March 17, 1998	0515	0740	Pull HC core pipe, add casing shoe, run HC core pipe and NX core barrel.
	0740	0950	Rock core 15.8m (52 ft) to 17.7m (58 ft). (NX).
	0950	1100	Rig up and lower pressuremeter on A rod.
	1100	1150	Pressuremeter test at 17.7m (58 ft).
	1150	1245	Pull pressuremeter test equipment to surface.
	1245	1345	Ream-out test section, 15.8m (52 ft) to 17.7m (58 ft).
	1345	1720	Rock core with NX core barrel from 17.7m (58 ft) to 21m (69 ft).
	1720	1750	Pull core barrel.
	1750	1920	Ream 17.7m (58 ft) to 21m (69 ft) with HC casing bit.
	1920	2000	Run NX core pipe.
	2000	2050	Rock core 21m (69 ft) to 22.7m (74.5 ft).
	2050	2140	Rig up and lower pressuremeter on A rod.
	2140	2300	Pressuremeter test at 22.7m (74.5 ft).
	2300	2400	Pressuremeter test at 22.1m (72.5 ft).
March 18, 1998	0000	0100	Pull pressuremeter test equipment to surface.
	0100	0130	Run in hole with NX core barrel.
	0130	0300	NX core 22.7m (74.5 ft) to 25m (82 ft).
	0300	0400	Pull out core barrel and run in hole with core barrel.
	0400	0600	NX core 25m (82 ft) to 27.7m (91 ft).
	0600	0745	Rig up and lower pressuremeter on A rod.
	0745	0820	Pressuremeter test at 27.7m (91 ft).
	0820	0850	Pressuremeter test at 27.1m (89 ft).
	0850	0915	Pull pressuremeter test equipment to surface.
	0915	0940	Run in hole with NX core barrel.
	0940	1325	Rock core 27.7m (91 ft) to 32.6m (107 ft).
	1325	1415	Pull core barrel.
	1415	1435	Run pipe to 32.6m (107 ft).
	1435	1510	Recover 1.1m (3.5 ft) of previous rock core run.
	1510	1600	Pull core barrel.
	1600	1635	Rig up for pressuremeter test and lower into hole.

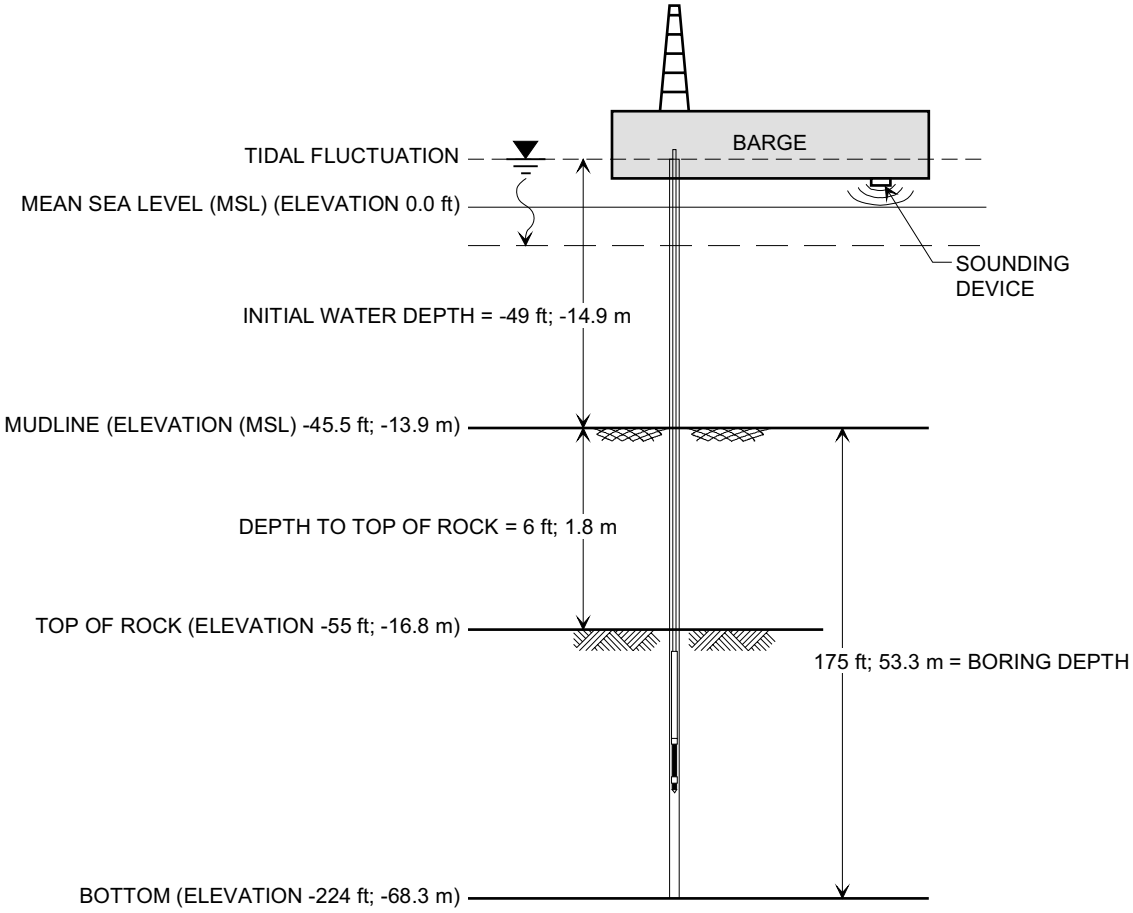
SUMMARY OF FIELD OPERATIONS
Boring 98-2
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
March 18, 1998	1635	1730	Pressuremeter test at 32.6m (107 ft).
	1730	1800	Pull pressuremeter test equipment to surface.
	1800	1820	Run core pipe into hole.
	1820	2210	Rock core 32.6m (107 ft) to 37.2m (122 ft).
	2210	2300	Rock core 37.2m (122 ft) to 38.7m (127 ft).
	2300	2400	Pull out core barrel. Set up pressuremeter equipment.
March 19, 1998	0000	0045	Run in hole with pressuremeter test equipment.
	0045	0130	Run pressuremeter test.
	0130	0215	Pull pressuremeter equipment. Run core barrel.
	0215	0415	Rock core 38.7m (127 ft) to 40.4m (132.5 ft).
	0415	0505	Pull core barrel, retrieve core, and run core barrel.
	0505	0715	Rock core 40.4m (132.5 ft) to 43.4m (142.5 ft).
	0715	0850	Pull core barrel, retrieve core (stuck in barrel), and run into hole with core barrel.
	0850	1030	Rock core 43.4m (142.5 ft) to 46m (151 ft).
	1030	1130	Pull core barrel, retrieve core, and run core barrel.
	1130	1900	Rock core 46m (151 ft) to 53.2m (174.5 ft).
	1900	2030	Pull core pipe and service rig.
	2030	2140	Perform downhole logging, 20.1m (66 ft) to bottom of hole (first suspension log run).
	2140	2230	Perform downhole logging, 20.1m (66 ft) to bottom of hole (second suspension log run).
	2230	2330	Downhole caliper logging by Welenco.
	2330	2400	Acoustic logging by Welenco.
March 20, 1998	0000	0030	Acoustic logging by Welenco.
	0030	0100	Pull HC core pipe.
	0100	0430	Caliper, acoustic and suspension logging from 7.3m (24 ft) to 20.1m (66 ft).
	0430	0515	Cement borehole.
	0515	0600	Pull drill pipe.
	0600	0800	Pull casing.
	0800	1100	Move barge into location for Boring 98-6.

SUMMARY OF FIELD OPERATIONS
Boring 98-2
SFOBB East Span Seismic Safety Project



Coordinates in NAD83, CA Zone 3, meters.



BORING 98-2 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-2.2

9842\0035loc2.dsf(1,3)

PROJECT NO:	98-42-0035	**START DATE:**	3/15/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-2 (North of Pier E2)	**COMPLETION DATE:**	3/20/98	**DRILLING METHOD:**	Mud Rotary Boring

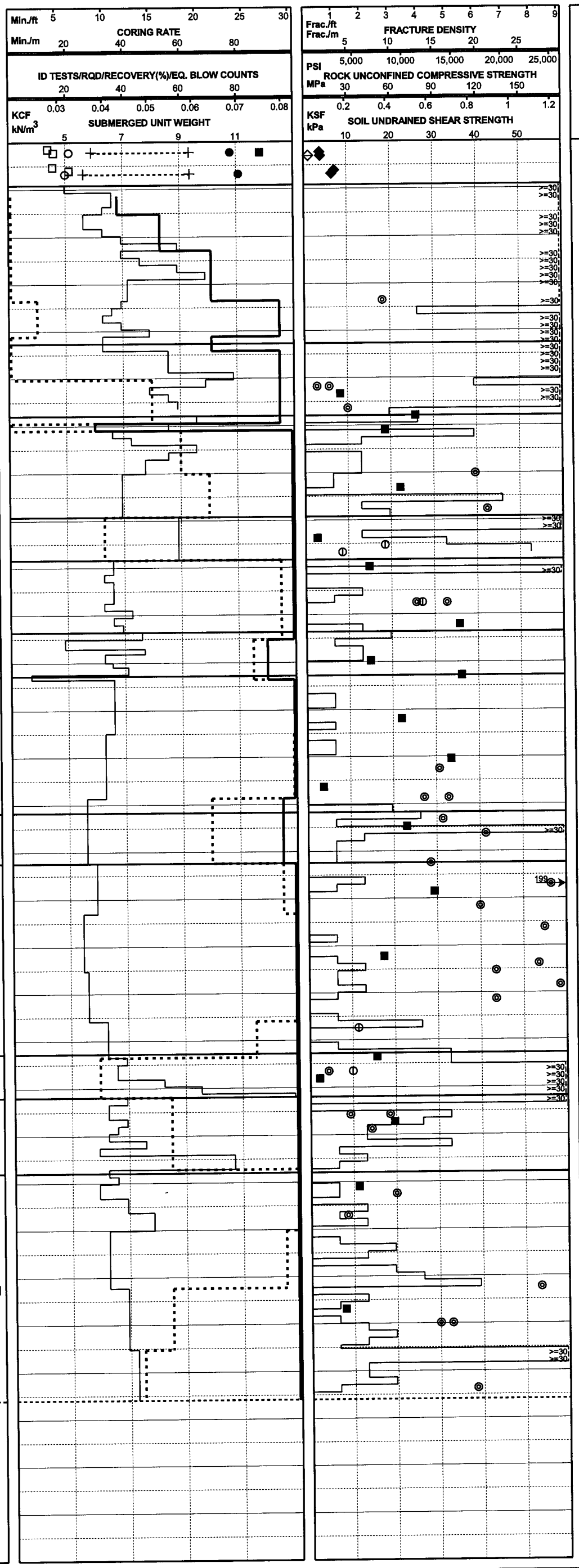
Coordinates: E1836374 N647582
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -14.9 m (MSL)

Stratum	Material Description	Blow Count
I	Fat CLAY (CH), very soft, olive gray -with sandy silt pockets and a few shell fragments -with an organic odor at 0.3m -with black streaks, organic matter pockets, and a few sand pockets, at 1.2m (1.8m)	WOH, WOH, 30/30cm, 30/30cm
II	SANDSTONE (Graywacke) (RX), yellowish brown, intensely weathered, moderately soft to moderately hard, thickly bedded, very intensely fractured (8.5m)	38-0, 53-0, 71-0, 95-10
III	SILTSTONE (RX), medium dark gray, slightly weathered, moderately soft, laminated to thinly bedded, intensely to very intensely fractured (11.6m)	71-0, 95-0, 95-50
IV	SANDSTONE (Graywacke) (RX), medium gray, slightly weathered, hard, moderately fractured (15.8m)	30-0, 100-60, 100-70
V	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [3:1], slightly weathered to fresh (17.7m)	100-33
VI	SANDSTONE (Graywacke) (RX), medium gray, fresh, hard, slightly fractured (20.7m)	100-95, 100-95
VII	SANDSTONE (Graywacke) (RX) with very thinly to thinly interbedded SILTSTONE (RX) [4:1], fresh, bedding at 20 degrees, slightly to moderately fractured (22.6m)	90-85
VIII	SANDSTONE (Graywacke) (RX), medium gray, fresh, hard to very hard, thickly bedded, unfractured to slightly fractured -with a siltstone layer, hard, dipping at 20 degrees, with smooth fracture surfaces along bedding-planes, 23.5m to 23.9m (28.3m)	100-100, 100-99
IX	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2.5:1], fresh, smooth fracture surfaces along siltstone bedding surfaces, dipping at 20 degrees (30.5m)	95-70
X	SANDSTONE (Graywacke) (RX), medium gray, fresh, hard to very hard, very thickly bedded to massive, unfractured to slightly fractured (38.6m)	100-95, 100-100, 100-100, 100-85
XI	CLAYSTONE (RX), dark gray, fresh, moderately hard, intensely fractured (40.4m)	100-30
XII	SANDSTONE (Graywacke) (RX) with interbedded (CLAYSTONE) [5:1], fresh, dipping 10 to 30 degrees (43.6m)	100-55
XIII	SANDSTONE (Graywacke) (RX), medium gray, hard, very thickly bedded, slightly fractured -intensely fractured claystone layer with smooth fracture surfaces, 51.1m to 51.4m -moderately fractured siltstone layer with slightly rough fractures oriented 70 degrees, 51.4m to 51.8m -with claystone laminations, 51.8m to 52.0m	100-100, 100-95, 100-55, 100-45

See Plate 98-2.6 for detailed stratigraphy below 1.8m

TOTAL DEPTH: 53.3 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-2

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

FUGRO

PLATE 98-2.3

PROJECT NO: 98-42-0035
BORING: 98-2 (North of Pier E2)
START DATE: 3/15/98
COMPLETION DATE: 3/20/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836374 N647582
CA State Plane Zone 3, NAD83, Meters

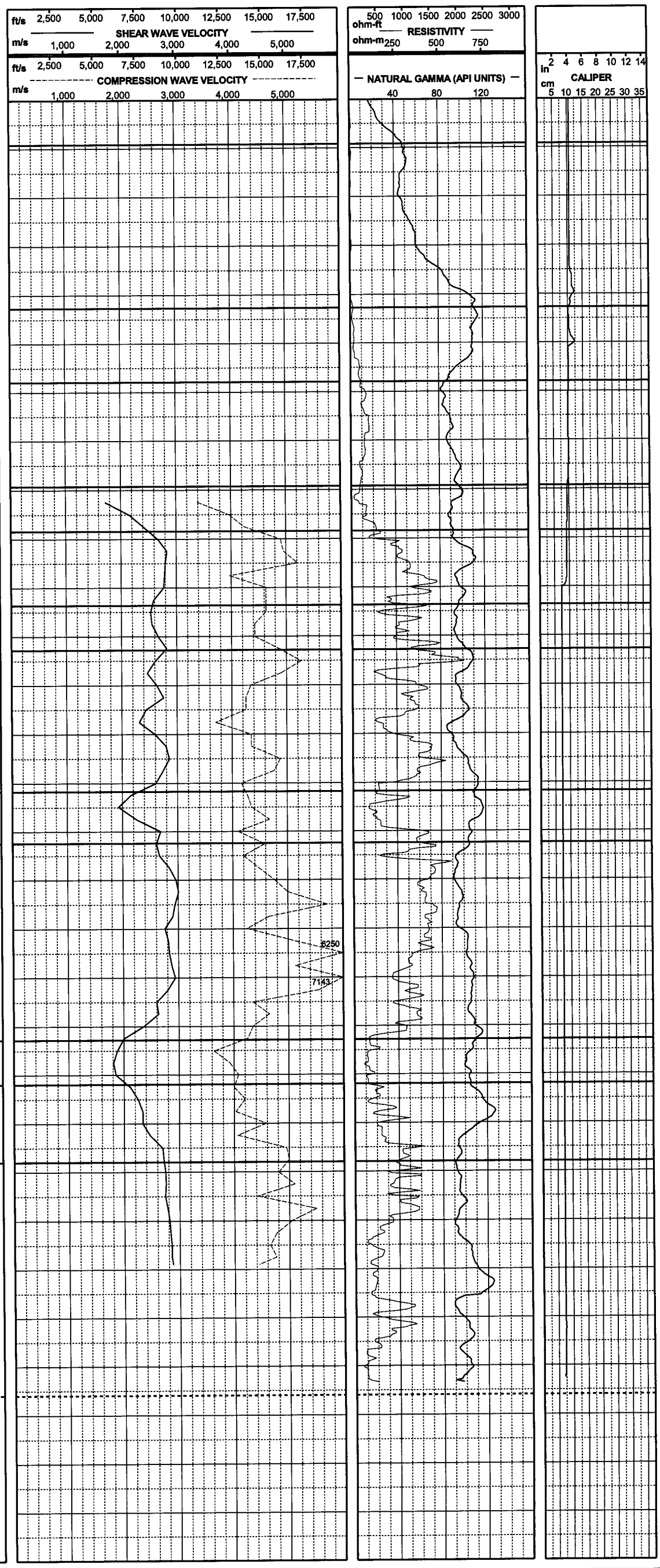
MUDLINE ELEVATION: -14.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
			Fat CLAY (CH), very soft, olive gray -with sandy silt pockets and a few shell fragments -with an organic odor at 0.3m -with black streaks, organic matter pockets, and a few sand pockets, at 1.2m (1.8m)	I
			SANDSTONE (Graywacke) (RX), yellowish brown, intensely weathered, moderately soft to moderately hard, thickly bedded, very intensely fractured See Plate 98-2.6 for detailed stratigraphy below 1.8m (8.5m)	II
			SILTSTONE (RX), medium dark gray, slightly weathered, moderately soft, laminated to thinly bedded, intensely to very intensely fractured (11.6m)	III
			SANDSTONE (Graywacke) (RX), medium gray, slightly weathered, hard, moderately fractured (15.8m)	IV
			SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [3:1], slightly weathered to fresh (17.7m)	V
			SANDSTONE (Graywacke) (RX), medium gray, fresh, hard, slightly fractured (20.7m)	VI
			SANDSTONE (Graywacke) (RX) with very thinly to thinly interbedded SILTSTONE (RX) [4:1], fresh, bedding at 20 degrees, slightly to moderately fractured (22.6m)	VII
			SANDSTONE (Graywacke) (RX), medium gray, fresh, hard to very hard, thickly bedded, unfractured to slightly fractured -with a siltstone layer, hard, dipping at 20 degrees, with smooth fracture surfaces along bedding-planes, 23.5m to 23.9m (28.3m)	VIII
			SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2.5:1], fresh, smooth fracture surfaces along siltstone bedding surfaces, dipping at 20 degrees (30.5m)	IX
			SANDSTONE (Graywacke) (RX), medium gray, fresh, hard to very hard, very thickly bedded to massive, unfractured to slightly fractured (38.6m)	X
			CLAYSTONE (RX), dark gray, fresh, moderately hard, intensely fractured (40.4m)	XI
			SANDSTONE (Graywacke) (RX) with interbedded (CLAYSTONE) [5:1], fresh, dipping 10 to 30 degrees (43.6m)	XII
			SANDSTONE (Graywacke) (RX), medium gray, hard, very thickly bedded, slightly fractured -intensely fractured claystone layer with smooth fracture surfaces, 51.1m to 51.4m -moderately fractured siltstone layer with slightly rough fractures oriented 70 degrees, 51.4m to 51.8m -with claystone laminations, 51.8m to 52.0m	XIII

Blow counts: WOH; 30/30cm; 30/30cm; 38-0; 53-0; 71-0; 95-10; 71-0; 95-0; 95-50; 30-0; 100-60; 100-70; 100-33; 100-95; 100-95; 90-85; 100-100; 100-99; 95-70; 100-95; 100-100; 100-100; 100-85; 100-30; 100-55; 100-100; 100-95; 100-55; 100-45

TOTAL DEPTH: 53.3 m

BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-2

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

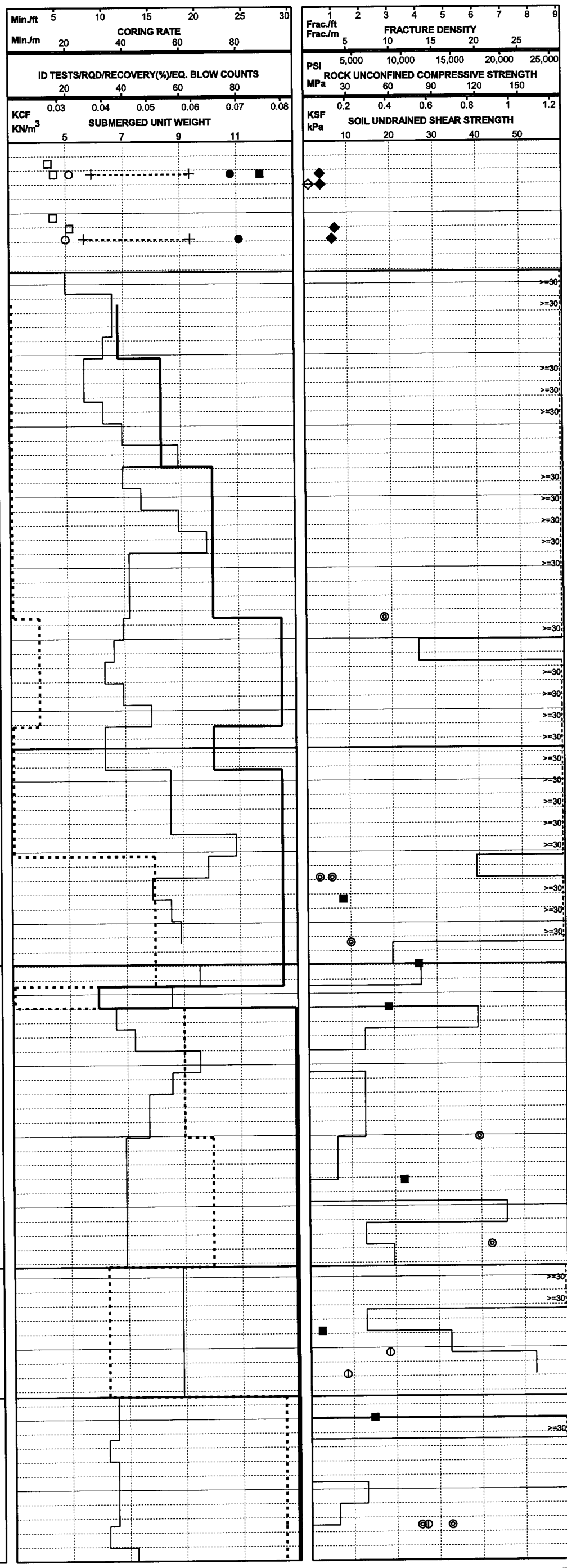
PLATE 98-2.4

PROJECT NO:	98-42-0035	**START DATE:**	3/15/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-2 (North of Pier E2)	**COMPLETION DATE:**	3/20/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836374 N647582
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -14.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-15		WOH	Fat CLAY (CH), very soft, olive gray -with sandy silt pockets and a few shell fragments -with an organic odor at 0.3m	I
-16	1	WOH	-with black streaks, organic matter pockets, and a few sand pockets, at 1.2m (1.8m)	
-17	2	30/30cm 30/30cm	SANDSTONE (Graywacke) (RX), yellowish brown, intensely weathered, moderately soft to moderately hard, thickly bedded, very intensely fractured -with slightly to moderately rough fracture surfaces -with intermixed light gray siltstone clasts to 4.6m	II
		38-0		
-18	3			
		53-0		
-19	4		-moderately weathered, fragments of yellowish brown sandstone ranging from coarse gravel to 125mm in length, yellowish orange, with iron oxide staining and some thin clay filling along high angle fractures, 4.6m to 6.7m	
-20	5			
		71-0		
-21	6		-intensely fractured, fractures oriented at 25 and 60 degrees, core pieces generally 50mm to 125mm long, moderately rough to rough fracture surfaces, with moderately thin, discontinuous clay filling, 6.7m to 8.2m	
-22	7			
		95-10		
-23	8		(8.5m)	
		71-0	SILTSTONE (RX), medium dark gray, slightly weathered, moderately soft, laminated to thinly bedded, intensely to very intensely fractured -smooth to slightly rough fractures, clean to very thin rust staining and calcite filling, broken into pieces ranging from 37mm to75mm in length along bedding plane partings, bedding at 20 degrees, with a few thin light gray sandstone beds [5:1]	III
-24	9			
		95-0		
-25	10			
-26	11	95-50	-Pressuremeter test at 10.9m, siltstone with thinly interbedded sandstone [5:1], intensely fractured into 50mm- to 100mm-pieces, with abundant calcite fracture filling -Pressuremeter test at 11.5m, slightly weathered, moderately hard, moderately fractured into 100mm to 200mm long pieces along 40 degree fractures, smooth, with thin calcite filling (11.6m)	
-27	12	30-0	SANDSTONE (Graywacke) (RX), medium gray, slightly weathered, hard, moderately fractured -moderately rough fractures, with very thin yellowish orange staining	IV
-28	13	100-60	-with a 150mm-thick moderately hard siltstone layer at 12.8m	
-29	14			
-30	15	100-70	-intensely fractured (25mm to 75mm spacing) with slightly rough to rough fractures oriented at 50 to 60 degrees, yellowish orange staining and moderately thin (3mm-thick) discontinuous calcite fracture filling, below 14.9m (15.8m)	
-31	16		SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [3:1], slightly weathered to fresh -sandstone: medium gray, hard, moderately fractured, moderately rough, with very thin yellowish orange staining -siltstone: dark gray, moderately hard, thinly bedded, intensely to very intensely fractured, dipping at 20 degrees -Pressuremeter test at 17.0m, sandstone with thinly interbedded siltstone [4:1] (over test interval), moderately fractured	V
-32	17	100-33	(17.7m)	
-33	18		SANDSTONE (Graywacke) (RX), medium gray, fresh, hard, slightly fractured -moderately rough fractures, with very thin yellowish orange staining, and closed, healed fractures oriented at 60 degrees, with tight, very thin calcite filling -with widely-spaced, thin fractures at 20 degrees, with discontinuous calcite filling, to 19.5m -with a 150mm-thick siltstone bed at 18.1m	VI
		100-95		
-34	19		-with a moderately hard thin siltstone bed dipping 20 degrees, at 19.5m	
		100-95		



LOG OF BORING AND TEST RESULTS

BORING 98-2

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

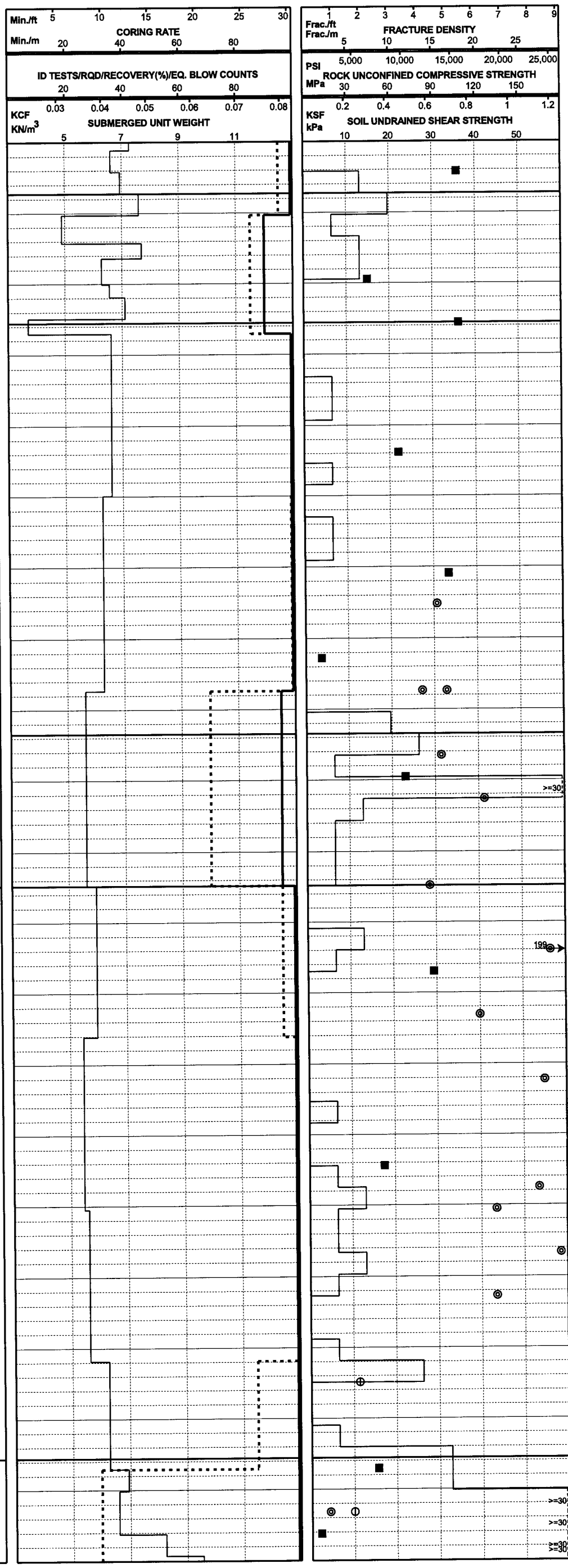
PLATE 98-2.5a

PROJECT NO:	98-42-0035	**START DATE:**	3/15/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-2 (North of Pier E2)	**COMPLETION DATE:**	3/20/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836374 N647582
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -14.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-35		100-95	SANDSTONE (Graywacke) (RX), medium gray, fresh, hard, slightly fractured (20.7m)	VI
-36	21	90-85	SANDSTONE (Graywacke) (RX) with very thinly to thinly interbedded SILTSTONE (RX) [4:1], fresh, bedding at 20 degrees, slightly to moderately fractured -fractures oriented at 60 and 70 degrees, with thin calcite filling, tight, healed -sandstone: medium gray, hard, moderately rough, with very thin yellowish orange staining -siltstone: dark gray, moderately hard, smooth fracture/ bedding surfaces -Pressuremeter test at 21.7m, sandstone with thinly interbedded siltstone [10:1], with thin healed fractures at 20 degrees in sandstone (22.6m) -Pressuremeter test at 22.2m, sandstone with thinly interbedded siltstone [3:1], with smooth fracture surfaces in siltstone and thin, healed, 65 to 75 degree calcite filled fractures	VII
-37	22			
-38	23	100-100	SANDSTONE (Graywacke) (RX), medium gray, fresh, hard to very hard, thickly bedded, unfractured to slightly fractured - fractures oriented at 70 degrees, with tight, healed, moderately thin calcite/quartz filling -with a siltstone layer, hard, dipping at 20 degrees, with smooth fracture surfaces along bedding-planes, 23.5m to 23.9m	VIII
-39	24			
-40	25		-with a150mm-thick siltstone layer, smooth bedding plane partings at 20 degrees, thin calcite /quartz filling, at 25.6m	
-41	26	100-99	-Pressuremeter test at 26.1m, sandstone, hard to very hard, very slightly fractured, with a few thin, healed, high-angle, quartz filled fractures	
-42	27		-Pressuremeter test at 27.3m, sandstone, hard to very hard, very slightly fractured, with a few thin, healed, high-angle, quartz-filled fractures (28.3m)	
-43	28			
-44	29	95-70	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2.5:1], fresh, smooth fracture surfaces along siltstone bedding surfaces, dipping at 20 degrees -sandstone: medium gray, hard, slightly fractured, with very thin yellowish orange staining and thin, healed, quartz/ calcite filled fractures at 60 to 70 degrees -siltstone: dark gray, moderately hard, intensely fractured, smooth to polished (30.5m)	IX
-45	30			
-46	31	100-95	SANDSTONE (Graywacke) (RX), medium gray, fresh, hard to very hard, very thickly bedded to massive, unfractured to slightly fractured -fractures oriented at 70 degrees, with very thin to moderately thin, healed calcite-/quartz-filling, with a few very thin yellowish orange staining -with tight calcite-filled fractures, healed, closed, oriented at 60 to 70 degrees, at 30.8m -150mm-thick, moderately hard siltstone layer dipping 10 degrees with smooth, planar fracture surfaces, at 31.4m -Pressuremeter test at 31.9m, sandstone, hard, slightly fractured, with thin healed calcite/quartz-filled fractures at 60 to 70 degrees -very hard, with a few thin, tight calcite filled joints oriented at 40 to 60 degrees, 32.6m to 35.1m	X
-47	32			
-48	33		-with slight mineralization at 33.5m	
-49	34	100-100	-slightly rough fractures oriented 20 degrees with thin quartz filling and pyrite flakes, 34.1m to 35.4m	
-50	35		-with thin calcite/quartz-filled fractures oriented at 40, 50, and 60 degrees, spacing 6 to 10 fractures per meter, 35.1m to 38.4m	
-51	36	100-100		
-52	37			
-53	38	100-85	-Pressuremeter test at 38.4m (38.6m)	
-54	39	100-30	CLAYSTONE (RX), dark gray, fresh, moderately hard, intensely fractured -with clean, smooth to polished fracture and bedding plane parting surfaces, 38.6m to 40.4m -with thin sandstone beds at 39.6m and 40.1m	XI



LOG OF BORING AND TEST RESULTS

BORING 98-2

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

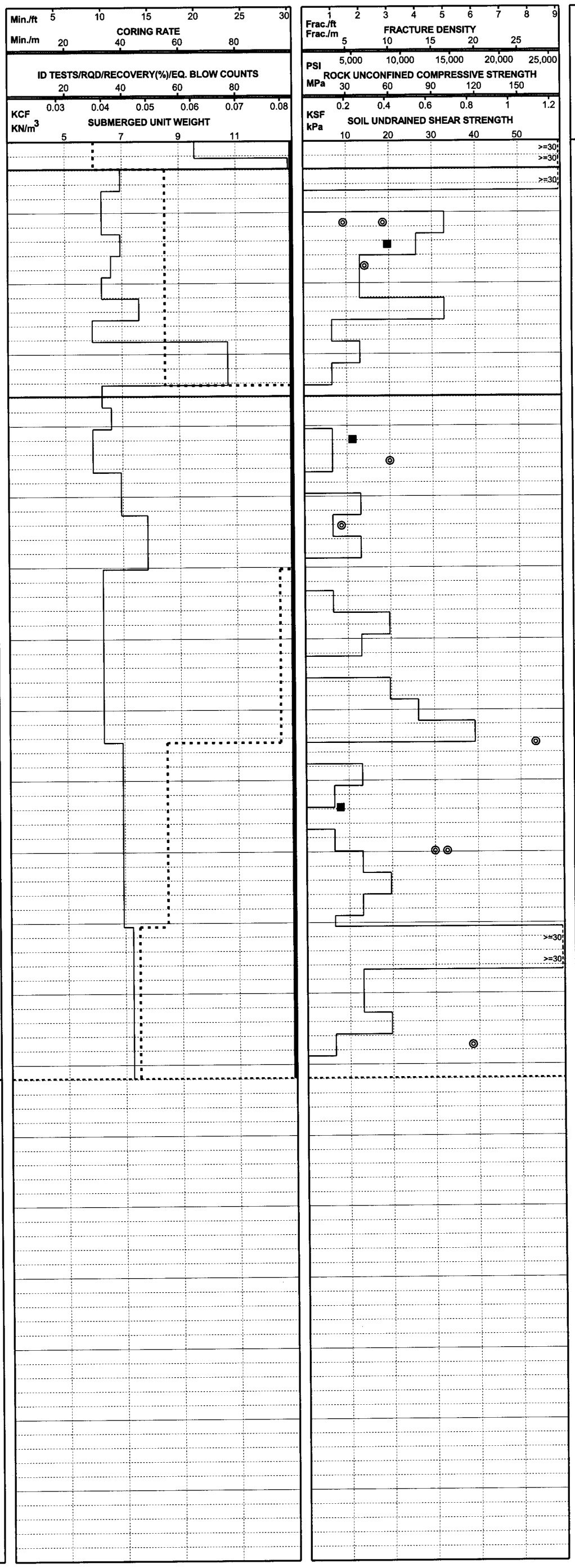
PLATE 98-2.5b

PROJECT NO:	98-42-0035	**START DATE:**	3/15/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-2 (North of Pier E2)	**COMPLETION DATE:**	3/20/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836374 N647582
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -14.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-55		100-30	CLAYSTONE (RX), dark gray, fresh, moderately hard, intensely fractured (40.4m)	XI
-56	41		SANDSTONE (Graywacke) (RX) with interbedded (CLAYSTONE) [5:1], fresh, dipping 10 to 30 degrees -sandstone: medium gray, hard, thickly bedded, slightly fractured, very clean, slightly rough, with a few, very thin, healed, calcite/quartz-filled fractures -claystone: dark gray, moderately hard, very thin to thinly bedded, intensely fractured, very thin fracture filling, smooth	
-57	42	100-55		XII
-58	43		(43.6m)	
-59	44		SANDSTONE (Graywacke) (RX), medium gray, hard, very thickly bedded, slightly fractured -very thin to thin fractures oriented at 50 to 60 degrees, slightly rough, tight, with calcite/quartz filling, spacing 75mm to 300mm -25mm-thick claystone layer with very thin fracture filling, at 44.2m	
-60	45	100-100		
-61	46		-thin, healed calcite/quartz-filled fractures, orientated at 40 to 60 degrees, 3 to 10 per meter, 46.0m to 50.9m	
-62	47	100-95		
-63	48		-with some pyrite mineralization at 48.5m	XIII
-64	49		-with pyrite flakes at 49.4m	
-65	50	100-55		
-66	51		-intensely fractured claystone layer with smooth fracture surfaces, 51.1m to 51.4m -moderately fractured siltstone layer with slightly rough fractures oriented 70 degrees, 51.4m to 51.8m -with claystone laminations, 51.8m to 52.0m	
-67	52	100-45	-with tight calcite/quartz-filled joints and thin patchy calcite filling, below 52.1m	
-68	53		TOTAL DEPTH: 53.2 m BACKFILLED WITH: Cement Grout	
-69	54			
-70	55			
-71	56			
-72	57			
-73	58			
-74	59			



LOG OF BORING AND TEST RESULTS

BORING 98-2

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-2.5c

Earth Mechanics

FUGRO

98-2		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
0.3	1					4.4																							
0.5	2	78	64	29	1.42	4.6	88	2				3.7																	H
0.6	3											3.8		1.1															
1.1	4					4.6																							
1.2	5					5.1						7.2																	
1.4	6	81	64	26	1.46							6.5																	
6.7	13																								54.7				
10.1	16d																			4.1	18	4.1	19						
10.4	16a																								8.6				
10.4	16b																								17.1				
10.7	16e																							24.7		26.6	18.1	0.18	
11.3																									30.0				
11.6	16f																							77.1		26.6	54.3	0.24	
12.2	17b																							55.9		26.4	35.9	0.37	
14.0	18																								118.8				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-2
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/09:42 AM)

Earth Mechanics

FUGRO

98-2		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
14.6	19d																							66.3		26.4	44.2	0.38	
15.5	19b																								127.1				
16.8	20c																							8.0		26.2	23.0		
16.8	20d																			18.6	40	21.4	32						
17.1	20a																								55.6				
17.4	20b																								25.7				
18.0	21d																							44.4		26.4	47.9	0.17	
19.5	21b																								81.3				
19.5	21a																								77.0				
19.5	21c																								98.4				
20.4	22a																							107.1		26.4	69.0	0.26	
20.7	22b																			0.0	24	1.4	21						
21.9	23a																							44.6		26.4	32.8	0.34	
22.6	23b																							108.1		26.6	50.0	0.18	
24.4	24c																			23.4	26	12.4	23						

Identification Tests
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C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-2
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/08:42 AM)

Earth Mechanics

FUGRO

98-2

DEPTH (m)	Sample No.	IDENTIFICATION TESTS: Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	STRENGTH ESTIMATE (kPa): Torvane	Pocket Pen.	MINIATURE VANE TESTS (kPa): Undist.	Remold.	Resid.	REMOTE VANE (kPa)	UU TRIAXIAL (kPa): Undist.	Remold.	MULTI-STAGE TRIAXIAL: c (kPa)	ϕ (deg.)	DIRECT SHEAR TESTS: Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	q_u TESTS (MPa): UC	Point Load Test	OTHER ROCK PARAMETERS: Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	ADDITIONAL TESTS
24.4	24d																							65.8		26.4	40.6	0.27	
26.1	25e																							100.2		26.6	35.5	0.19	
26.5	25a																								92.0				
27.3	25f																							11.0		26.4	31.4	0.25	
27.7	25c																								98.4				
27.7	25b																								81.3				
28.7	26a																								94.2				
29.0	26d																							69.0		26.2	50.7	0.33	
29.3	26b																								124.1				
30.5	26c																								85.6				
31.4	27a																								199.4				
31.7	27c																							87.9		26.6	40.1	0.20	
32.3	27b																								119.8				
33.2	28a																								164.8				
34.4	28d																							52.3		26.4	42.1	0.27	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-2
SFOBB East Span Seismic Safety Project

PLATE 98-2.6c

80035SMA(8/12/98/09:42 AM)

Earth Mechanics

FUGRO

98-2		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
34.7	28c																								160.5				
35.1	28b																								130.5				
35.7	29a																								175.5				
35.7	29d																			57.9	42	39.3	36						
36.3	29b																								130.5				
37.5	30																								34.2				
38.7	30b																							46.8		26.2	20.6	0.18	
39.3	31a																								30.0				
39.3	31b																								12.8				
39.6	31c																							6.5		26.4	22.3	0.35	
41.1	34a																								55.6				
41.1	32a																								27.8				
41.5	32c																							58.8		26.4	31.4	0.38	
41.6	32b																								42.8				
44.2	33c																							33.7		26.2	47.9	0.24	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-2
SFOBB East Span Seismic Safety Project

PLATE 98-2.6d

B003SSMA/8/12/98/08:42 AM

Earth Mechanics

FUGRO

98-2		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
44.5	33a																								59.9				
45.4	33b																								25.7				
48.5	34b																								160.5				
49.4	35c																							23.7		26.9	55.6		
50.0	35a																								89.9				
50.0	35b																								98.4				
52.7	36																								115.5				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

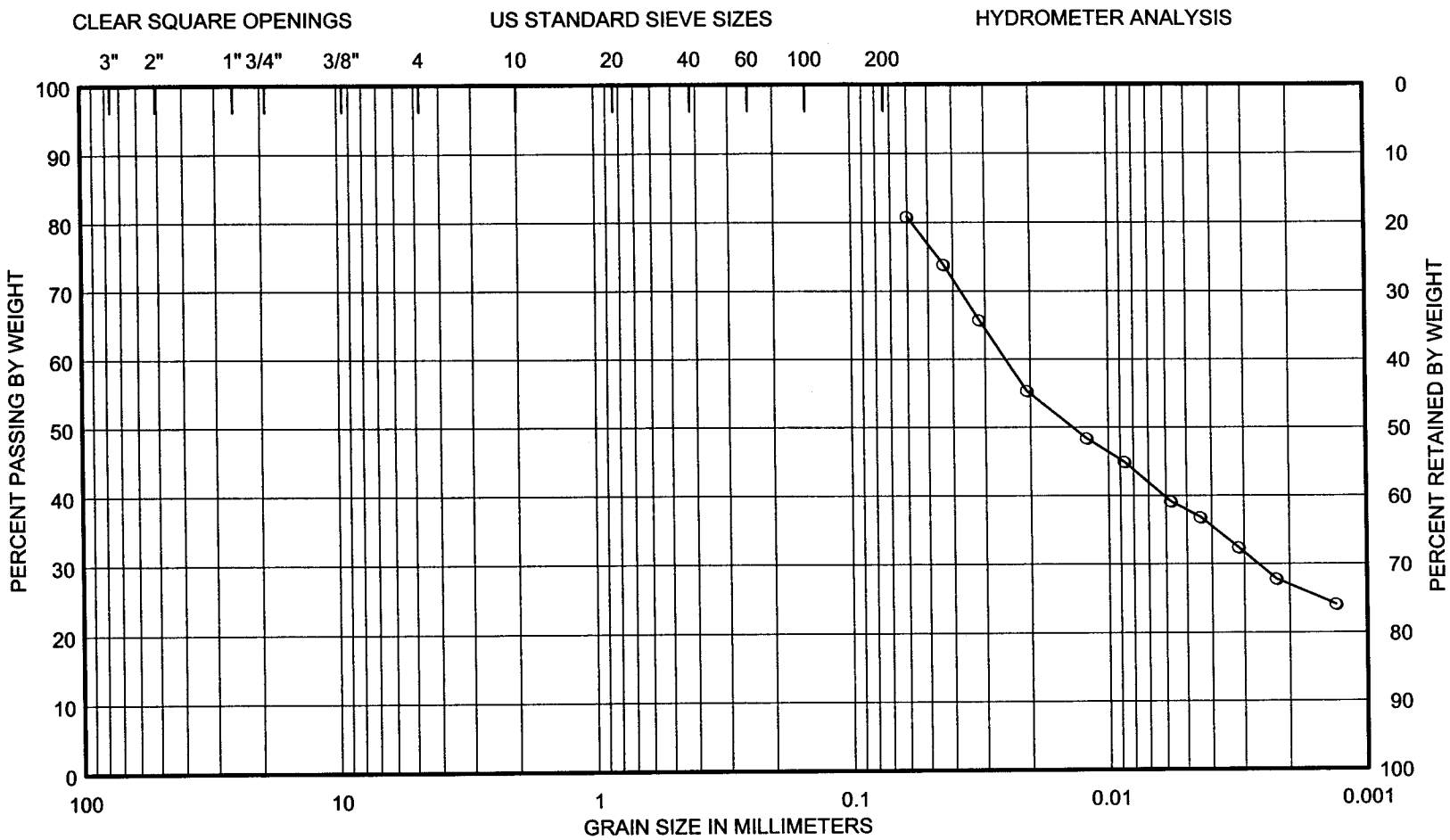
Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-2
SFOBB East Span Seismic Safety Project

PLATE 98-2.6e

3003SSMA(8/12/98/08:42 AM)



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
2	0.5	⊙——⊙	FAT CLAY (CH) with sandy silt pockets

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-2

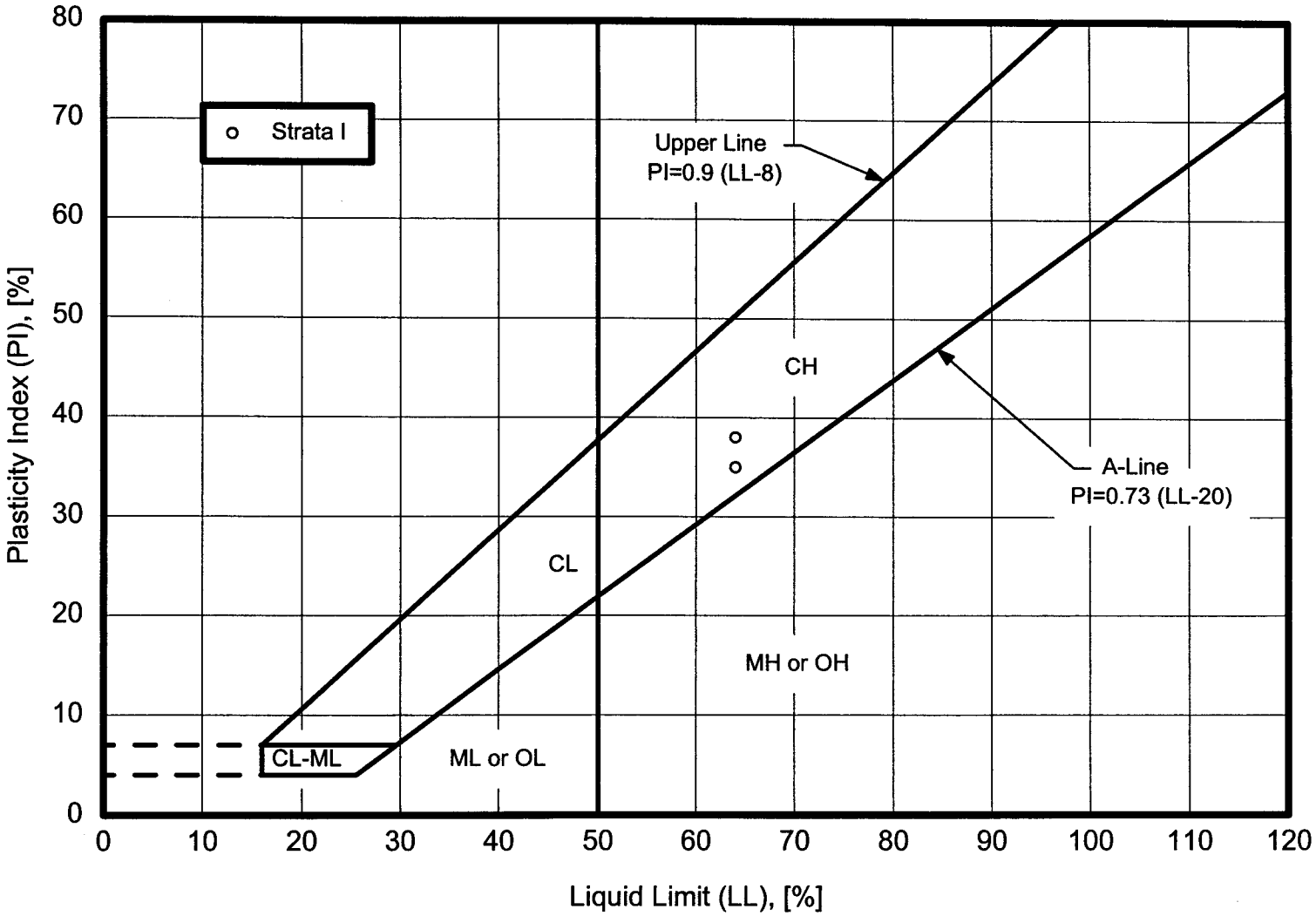
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-2.7



PLASTICITY CHART
Boring 98-2
SFOBB East Span Seismic Safety Project

Earth Mechanics
FUGRO

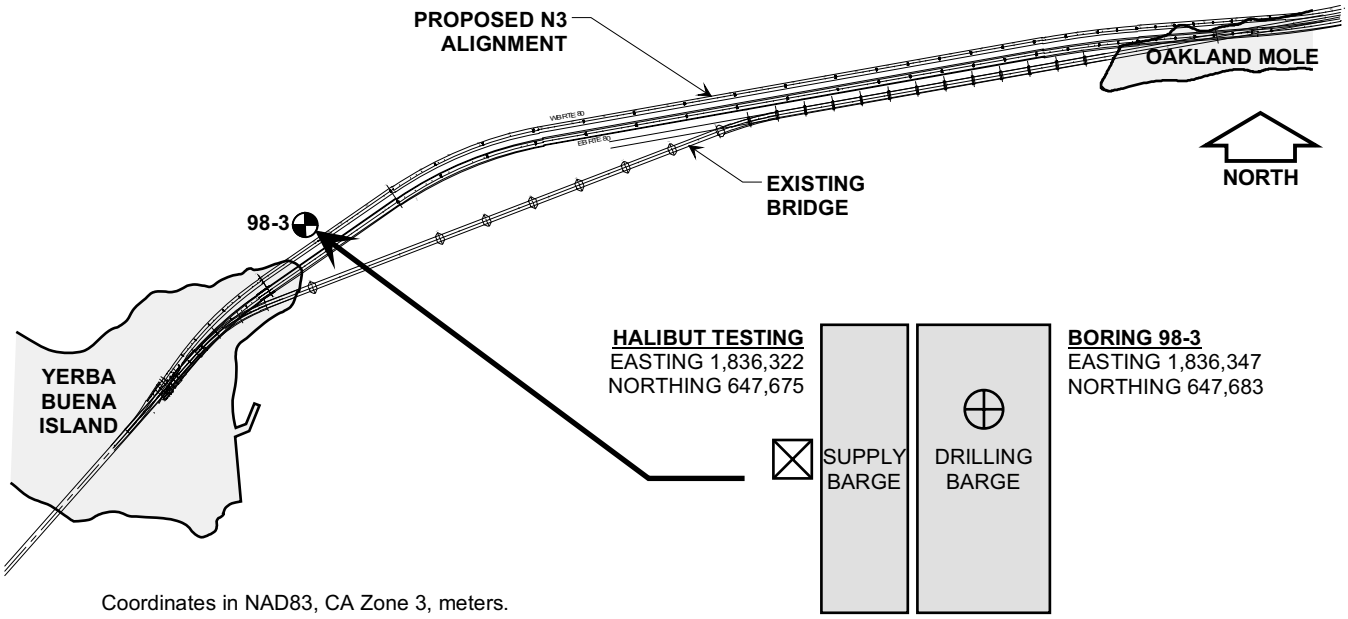
BORING 98-3

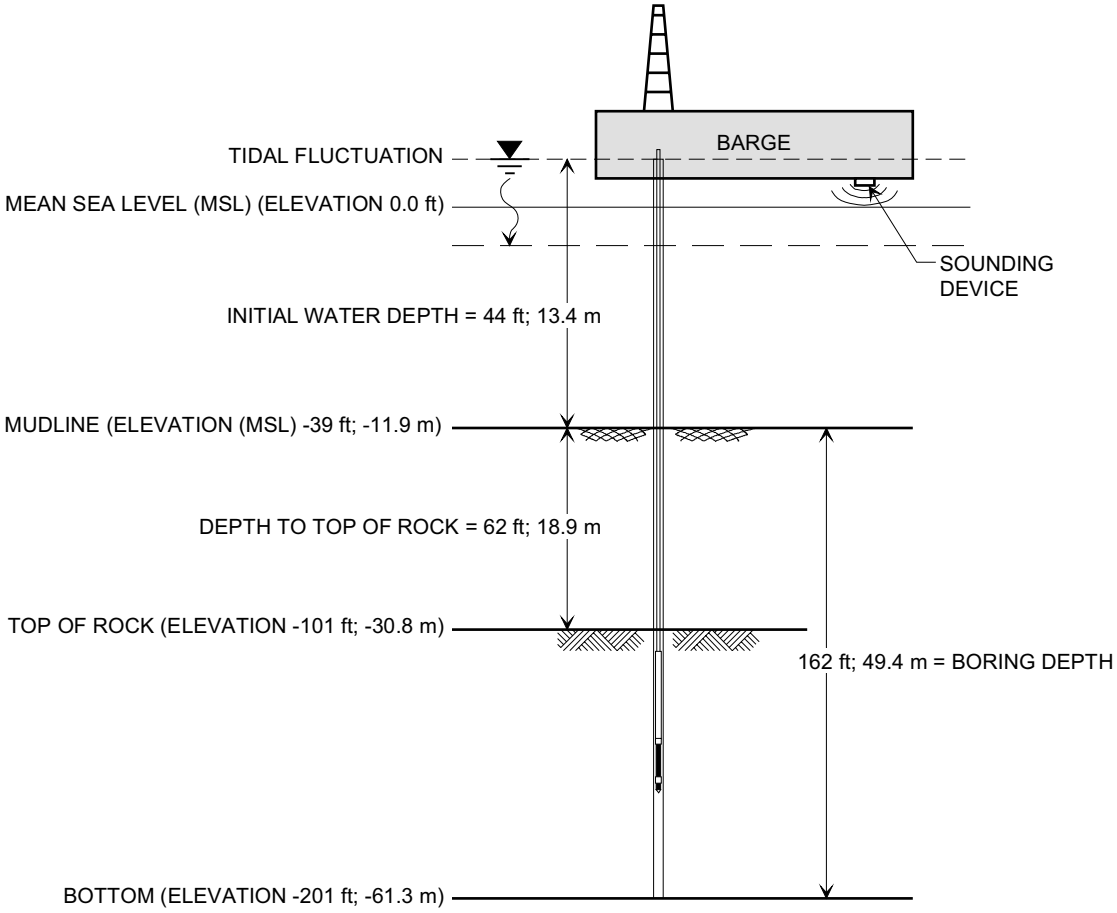
Date	Time From	Time To	Description of Activity
February 25, 1998	0900	*1400	Crew travels from Houston, Texas and arrives at Oakland, California.
			*Note: switch to local time.
	1400	1430	Travel to Alameda motel. Two crew members check in. Remaining crew travels to Vallejo and checks into motel.
	1430	1900	Check out mobilization facility on Mare Island and prepare for mobilization.
	1900	2400	Standby.
February 26, 1998	0000	0700	Standby.
	0700	1930	Perform mobilization activities at CS Marine dock on Mare Island, California.
	1930	2400	Standby.
February 27, 1998	0000	0700	Standby.
	0700	1900	Perform mobilization activities at CS Marine dock.
	1900	2400	Standby.
February 28, 1998	0000	0700	Standby.
	0700	1900	Perform mobilization activities at CS Marine dock.
	1900	2400	Standby.
March 1, 1998	0000	0700	Standby.
	0700	1200	Perform mobilization activities at CS Marine dock.
	1200	1845	Travel to Alameda. Barge travels to boring location 98-3.
	1845	1945	Barge arrives at location 98-3.
	1915	1940	Crew travels to dock.
	1940	2010	Wait on crew boat.
	2010	2040	Travel to west barge, pick up supplies, travel to east barge.
	2040	2330	Set up mud pits and vane equipment.
	2330	2400	Rig-up to drill and sample.
March 2, 1998	0000	0100	Run drill pipe to mudline.
	0100	0130	Measure water depth of 13.4m (44 ft) using bottom sensor. Current tide level is approximately +1.5m (+5.0 ft) MSL. Calculate mudline elevation of -11.9m (-39 ft) MSL.
	0130	0530	Drill and sample 0m (0 ft) to 8.8m (29 ft) penetration.
	0530	0630	Pull drill pipe to deck and prepare to set casing.
	0630	1650	Set casing. Drill and sample 8.8m (29 ft) to 13.4m (44 ft).
	1650	1730	Repair mud pump hose.
	1730	2400	Drill and sample 13.4m (44 ft) to 16.2m (53 ft).
March 3, 1998	0000	0315	Drill and sample 16.2m (53 ft) to 17.7m (58 ft).

SUMMARY OF FIELD OPERATIONS
Boring 98-3
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
March 3, 1998	0315	0525	Mix mud. Repair mud pump hose.
	0525	0540	Dump mud pit.
	0540	0700	Drill and sample 18.2m (60 ft) to 18.9m (62 ft). Hit bedrock at 18.9m (62 ft) penetration.
	0700	1200	Prepare for rock coring.
	1200	2400	Rock coring 18.9m (62 ft) to 26.8m (88 ft) penetration.
	*	*	* * * * * *
	1400	2300	Run Halibut at 0.6m (2 ft) intervals from 0.6m (2 ft) to 4.3m (14 ft) penetration.
	*	*	* * * * * *
March 4, 1998	0000	0645	Rock coring 26.8m (88 ft) to 34.4m (113 ft) penetration.
	*	*	* * * * * *
	0100	0330	Run Halibut at 4.9m (16 ft) to 5.5m (18 ft) penetration.
	*	*	* * * * * *
	0645	0710	Fuel and grease drill rig.
	0710	1755	Rock coring 34.4m (113 ft) to 49.4m (162 ft) penetration.
	1755	2000	Velocity profiling.
	2000	2030	Wait on Welenco (Acoustic and E-logging personnel).
	2225	2235	Pull core pipe to deck.
	2235	2400	Acoustic logging by Welenco.
March 5, 1998	0000	0115	Acoustic logging.
	0115	0215	Pull drill pipe to deck.
	0215	0500	Downhole logging. Prepare to grout drill hole.
	0500	0800	Grout borehole and pull casing.
	0800	1000	Pull anchors. Position barge on boring location 98-4, northeast of Pier E2, and set four-point anchor spread.

SUMMARY OF FIELD OPERATIONS
Boring 98-3
SFOBB East Span Seismic Safety Project





BORING 98-3 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-3.2

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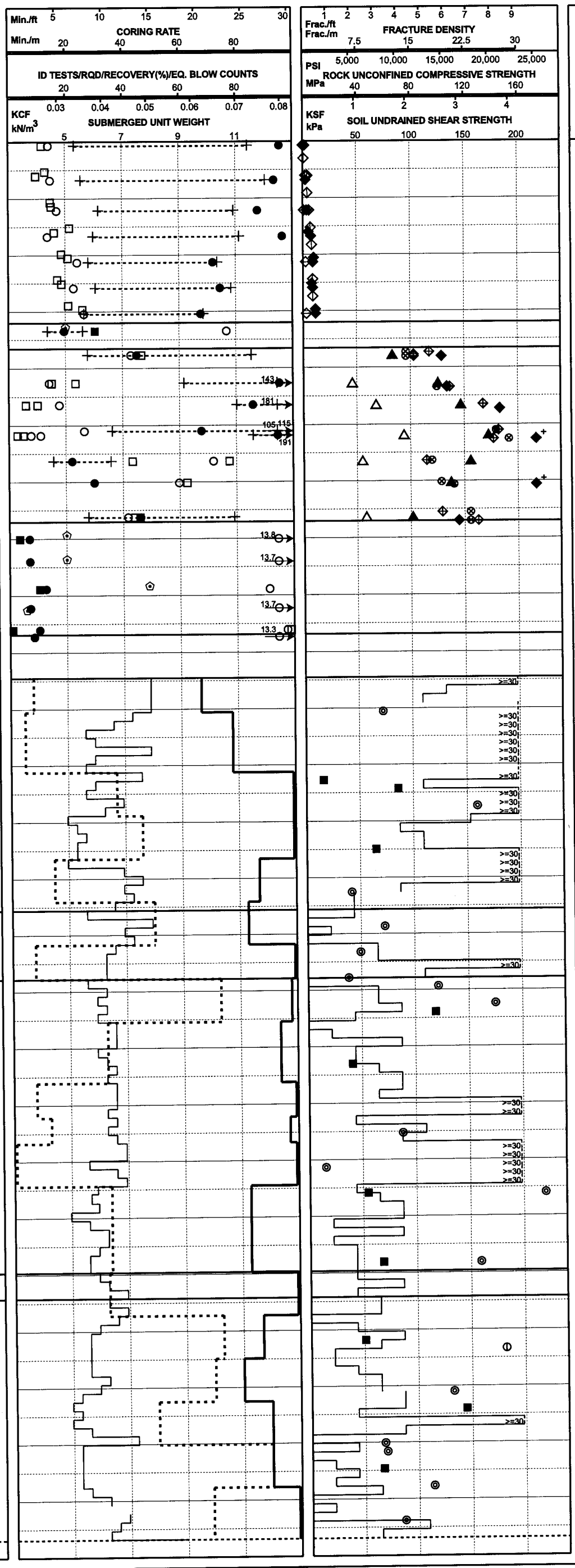
PROJECT NO:	98-42-0035	**START DATE:**	3/1/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-3 (Northeast of Pier E2)	**COMPLETION DATE:**	3/5/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836347 N647682
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -11.9 m (MSL)

Stratum	Material Description	Depth (m)
I	Fat CLAY (CH), very soft, dark olive gray -with silt pockets, shell fragments and black streaks -with worm holes at 0.9m, and organic matter pockets below 0.9m -with mica below 3.7m	(6.4m)
II	Sandy Lean CLAY (CL), olive gray, very stiff, with a silty fine sand seam, at 6.4m	(7.3m)
III	Fat CLAY (CH), very stiff, greenish gray -with an H2S odor to 12.5m -with brown and black organic matter pockets to 11.3m -with coarse gravel and many dark brown to black organic clay seams, at 8.5m -with sand pockets and a trace of gravel, at 11.0m -lean clay with sand, at 11.9m -with sand pockets and a few sand seams, at 13.1m	(13.4m)
IV	Fine GRAVEL with fine to coarse sand (GP-GC), dense to very dense, dark greenish gray, angular to subrounded -slightly cemented, brown, silty sand with gravel pockets, at 16.5m	(17.4m)
V	Silty GRAVEL with sand (GM), very dense, brown -with layers of coarse gravel consisting of intensely weathered, moderately hard brown sandstone -with brown slightly clayey silt infilling at18.3m	(18.9m)
VI	SANDSTONE (Graywacke) (RX), dark greenish gray to grayish black, moderately to slightly weathered, moderately hard to very hard, fine grained, moderately to intensely fractured into pieces generally less than 75mm long See Plate 98-3.6 for detailed stratigraphy below 18.9m	(27.1m)
VII	SILTSTONE (RX), dark gray, slightly weathered, moderately hard to hard, moderately fractured	(29.6m)
VIII	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered, hard to very hard, slightly fractured -with thinly interbedded claystone, 35.2m to 35.7m -vertical fractures, 35.7m to 36.9m -with a 300mm-thick claystone bed dipping about 15 degrees, 38.6m to 38.9m	(39.9m)
IX	SILTSTONE (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) and CLAYSTONE (RX), light to dark gray, fresh, moderately hard, moderately fractured	(40.8m)
X	SANDSTONE (Graywacke) (RX), light gray, fresh, moderately hard to hard, thickly bedded, moderately fractured -thinly interbedded siltstone and claystone, dipping 30 degrees, 48.3m to 48.8m SANDSTONE (Graywacke) (RX), below 48.8m	

TOTAL DEPTH: 49.4 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-3

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

FUGRO

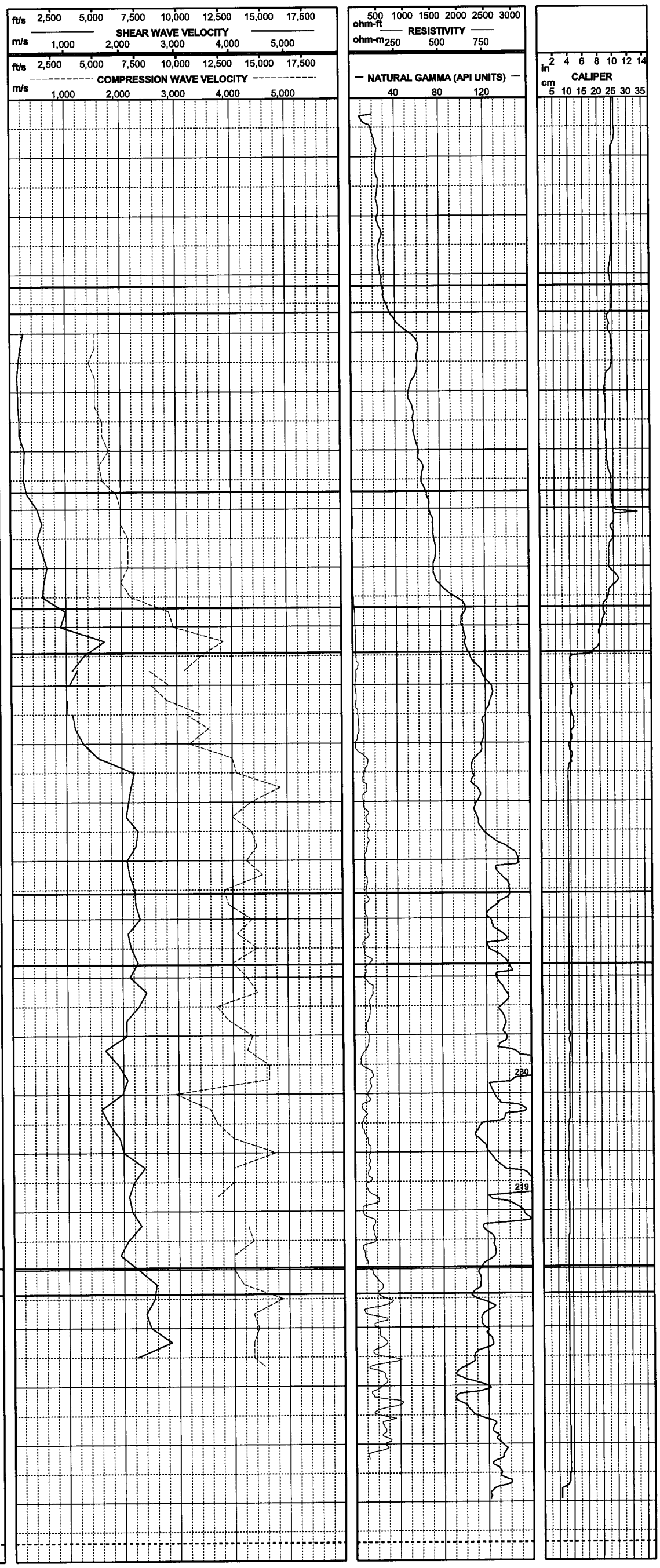
PLATE 98-3.3

PROJECT NO: 98-42-0035
BORING: 98-3 (Northeast of Pier E2)
START DATE: 3/1/98
COMPLETION DATE: 3/5/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836347 N647682
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -11.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
			Fat CLAY (CH), very soft, dark olive gray -with silt pockets, shell fragments and black streaks	I
-13		WOH		
	2	WOH	-with worm holes at 0.9m, and organic matter pockets below 0.9m	
-15		WOH		
	4	WOH	-with mica below 3.7m	
-17		WOH		
	6	WOH	(6.4m)	
-19		20	Sandy Lean CLAY (CL), olive gray, very stiff, with a silty fine sand seam, at 6.4m (7.3m)	II
	8	18/60cm	Fat CLAY (CH), very stiff, greenish gray -with an H2S odor to 12.5m	III
-21		PUSH	-with brown and black organic matter pockets to 11.3m	
	10	PUSH	-with coarse gravel and many dark brown to black organic clay seams, at 8.5m	
-23		PUSH	-with sand pockets and a trace of gravel, at 11.0m	
	12	PUSH	-lean clay with sand, at 11.9m	
-25		PUSH	-with sand pockets and a few sand seams, at 13.1m (13.4m)	
	14	50/30cm	Fine GRAVEL with fine to coarse sand (GP-GC), dense to very dense, dark greenish gray, angular to subrounded	IV
-27		50/30cm		
	16	49	-slightly cemented, brown, silty sand with gravel pockets, at 16.5m	
-29		6	(17.4m)	
	18	30/30cm 30/30cm 100/10cm 30/15cm 30/5cm	Silty GRAVEL with sand (GM), very dense, brown -with layers of coarse gravel consisting of intensely weathered, moderately hard brown sandstone with brown slightly clayey silt infilling at18.3m (18.9m)	V
-31	20	67-8	SANDSTONE (Graywacke) (RX), dark greenish gray to grayish black, moderately to slightly weathered, moderately hard to very hard, fine grained, moderately to intensely fractured into pieces generally less than 75mm long	VI
-33		78-5		
	22			
-35		100-37	See Plate 98-3.6a for detailed stratigraphy below 18.9m	
	24	100-46		
-37				
	26	87-15	(27.1m)	
-39	28	83-50	SILTSTONE (RX), dark gray, slightly weathered, moderately hard to hard, moderately fractured	VII
-41		100-8	(29.6m)	
	30	98-73	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered, hard to very hard, slightly fractured	VIII
-43				
	32	94-33		
-45				
	34	100-8		
-47		97-13	-with thinly interbedded claystone, 35.2m to 35.7m -vertical fractures, 35.7m to 36.9m	
	36	100-0		
-49				
	38	83-34	-with a 300mm-thick claystone bed dipping about 15 degrees, 38.6m to 38.9m	
-51			(39.9m)	
	40	100-33	SILTSTONE (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) and CLAYSTONE (RX), light to dark gray, fresh, moderately hard, moderately fractured (40.8m)	IX
-53			SANDSTONE (Graywacke) (RX), light gray, fresh, moderately hard to hard, thickly bedded, moderately fractured	X
	42	87-73		
-55				
	44	80-70		
-57		90-50		
	46			
-59		90-90		
	48	100-69	-thinly interbedded siltstone and claystone, dipping 30 degrees, 48.3m to 48.8m SANDSTONE (Graywacke) (RX), below 48.8m	
-61			TOTAL DEPTH: 49.4 m BACKFILLED WITH: Cement Grout	



LOG OF BORING AND TEST RESULTS

BORING 98-3

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

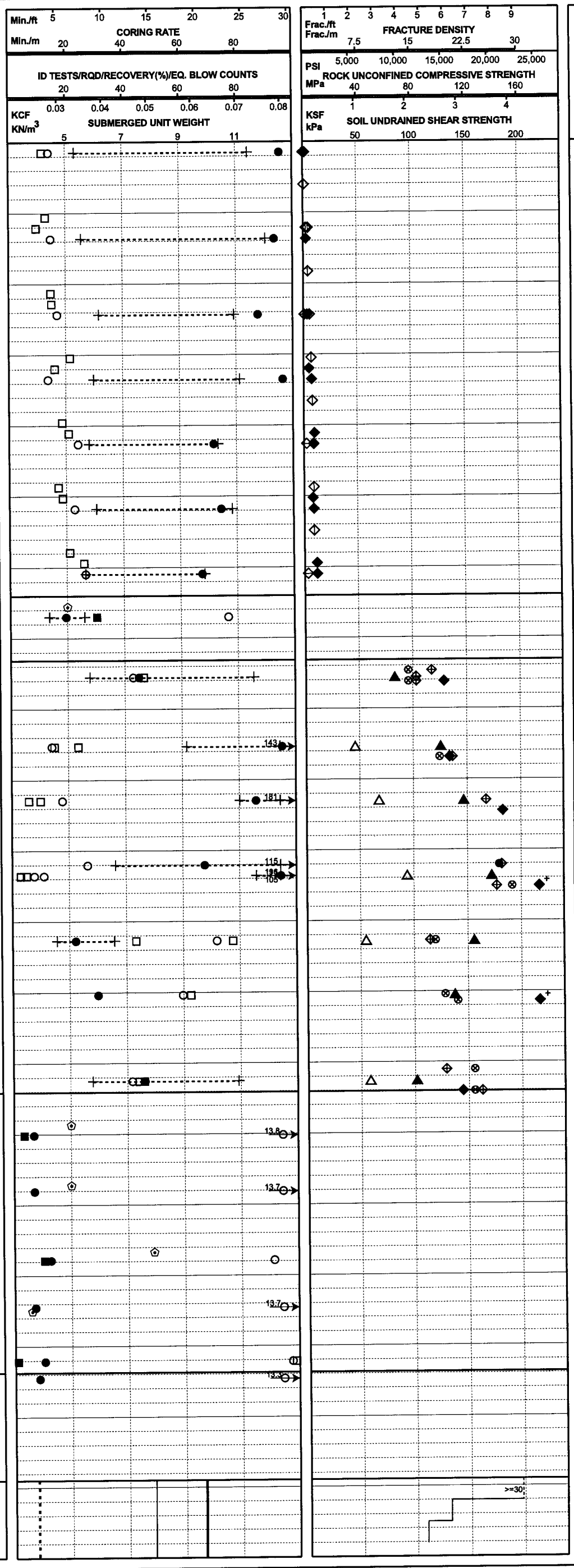
PLATE 98-3.4

PROJECT NO: 98-42-0035
BORING: 98-3 (Northeast of Pier E2)
START DATE: 3/1/98
COMPLETION DATE: 3/5/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836347 N647682
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -11.9 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-12				WOH	Fat CLAY (CH), very soft, dark olive gray -with silt pockets, shell fragments and black streaks	I
-13	1			WOH		
-14	2			WOH	-with worm holes at 0.9m, and organic matter pockets below 0.9m	
-15	3			WOH		
-16	4			WOH	-with mica below 3.7m	
-17	5			WOH		
-18	6			WOH	(6.4m)	
-19	7			20	Sandy Lean CLAY (CL), olive gray, very stiff, with a silty fine sand seam, at 6.4m (7.3m)	II
-20	8			18/60cm	Fat CLAY (CH), very stiff, greenish gray -with an H2S odor to 12.5m -with brown and black organic matter pockets to 11.3m	III
-21	9			PUSH	-with coarse gravel and many dark brown to black organic clay seams, at 8.5m	
-22	10			PUSH		
-23	11			PUSH	-with sand pockets and a trace of gravel, at 11.0m	
-24	12			PUSH	-lean clay with sand, at 11.9m	
-25	13			PUSH	-with sand pockets and a few sand seams, at 13.1m (13.4m)	
-26	14			50/30cm	Fine GRAVEL with fine to coarse sand (GP-GC), dense to very dense, dark greenish gray, angular to subrounded	IV
-27	15			50/30cm		
-28	16			49		
-29	17			6	-slightly cemented, brown, silty sand with gravel pockets, at 16.5m	
				30/30cm	(17.4m)	
-30	18			30/30cm 100/10cm 30/15cm	Silty GRAVEL with sand (GM), very dense, brown -with layers of coarse gravel consisting of intensely weathered, moderately hard brown sandstone -with brown slightly clayey silt infilling at18.3m (18.9m)	V
-31	19			30/5cm 67-8	SANDSTONE (Graywacke) (RX), dark greenish gray to grayish black, moderately to slightly weathered, moderately hard to very hard, fine grained, moderately to intensely fractured into pieces generally less than 75mm long	VI



LOG OF BORING AND TEST RESULTS

BORING 98-3

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

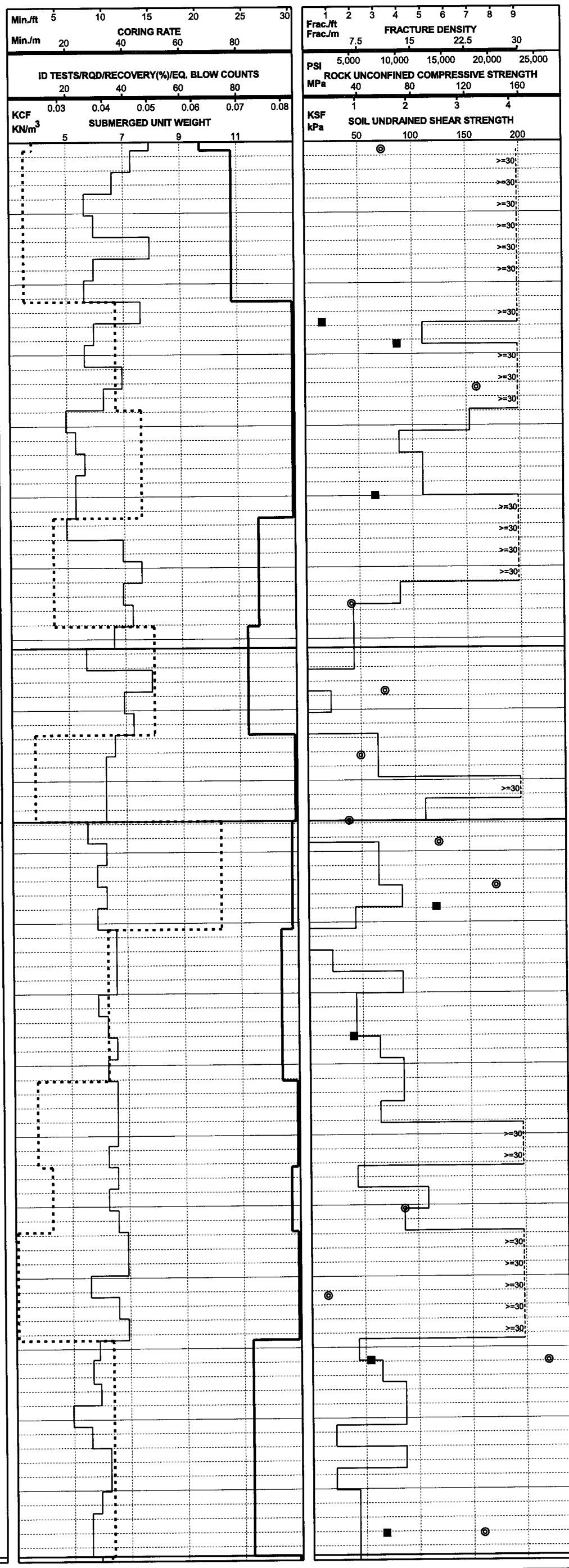
PLATE 98-3.5a

PROJECT NO:	98-42-0035	**START DATE:**	3/1/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-3 (Northeast of Pier E2)	**COMPLETION DATE:**	3/5/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836347 N647682
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -11.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-32		67-8	SANDSTONE (Graywacke) (RX), dark greenish gray to grayish black, moderately to slightly weathered, moderately hard to very hard, fine grained, moderately to intensely fractured into pieces generally less than 75mm long -intensely fractured, 20.1m to 22.3m	
-33	21	78-5	-with very thinly interbedded siltstone at 21.6m	
-34	22		-grayish black, slightly weathered, moderately fractured, slightly to moderately rough, with yellowish orange staining, below 22.3m -with very thin (1mm- to 2mm-thick) calcite/quartz fracture filling at 60 degrees, below 22.6m	
-35	23	100-37		VI
-36	24	100-46	-slightly to moderately rough fractures at 35 to 45 degrees with yellowish orange staining, 24.1m to 25.0m	
-37	25		-slightly to moderately rough fractures at 70 degrees to vertical, with very thin pale olive clay filling, 25.3m to 25.9m	
-38	26	87-15	-with thin to very thin (25mm- to 50mm-thick) claystone beds, at 25.9m and 26.2m	
-39	27		(27.1m)	
-40	28	83-50	SILTSTONE (RX), dark gray, slightly weathered, moderately hard to hard, moderately fractured -fractures inclined 45 degrees with yellowish orange staining -with fine grained sandstone lenses below 27.9m	VII
-41	29	100-8	-with yellow staining along fracture surfaces at 28.7m -intensely fractured, 29.0m to 29.3m -with a vertical fracture and yellowish orange staining, at 29.3m	
			(29.6m)	
-42	30	98-73	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered, hard to very hard, slightly fractured -with tight, closed fractures inclined at 30 to 60 degrees, with iron oxide staining and some 1mm- to 6mm-thick calcite/quartz filling on high-angle fractures	
-43	31		-moderately fractured at 31.1m	
-44	32	94-33	-with a thin near vertical fracture, 32.0m to 32.9m	
-45	33		-intensely fractured, near vertical fractures with discontinuous calcite/quartz filling, 33.2m to 36.9m -with a thin (40mm thick) claystone layer dipping at 45 degrees, at 33.2m	
-46	34	100-8	-vertical fracture with up to 3mm-thick calcite/quartz filling, 33.2m to 34.1m -intensely fractured, 33.2m to 34.4m -bedding at 45 degrees at 34.1m -with a black 200mm-thick siltstone layer at 34.3m	VIII
-47	35	97-13	-with thinly interbedded claystone, 35.2m to 35.7m -vertical fractures, 35.7m to 36.9m	
-48	36	100-0	-with thin (3mm) white mineralization at 36.0m	
-49	37		-moderately fractured with thinly interbedded claystone, 36.9m to 39.9m -with a thin (50mm-thick) claystone bed dipping about 15 degrees, at 37.3m	
-50	38	83-34	-with a 300mm-thick claystone bed dipping about 15 degrees, 38.6m to 38.9m	
-51	39	100-33	(39.9m)	IX



LOG OF BORING AND TEST RESULTS

BORING 98-3

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

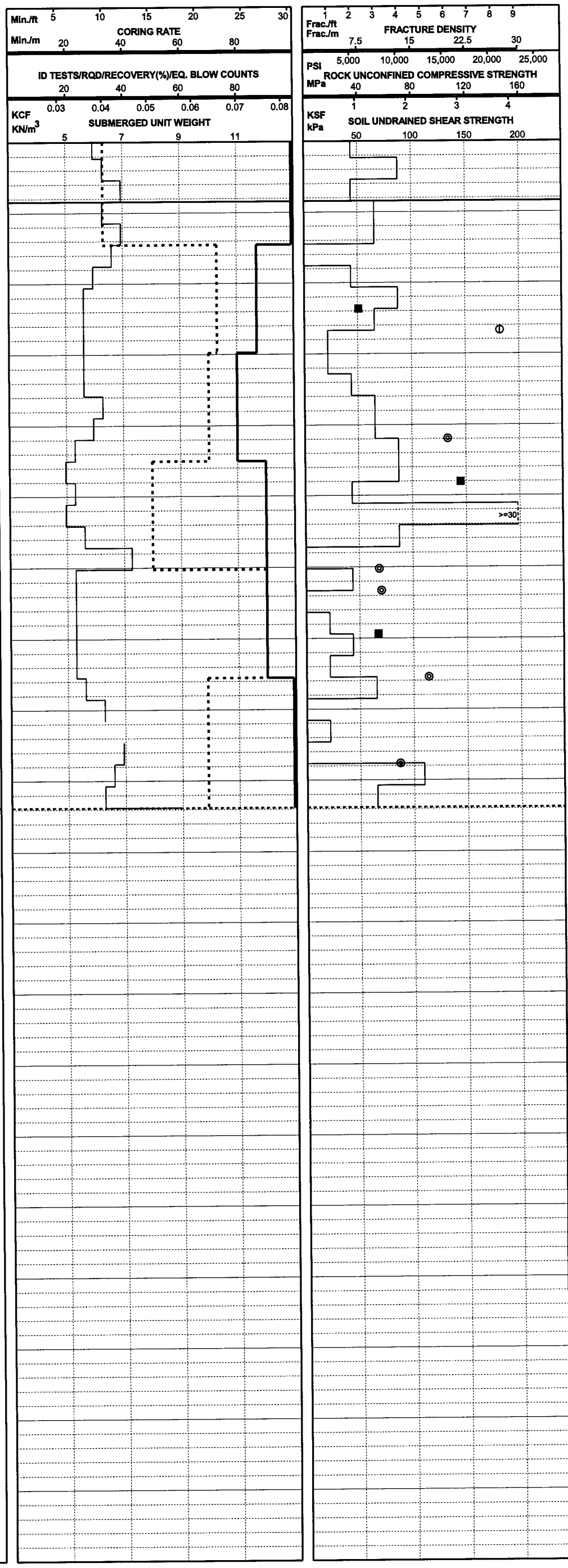
PLATE 98-3.5b

PROJECT NO:	98-42-0035	**START DATE:**	3/1/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-3 (Northeast of Pier E2)	**COMPLETION DATE:**	3/5/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836347 N647682
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -11.9 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-52			SILTSTONE (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) and CLAYSTONE (RX), light to dark gray, fresh, moderately hard, moderately fractured -with slightly polished surfaces parallel to bedding (40.8m)	IX
		100-33		
-53	41		SANDSTONE (Graywacke) (RX), light gray, fresh, moderately hard to hard, thickly bedded, moderately fractured -slightly rough fractures, with little to no mineralization -with healed fractures oriented at 60 degrees, thin calcite/quartz-filled fractures oriented at 45 degrees, 41.8m to 46.0m	X
-54	42	87-73	-with a 150mm-thick dark gray siltstone bed, at 42.1m	
-55	43			
-56	44	80-70	-with 1mm- to 3mm-thick calcite/quartz-filled fractures oriented at 70 degrees, at 44.5m	
-57	45	90-50		
-58	46		-with a vertical fracture at 46.0m -with laminated siltstone at 46.5m	
-59	47	90-90	-with smooth to slightly rough, thin (less than 1mm) calcite/quartz-filled fractures oriented at 70 degrees, 47.5m to 49.4m	
-60	48	100-69	-with a thin claystone bed dipping 30 degrees, at 48.2m -thinly interbedded siltstone and claystone, dipping 30 degrees, 48.3m to 48.8m SANDSTONE (Graywacke) (RX), below 48.8m	
-61	49		TOTAL DEPTH: 49.4 m BACKFILLED WITH: Cement Grout	
-62	50			
-63	51			
-64	52			
-65	53			
-66	54			
-67	55			
-68	56			
-69	57			
-70	58			
-71	59			



LOG OF BORING AND TEST RESULTS

BORING 98-3

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-3.5c

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ó (deg.)	Peak c (kPa)	Peak ó (deg.)	Post Peak c (kPa)	Post Peak ó (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
0.2	1	96	84	23	1.18	4.2						1.7		0.3															
0.6	400														1.0														
1.1	2					4.3																							
1.2	3					4.0																							
1.2	401														2.4														
1.2	402														4.3														
1.4	4	94	91	26	1.05							2.6																	
1.8	403														4.3														
2.1	5					4.5																							
2.3	6					4.5																							
2.4	7	88	79	32	1.18				2.69			3.6		0.9															
2.4	404														5.7														
3.0	8					5.1																							
3.0	405														7.2														
3.2	9					4.6						5.2																	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ó = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

PLATE 98-3.6a

80035SMA(6/12/98/08:45 AM)

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
3.4	10	96	81	30	1.29							7.4																	
3.7	406														8.1														
4.0	11					4.9																							
4.1	12					5.1						10.1																	
4.3	13	72	74	28	0.96							8.8		2.6															
4.3	407														9.1														
4.9	14					4.7																							
4.9	408														9.1														
5.0	15					4.9						8.2																	
5.2	16	74	79	31	0.92							9.0																	
5.5	409														9.1														
5.8	17					5.1																							
5.9	18					5.6						11.5																	
6.1	19	68	69	27	0.98							11.7		3.3															
6.7	20	20	26	14	0.46		30																						H

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

PLATE 98-3.6b

6003SSMA(9/12/98/0:35 AM)

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
7.5	21									117.3	95.8																		
7.6	22	45	86	28	0.30					102.9																			
7.6	22	45				7.7										83.1													
7.6	23									102.9	95.8	128.9																	
8.5	24	95	143	62	0.41																								
8.5	24							9																					
8.5	24	95				4.5										125.4													
8.5	24					5.3											45.8												
8.7	25									136.5	124.5	133.8																	
9.3	26	86	181	80	0.06					167.6																			
9.3	26	86				4.0										146.6													
9.3	26					3.6											67.7												
9.4	27											183.1																	
10.2	28	68	115	36	0.40					181.9	179.6																		C
10.4	29	105	191	86	0.18			14	2.30																				

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

8003SSMAX(6/12/98/10:45 AM)

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
10.4	29	116				3.5										172.5													
10.4	29					3.3											93.8												
10.5	30									177.2	191.5	216.9																	
11.3	32	22	36	16	0.32					114.9	119.7																		
11.3	32	22				10.7										155.9													
11.3	32					7.3											54.9												
12.0	33										128.5																		
12.0	33	30				9.3										137.5													
12.1	34										140.2	216.9																	
13.1	35									129.3	155.6																		
13.3	36	46	79	28	0.36																								
13.3	36	46				7.4										101.7													
13.3	36					7.6											58.2												
13.4	37									162.8	155.6	144.6																	
14.0	38	7					4																						

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

8003SSMA(9/12/98/08:35 AM)

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
14.8	39	7																											
15.8	40	13					10																						
16.5	41	7																											
17.2	42	10				12.9	1																						
17.5	43	8																											
20.1	46																								57.8				
22.6	47d																							12.8		26.4	28.8		
22.9	47b																							68.6		26.4	29.2		
23.5	48																								127.7				
25.0	50b																							51.8		26.6	56.6	0.33	
26.4	51																								33.4				
27.7	52																								57.8				
28.0	52b																	689	53							26.2	21.8	0.38	
28.7	53																								39.5				
29.6	54																								30.4				

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/09:45 AM)

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
29.9	56																								97.3				
30.5	54b																								139.8				
30.8	54c																							94.9		26.6	41.0	0.27	
32.6	55a																							32.7		26.4	49.2		
34.1	56a																			9.7	25	16.5	27						
35.1	57a																								69.9				
36.3	58																								12.2				
37.2	59b																								176.3				
37.2	59d																							43.6		26.4	41.0	0.39	
39.5	57																								127.7				
39.6	59c																							54.6		26.4	39.2	0.26	
40.5	60b																			11.7	28	13.8	25						
42.4	61c																							40.6		26.4	53.9	0.19	
42.7	58																								145.9				
44.2	59																								106.4				

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/09:45 AM)

Earth Mechanics

FUGRO

98-3		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
44.8	63c																							115.7		26.2	55.6		
46.0	60																								54.7				
46.3	62																								56.2				
46.9	62e																							53.6		26.6	53.0	0.17	
47.5	63																								91.2				
48.8	67																								69.5				

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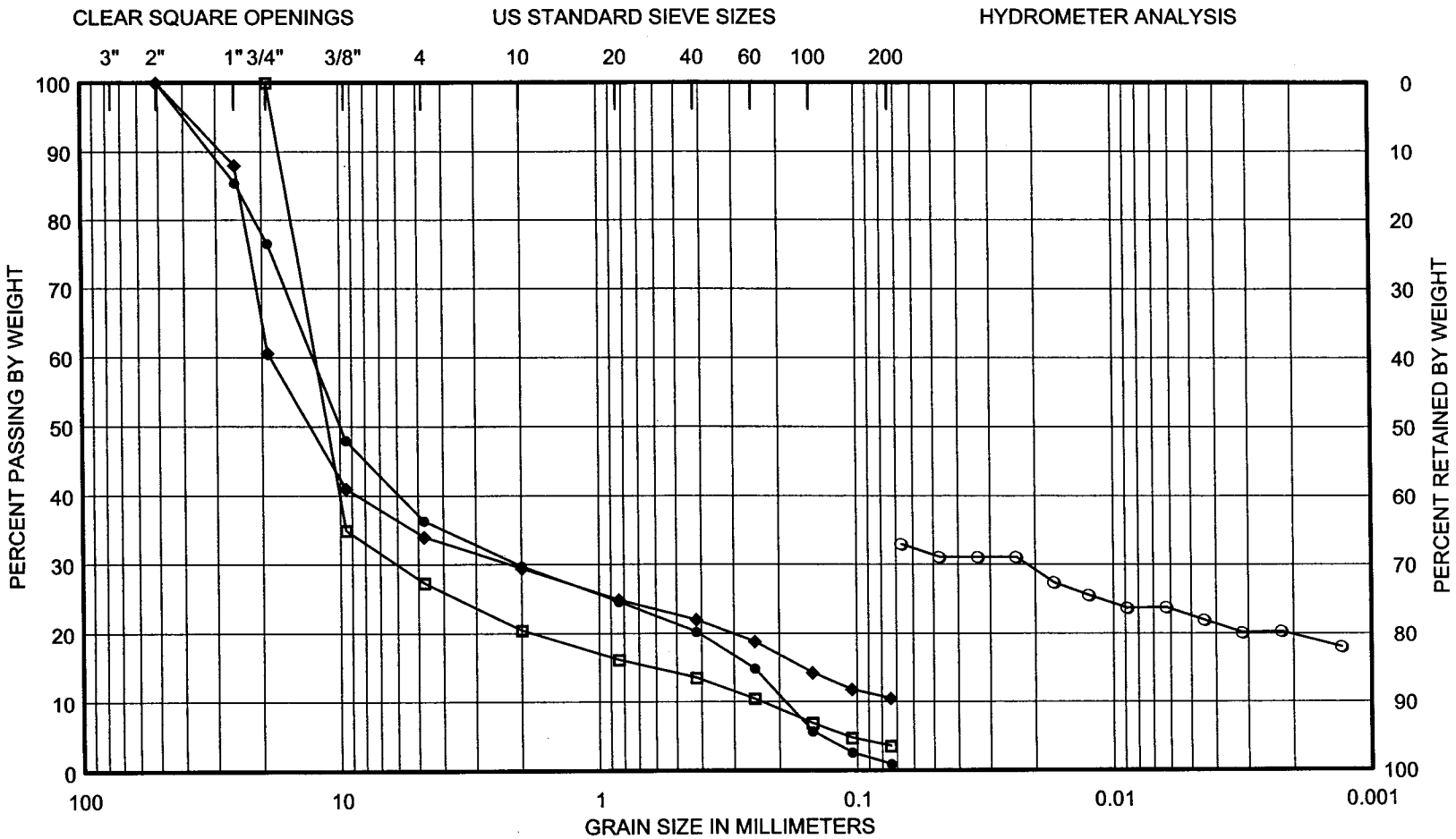
SUMMARY OF LABORATORY TEST RESULTS
BORING 98-3
SFOBB East Span Seismic Safety Project

3003SSMA(6/12/98/08:45 AM)



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
20	6.7	○—○	CLAYEY SAND (SC)
38	14.0	□—□	FINE GRAVEL (GP) with fine to coarse sand
40	15.8	◆—◆	GRAVEL (GP-GM) with silt and sand
42	17.2	●—●	FINE WITH COARSE GRAVEL (GP) with fine to coarse sand

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-3

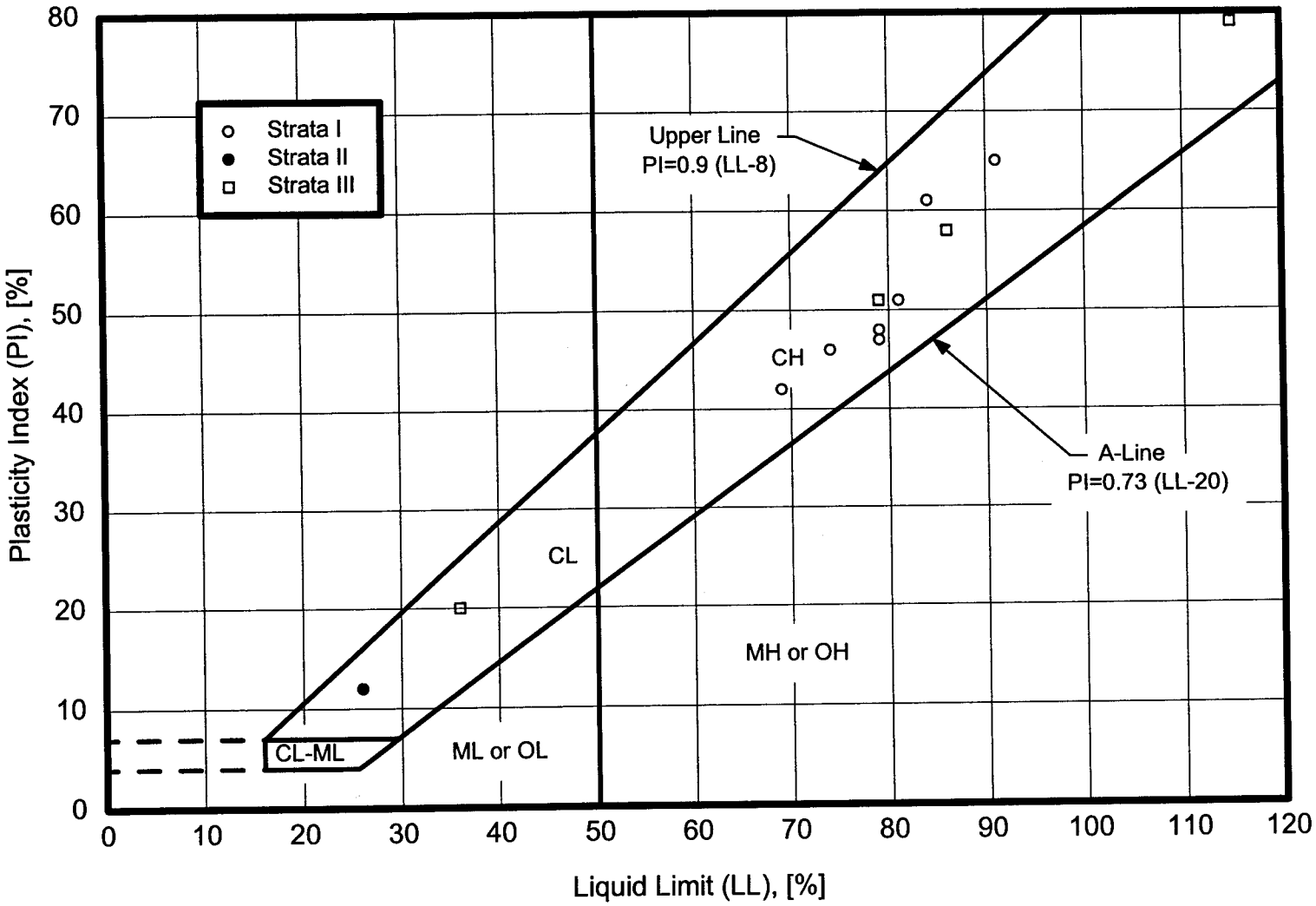
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

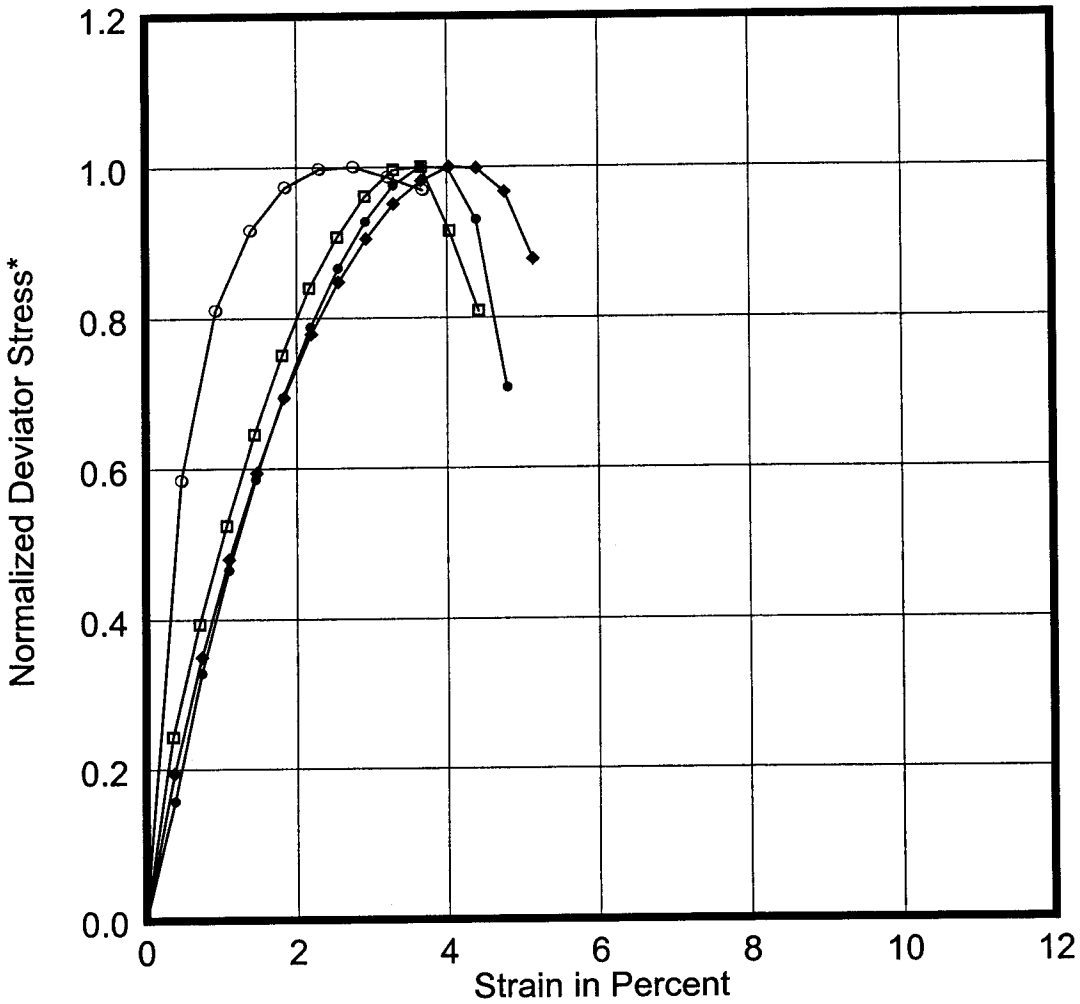
FUGRO

PLATE 98-3.7



PLASTICITY CHART
Boring 98-3
SFOBB East Span Seismic Safety Project

Earth Mechanics
FUGRO



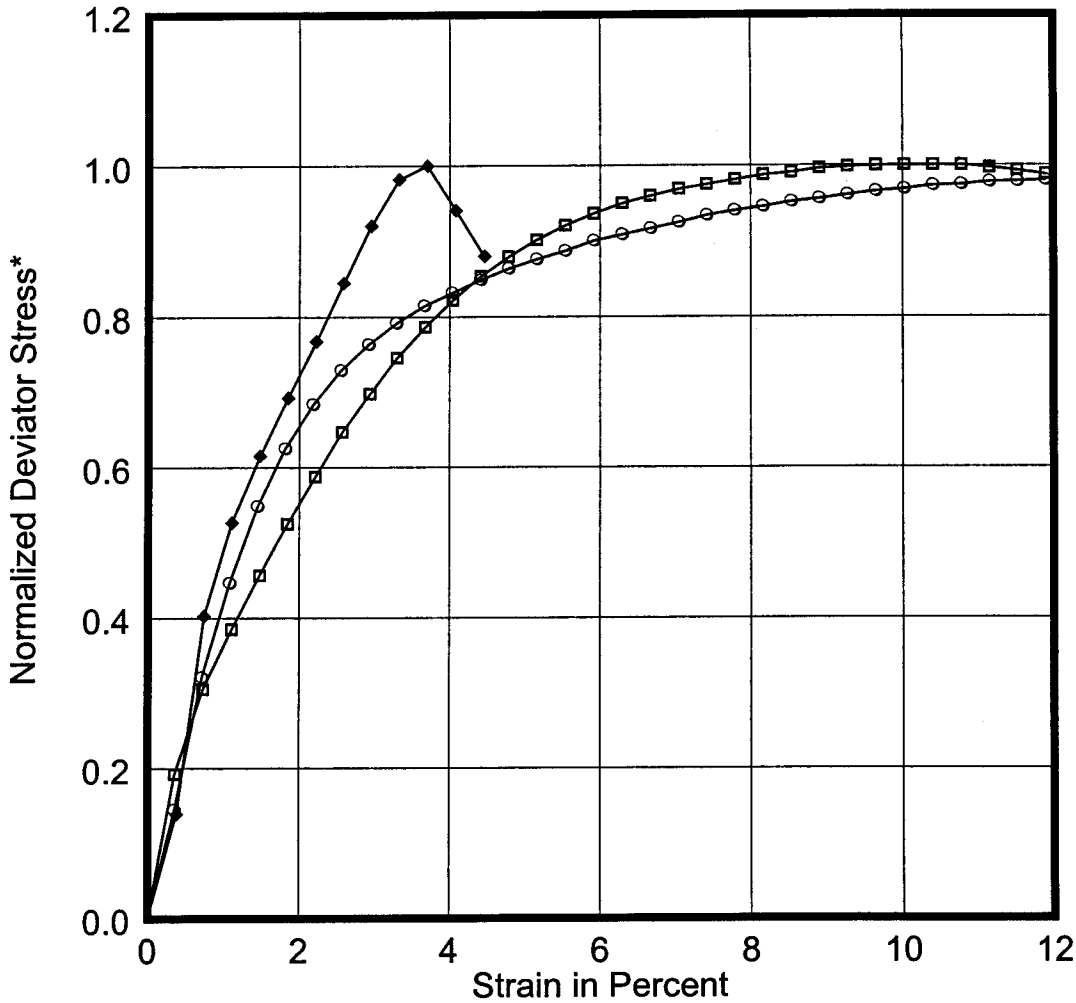
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	22	7.6	UU	827	166	0.4
□——□	24	8.5	UU	827	251	1.0
◆——◆	26	9.3	UU	1724	293	1.2
●——●	29	10.4	UU	1724	345	1.2

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-3
SFOBB - East Span Seismic Safety Project

PLATE 98-3.9a



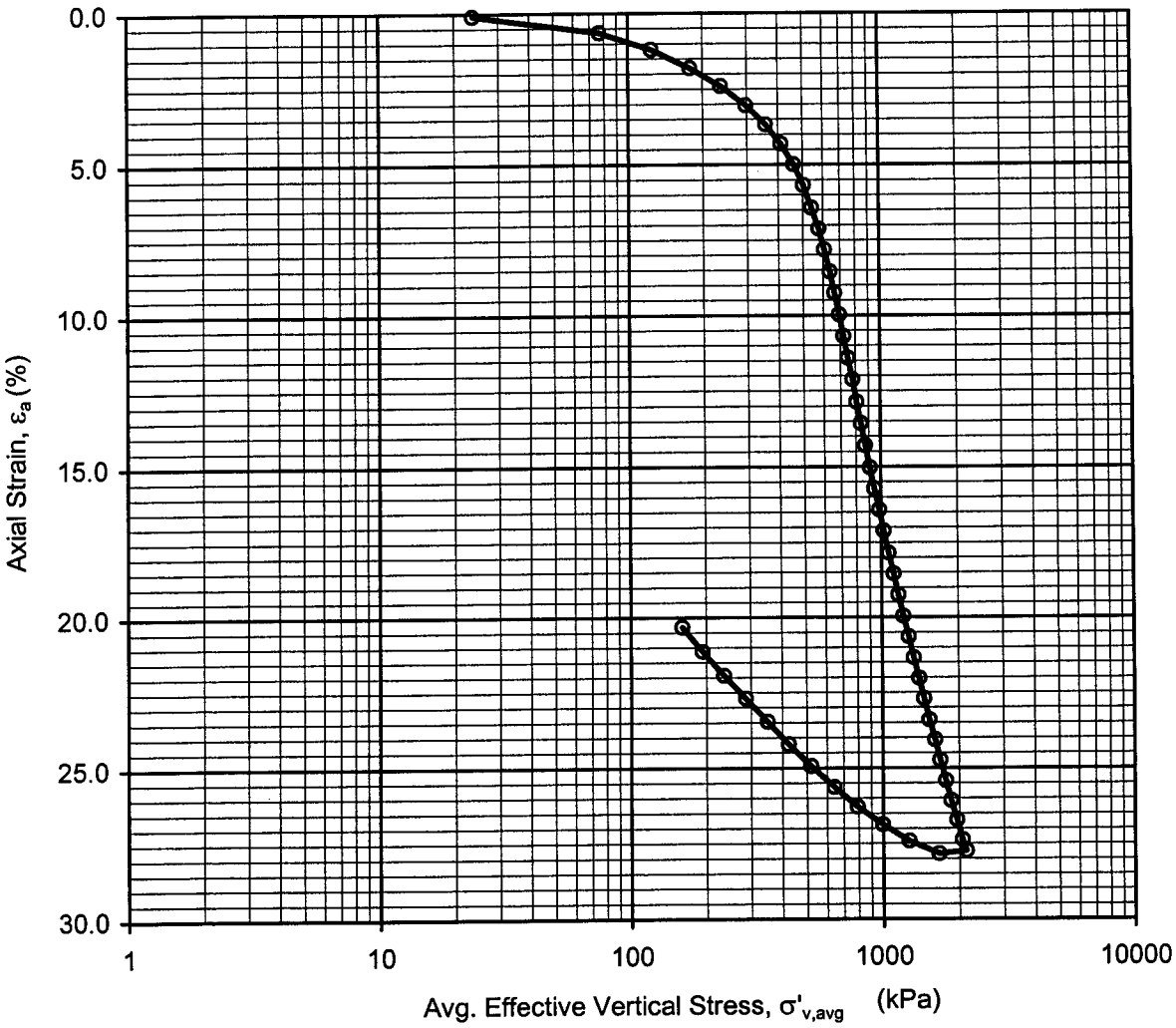
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	32	11.3	UU	827	312	1.3
□——□	33	12.0	UU	827	275	1.7
◆——◆	36	13.3	UU	827	203	1.0

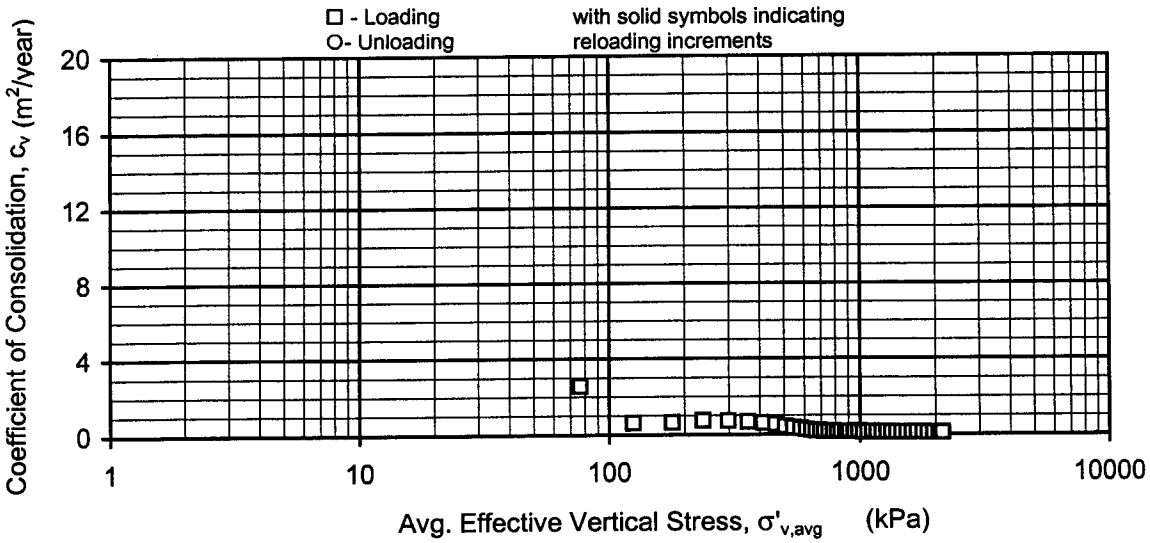
* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-3
SFOBB - East Span Seismic Safety Project

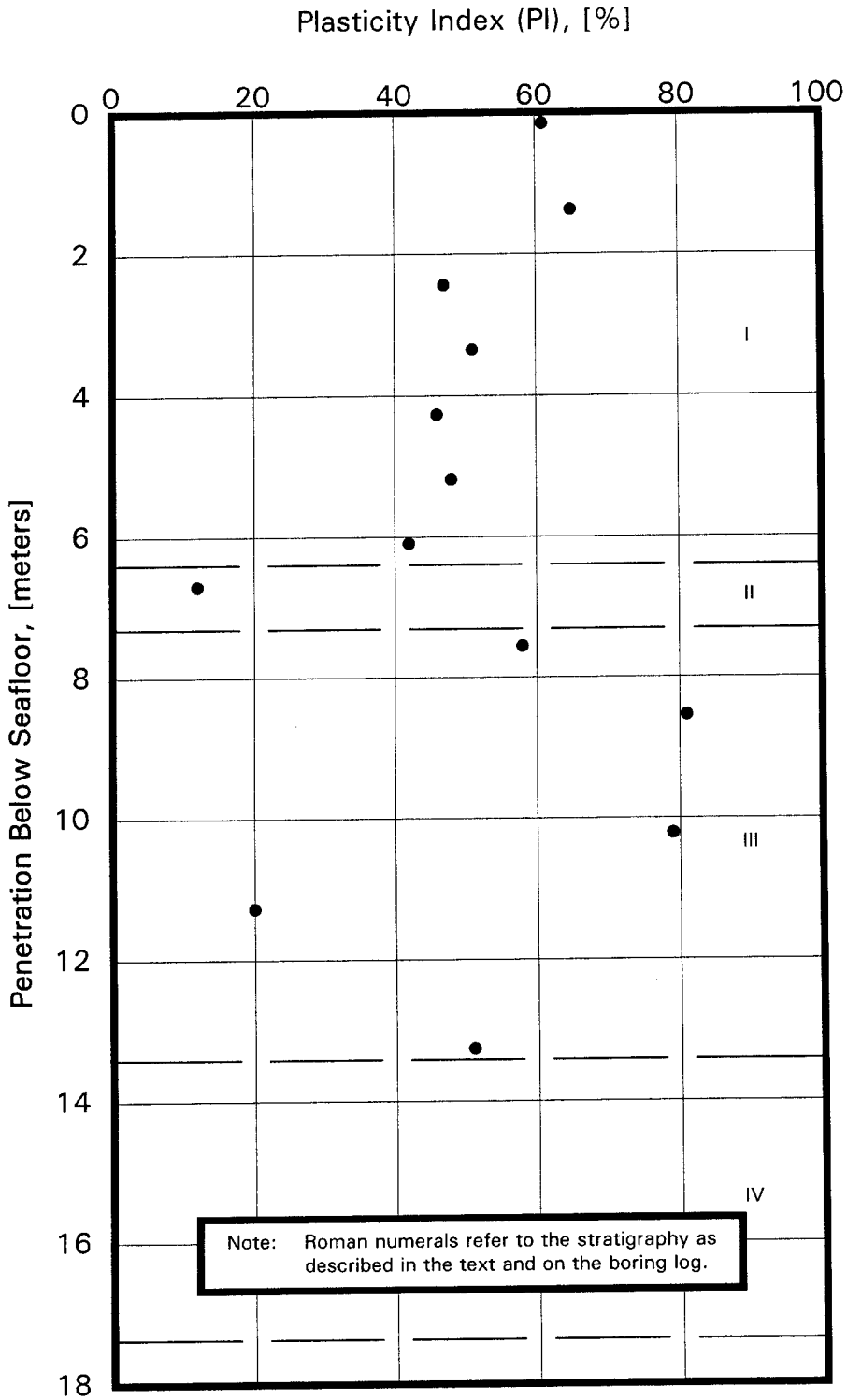
PLATE 98-3.9b



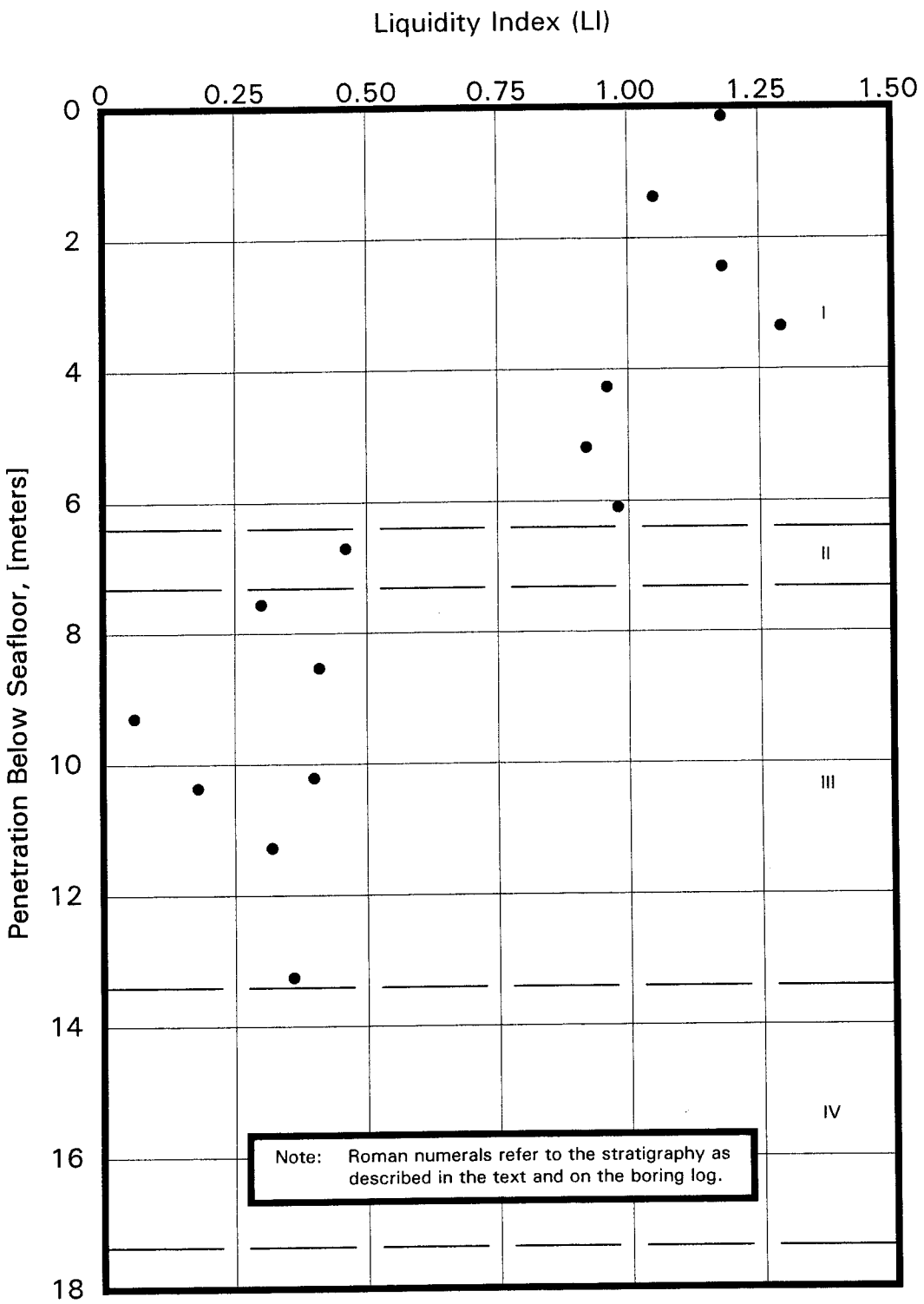


CRS CONSOLIDATION TEST RESULTS

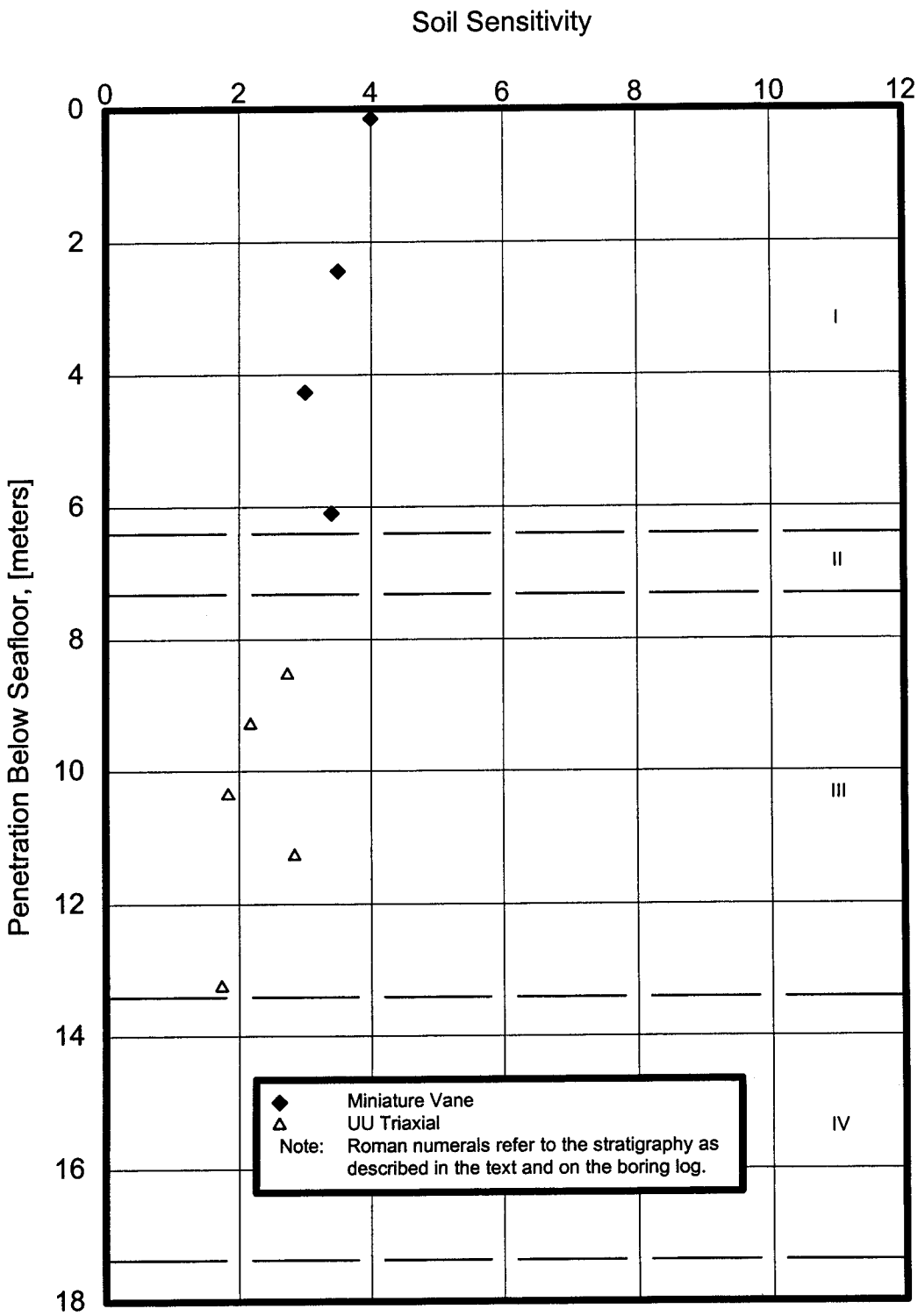
Sample No. 28 - Penetration: 10.8 m
Boring 98-3
SFOBB East Span Seismic Safety Project



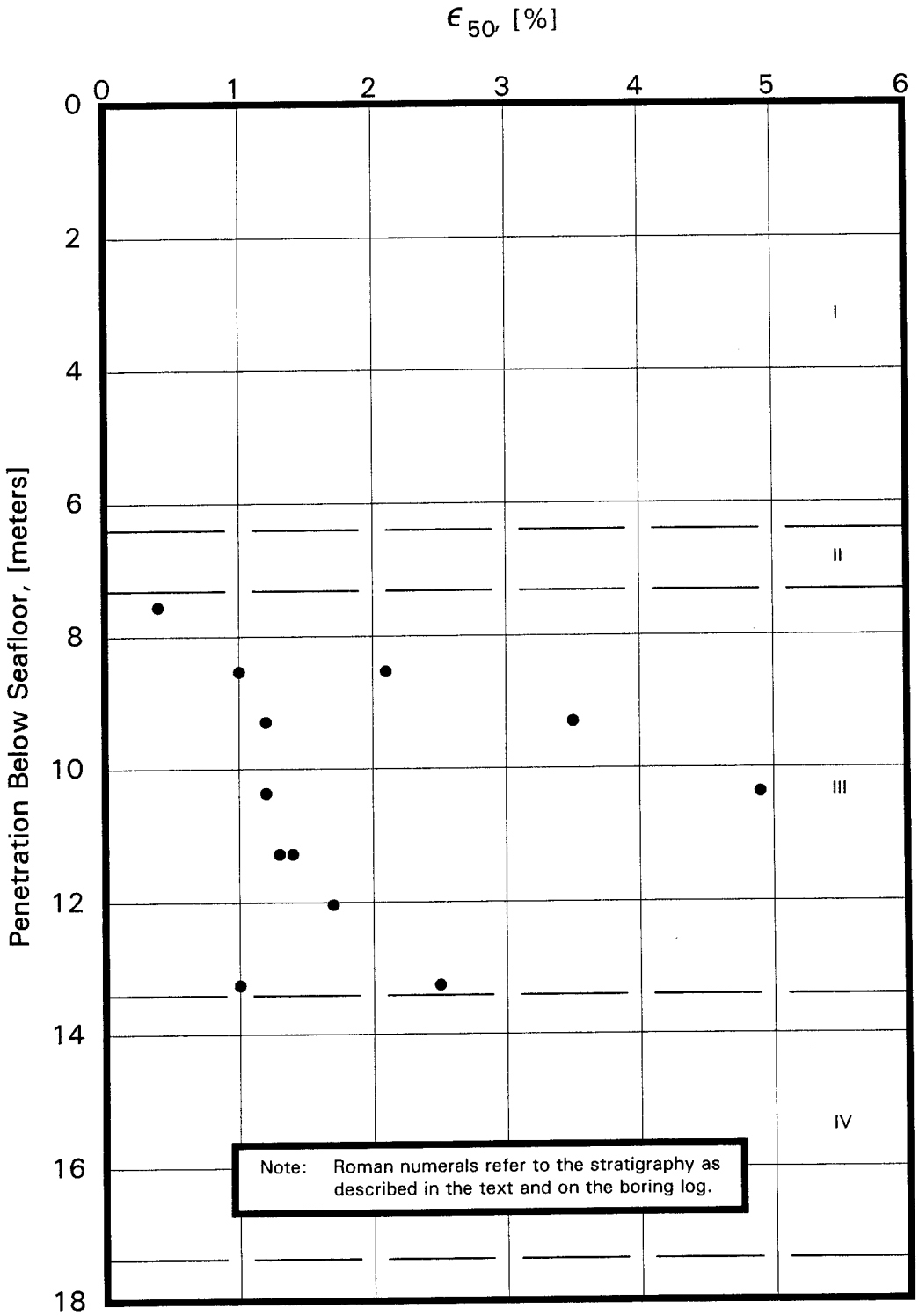
PLASTICITY INDEX PROFILE
Boring 98-3
SFOBB East Span Seismic Safety Project



LIQUIDITY INDEX PROFILE
Boring 98-3
SFOBB East Span Seismic Safety Project



SOIL SENSITIVITY PROFILE
Boring 98-3
SFOBB East Span Seismic Safety Project



ϵ_{50} PROFILE
Boring 98-3
SFOBB East Span Seismic Safety Project

BORING 98-4

Date	Time From	Time To	Description of Activity
March 5, 1998	0800	1000	Position barge on boring location 98-4, northeast of Pier E2, and set four-point anchor spread.
	1000	1045	Remove casing from drill rig.
	1045	1115	Lower drill pipe to mudline.
	1115	1300	Wait on repairs for generator.
	1300	1330	Measure water depth of 19.8m (65 ft) using bottom sensor.
	****	1330	Measure corrected water depth of 20.1m (66 ft) using fathometer. Current tide level is approximately +0.3m (+1 ft) MSL. Calculate mudline elevation of -19.8m (-65 ft) MSL.
	1330	1730	Drill and sample 0m (0 ft) to 4m (13 ft) penetration.
	1730	1800	Pull drill pipe to deck.
	1800	2400	Set casing.
March 6, 1998	0000	0215	Set casing.
	0215	0420	Run drill pipe to mudline. Attempt to wash out hole. Pull pipe and add drill bit.
	0420	0530	Drill to 3.7m (12 ft). Pull pipe and remove drill bit. Run drill pipe to 3.7m (12 ft) below mudline.
	0530	0700	Run core pipe to 3.7m (12 ft) below mudline.
	0700	0745	Rig repair.
	0745	0845	Unplug circulation pipe.
	0845	0945	Drill and sample to 4m (13 ft) penetration.
	0945	1745	Core 4m (13 ft) to 9.4m (31 ft) penetration.
	1745	1945	Set up pumps for seawater circulation.
	1945	2200	Drill 9.4m (31 ft) to 11m (36 ft) penetration.
	2200	2230	Repair overshot and drill pipe.
	2230	2300	Drill 11m (36 ft) to 12.5m (41 ft) penetration (no sample recovery).
	2300	2400	Clean out borehole.
March 7, 1998	0000	0600	Clean out borehole to 11m (36 ft) and re-sample 11m (36 ft) to 12.5m (41 ft) (no recovery).
	0600	0700	Drill and sample at 12.8m (42 ft).
	0700	2400	Rock core 13.1m (43 ft) to 26.2m (86 ft).
March 8, 1998	0000	2400	Rock core 26.2m (86 ft) to 49.2m (161.5 ft).
March 9, 1998	0000	1645	Rock core 49.2m (161.5 ft) to 69.5m (228 ft).
	1645	1715	Mix mud.
	1715	1750	Pull core pipe while pumping heavy mud.
	1750	1945	Acquire velocity profile.

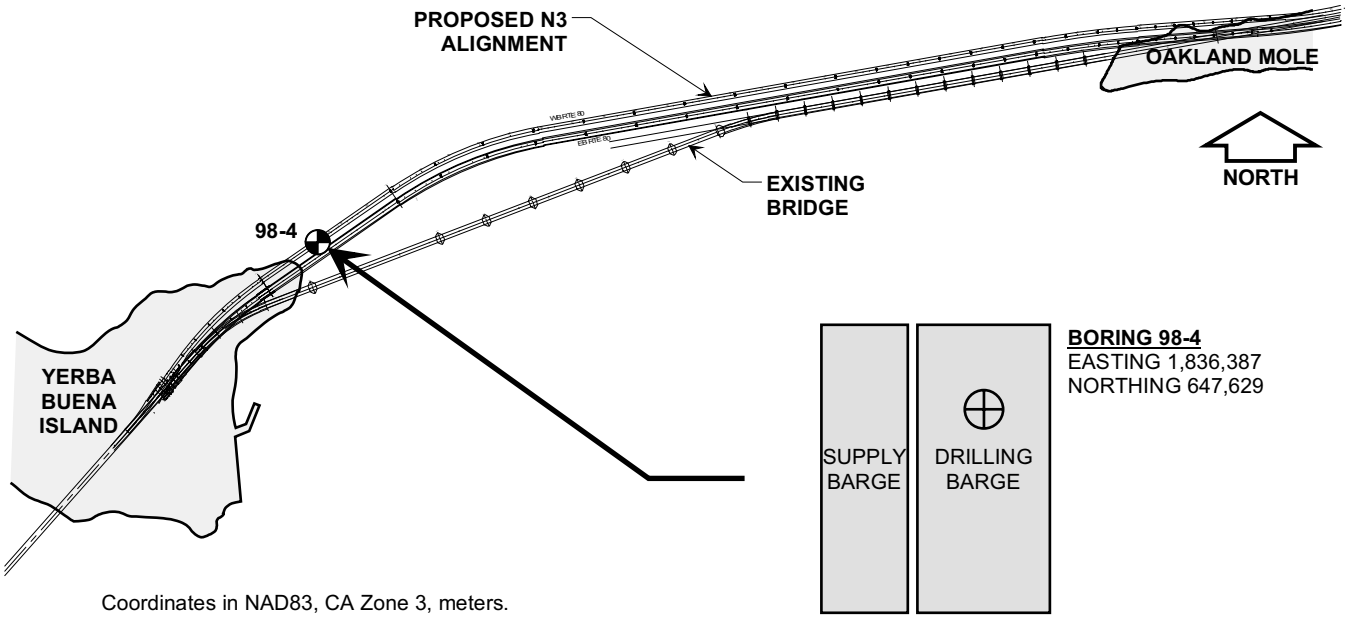
SUMMARY OF FIELD OPERATIONS
Boring 98-4
SFOBB East Span Seismic Safety Project

PLATE 98-4.1a

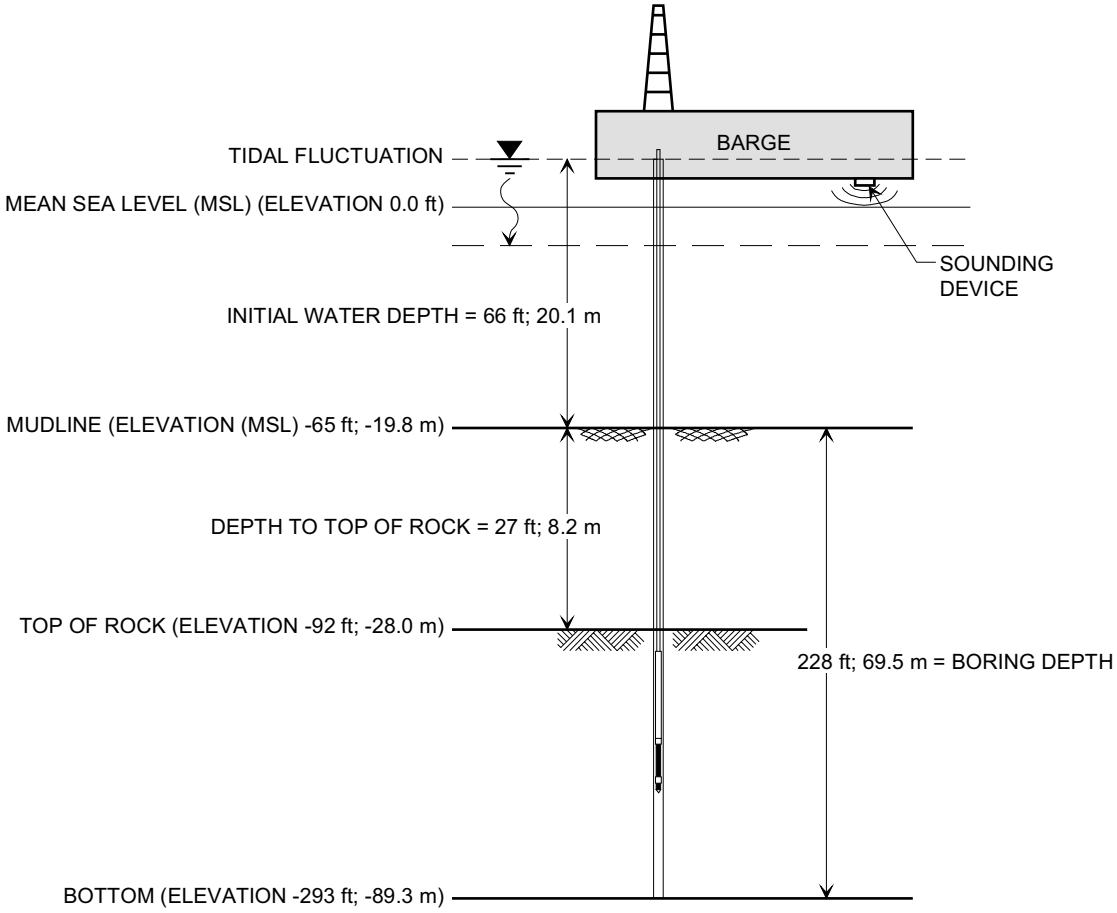
March 9, 1998	1945	2000	Rig down velocity profiler.
	2000	2145	Run caliper 18.3m (60 ft) to 69.5m (228 ft) penetration.
	2145	2240	Mix mud and pull core pipe to deck while pumping heavy mud into hole.
	2240	2300	Rig-up E-logger.
	2300	2400	Acquire E-log.
March 10, 1998	0000	0015	Finish E-log. Hole caved-in to 6.4m (21 ft) penetration.
	0015	0130	Grout borehole.
	0130	0215	Pull drill pipe.
	0215	0420	Pull casing.
	0420	0600	Pull anchors. Position barge on boring location 98-1, north of Pier E2, and set four-point anchor spread.

SUMMARY OF FIELD OPERATIONS
Boring 98-4
SFOBB East Span Seismic Safety Project

PLATE 98-4.1b



Coordinates in NAD83, CA Zone 3, meters.



BORING 98-4 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-4.2

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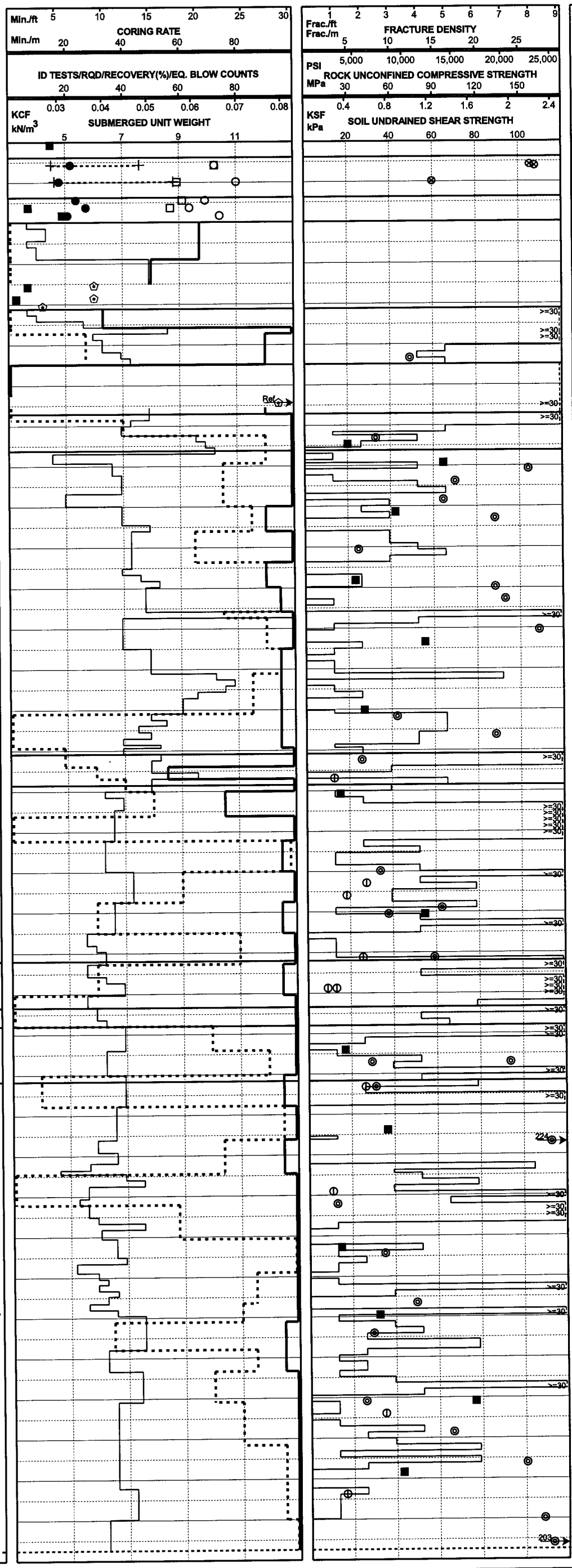
PROJECT NO:	98-42-0035	**START DATE:**	3/5/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-4 (Northeast of Pier E2)	**COMPLETION DATE:**	3/10/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836387 N647629
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -19.8 m (MSL)

Stratum	Material Description	Blow Count
I	Fat CLAY with gravel (CH), very soft, dark olive gray (0.8m) -with fine to coarse gravel, 0.2m to 0.8m	25/60cm 17/45cm
II	Sandy fat CLAY with gravel (CH), very stiff, olive gray (2.7m) -gravelly clay with sand, at 1.8m	25/45cm
III	SAND (SP), dense to very dense, dark gray (4.0m) -fine to medium grained, with shell fragments -dark gray gravel with sand, at 3.0m -sand with silt and gravel, at 3.4m	21/45cm 17/45cm 30/45cm
IV	Fine to coarse GRAVEL with clay (GP-GC), olive gray (8.2m) -with shell fragments -sandy gravel with clay and shell fragments, below 5.8m -intensely weathered, soft, moderate yellowish brown sandstone gravel, at 7.9m	67-0 67-0 50-0 50-0 30 30 30/30cm
V	SANDSTONE (Graywacke) (RX), moderate yellowish brown, intensely weathered, soft to moderately hard, thickly to very thickly bedded, fine to medium grained, moderately to well sorted, subangular to subrounded (11.0m)	33-0 100-0 90-27
VI	Interbedded SILTSTONE (RX), CLAYSTONE (RX),and SANDSTONE (Graywacke) (RX), medium to dark gray, intensely to moderately weathered, moderately soft, thinly to thickly bedded, very intensely fractured (13.4m)	0-0 Ref /10cm 90-0 100-0
VII	CLAYSTONE (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) [5:1], moderately to slightly weathered, moderately to intensely fractured, with thin clay infilling along fractures (15.2m)	100-40 100-90
VIII	SANDSTONE (Graywacke) (RX) with thinly interbedded CLAYSTONE (RX) [4:1], medium to dark gray, slightly weathered, moderately hard to hard, thinly to thickly bedded, fine grained, well sorted, moderately to slightly fractured -with a medium gray, slightly weathered, moderately hard siltstone bed,19.5m to 19.8m -medium gray fresh sandstone below 19.8m -with claystone, black, grading to siltstone, dark gray, 20.1m to 20.4m -with a dark gray, slightly fractured claystone layer, 21.3m to 21.9m SANDSTONE (Graywacke) (RX), moderate dark gray, fresh, hard, slightly fractured -with a claystone bed dipping 25 degrees, 23.3m to 23.8m See Plate 98-4.6 for detailed stratigraphy below 8.2m (30.2m)	100-75 90-85 100-65 90-90 95-95 100-75 100-90 95-95 95-85 95-0
IX	CLAYSTONE (RX), dark gray to black, slightly weathered, moderately hard, intensely to very intensely fractured (31.7m)	100-19 55-30
X	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered to fresh, hard, massive, moderately fractured, with a few thin interbedded siltstone and claystone layers -interbedded claystone, dipping 20 degrees, dark gray, moderately hard, intensely fractured, with 3mm- to 13mm-thick clay filling, 34.1m to 34.4m -with 40-degree, thin, healed, calcite/quartz-filled fractures, 34.4m to 36.3m (40.4m)	100-40 75-50 100-0 95-98 100-60 95-30 100-80
XI	CLAYSTONE (RX) with interbedded SANDSTONE (Graywacke) (RX) [3:1], fresh, intensely fractured (42.7m)	95-30
XII	SANDSTONE (Graywacke) (RX), moderate dark gray, fresh, hard, moderately fractured (43.6m)	100-0
XIII	CLAYSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [1:1], fresh (46.3m)	100-70 100-90
XIV	SANDSTONE (Graywacke) (RX), moderately dark gray, fresh to slightly weathered, hard to very hard, fine grained, moderately to intensely fractured -with a dark gray, hard, moderately to intensely fractured claystone bed, 57.8m to 58.1m -intensely fractured, slightly to moderately rough, 58.1m to 61.6m -with a dark gray claystone layer, 59.6m to 59.9m	95-10 100-95 95-74 100-0 100-58 100-99 100-85 100-80 95-35 95-85 100-70 100-80 100-95 100-95 100-99

TOTAL DEPTH: 69.5 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-4

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

FUGRO

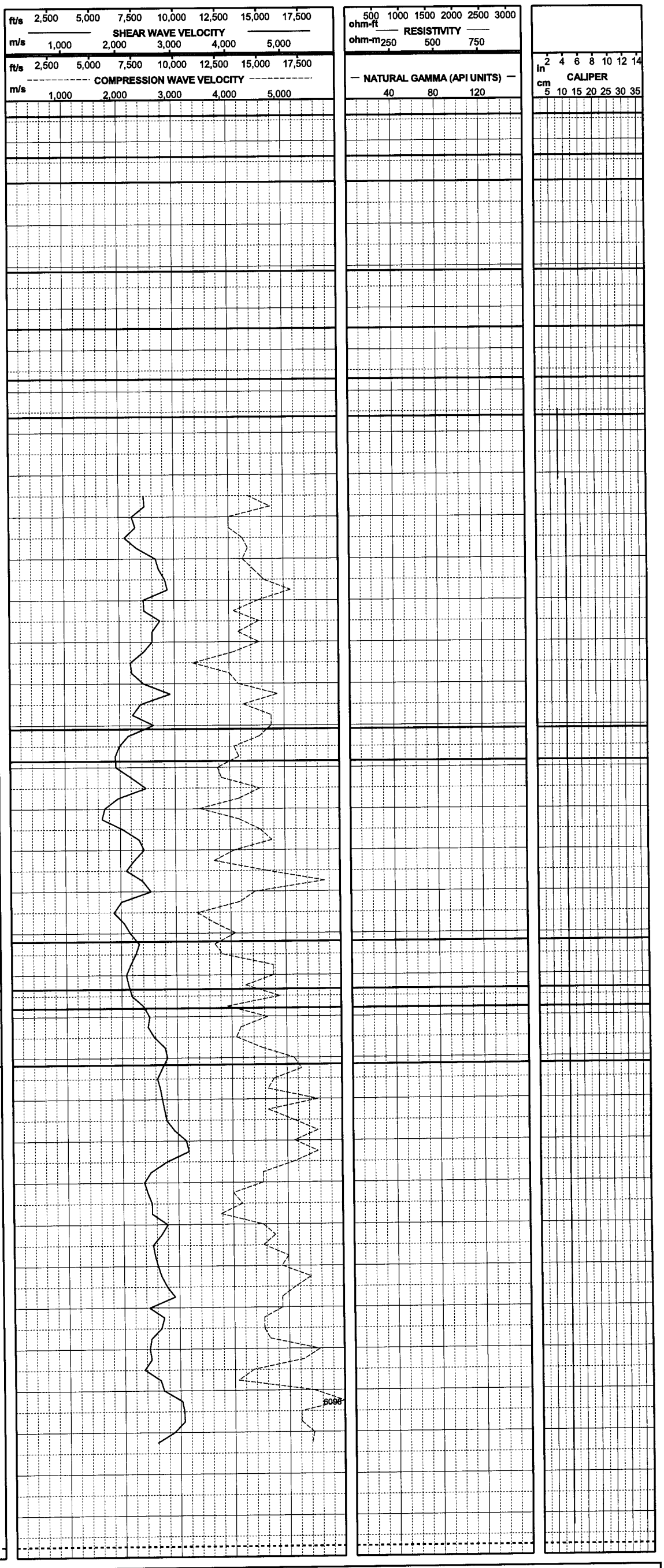
PLATE 98-4.3

PROJECT NO: 98-42-0035
BORING: 98-4 (Northeast of Pier E2)
START DATE: 3/5/98
COMPLETION DATE: 3/10/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836387 N647629
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -19.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		17/45cm 25/45cm	Fat CLAY with gravel (CH), very soft, dark olive gray (0.8m) -with fine to coarse gravel, 0.2m to 0.8m	I
-21	2	21/45cm 17/45cm 30/45cm	Sandy fat CLAY with gravel (CH), very stiff, olive gray -gravelly clay with sand, at 1.8m (2.7m)	II
-23	4	67-0 67-0	SAND (SP), dense to very dense, dark gray -fine to medium grained, with shell fragments (4.0m) -dark gray gravel with sand, at 3.0m -sand with silt and gravel, at 3.4m	III
-25	6	50-0 50-0 30 30 30/30cm	Fine to coarse GRAVEL with clay (GP-GC), olive gray -with shell fragments -sandy gravel with clay and shell fragments, below 5.8m -intensely weathered, soft, moderate yellowish brown sandstone gravel, at 7.9m (8.2m)	IV
-27	8	33-0 100-0 90-27	SANDSTONE (Graywacke) (RX), moderate yellowish brown, intensely weathered, soft to moderately hard, thickly to very thickly bedded, fine to medium grained, moderately to well sorted, subangular to subrounded (11.0m)	V
-29	10	0-0 Ref /10cm 90-0 100-0 100-40	Interbedded SILTSTONE (RX), CLAYSTONE (RX),and SANDSTONE (Graywacke) (RX), medium to dark gray, intensely to moderately weathered, moderately soft, thinly to thickly bedded, very intensely fractured (13.4m)	VI
-31	12	100-90 100-75	CLAYSTONE (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) [5:1], moderately to slightly weathered, moderately to intensely fractured, with thin clay infilling along fractures (15.2m)	VII
-33	14	90-85 100-65 90-90 95-95 100-75 100-90 95-95 95-85 95-0	SANDSTONE (Graywacke) (RX) with thinly interbedded CLAYSTONE (RX) [4:1], medium to dark gray, slightly weathered, moderately hard to hard, thinly to thickly bedded, fine grained, well sorted, moderately to slightly fractured -with a medium gray, slightly weathered, moderately hard siltstone bed,19.5m to 19.8m -medium gray fresh sandstone below 19.8m -with claystone, black, grading to siltstone, dark gray, 20.1m to 20.4m -with a dark gray, slightly fractured claystone layer, 21.3m to 21.9m SANDSTONE (Graywacke) (RX), moderate dark gray, fresh, hard, slightly fractured -with a claystone bed dipping 25 degrees, 23.3m to 23.8m See Plate 98-4.6 for detailed stratigraphy below 8.2m (30.2m)	VIII
-35	16	100-19 55-30 100-40	CLAYSTONE (RX), dark gray to black, slightly weathered, moderately hard, intensely to very intensely fractured (31.7m)	IX
-37	18	75-50 100-0 95-98 100-60 95-30 100-80	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered to fresh, hard, massive, moderately fractured, with a few thin interbedded siltstone and claystone layers -interbedded claystone, dipping 20 degrees, dark gray, moderately hard, intensely fractured, with 3mm- to 13mm-thick clay filling, 34.1m to 34.4m -with 40-degree, thin, healed, calcite/quartz-filled fractures, 34.4m to 36.3m (40.4m)	X
-39	20	95-30	CLAYSTONE (RX) with interbedded SANDSTONE (Graywacke) (RX) [3:1], fresh, intensely fractured (42.7m)	XI
-41	22	100-0	SANDSTONE (Graywacke) (RX), moderate dark gray, fresh, hard, moderately fractured (43.6m)	XII
-43	24	100-70 100-90	CLAYSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [1:1], fresh (46.3m)	XIII
-45	26	95-10 100-95 95-74 100-0 100-58 100-99 100-85 100-80 95-35 95-85 100-70 100-80 100-95 100-95 100-99	SANDSTONE (Graywacke) (RX), moderately dark gray, fresh to slightly weathered, hard to very hard, fine grained, moderately to intensely fractured -with a dark gray, hard, moderately to intensely fractured claystone bed, 57.8m to 58.1m -intensely fractured, slightly to moderately rough, 58.1m to 61.6m -with a dark gray claystone layer, 59.6m to 59.9m TOTAL DEPTH: 69.5 m BACKFILLED WITH: Cement Grout	XIV
-47	28			
-49	30			
-51	32			
-53	34			
-55	36			
-57	38			
-59	40			
-61	42			
-63	44			
-65	46			
-67	48			
-69	50			
-71	52			
-73	54			
-75	56			
-77	58			
-79	60			
-81	62			
-83	64			
-85	66			
-87	68			
-89				



LOG OF BORING AND TEST RESULTS

BORING 98-4

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

FUGRO

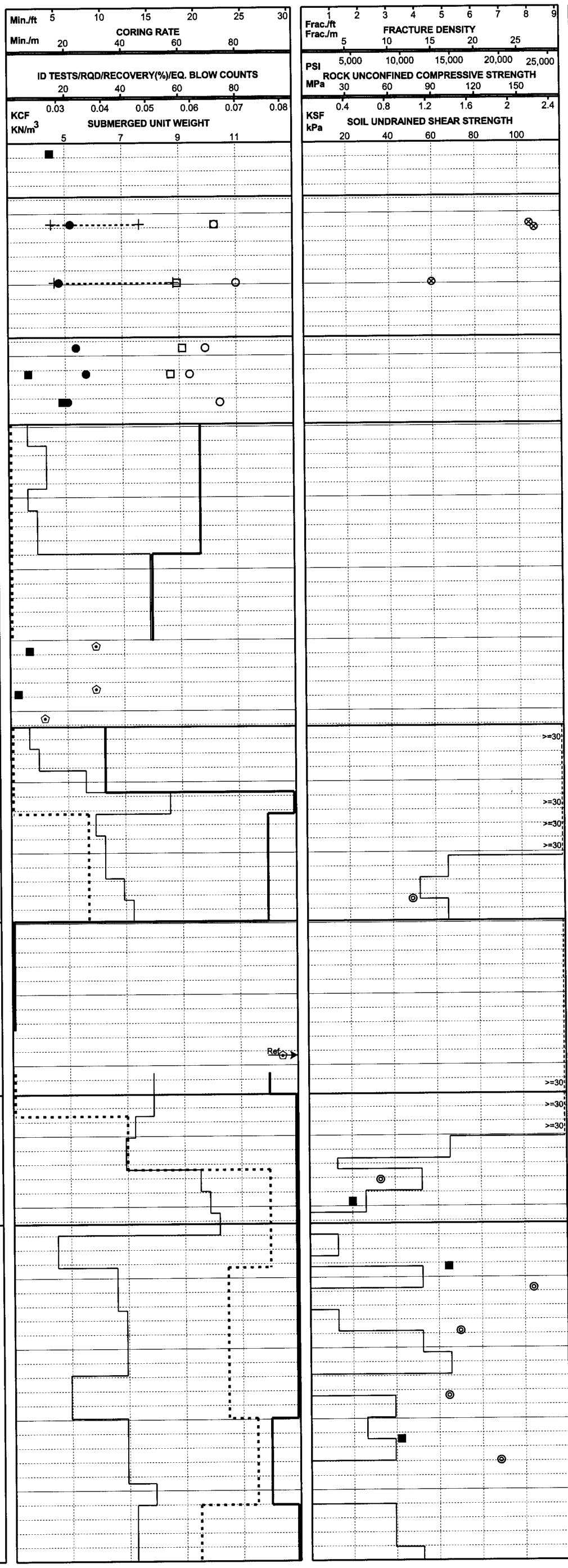
PLATE 98-4.4

PROJECT NO: 98-42-0035
BORING: 98-4 (Northeast of Pier E2)
START DATE: 3/5/98
COMPLETION DATE: 3/10/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836387 N647629
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -19.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-20		25/60cm	Fat CLAY with gravel (CH), very soft, dark olive gray -with fine to coarse gravel, 0.2m to 0.8m (0.8m)	I
-21	1	17/45cm	Sandy fat CLAY with gravel (CH), very stiff, olive gray	II
-22	2	25/45cm	-gravelly clay with sand, at 1.8m (2.7m)	
-23	3	21/45cm 17/45cm 30/45cm	SAND (SP), dense to very dense, dark gray -fine to medium grained, with shell fragments -dark gray gravel with sand, at 3.0m -sand with silt and gravel, at 3.4m (4.0m)	III
-24	4	67-0	Fine to coarse GRAVEL with clay (GP-GC), olive gray -with shell fragments	IV
-25	5	67-0		
-26	6	50-0 50-0	-sandy gravel with clay and shell fragments, below 5.8m	
-27	7	30		
-28	8	30 30/30cm	-intensely weathered, soft, moderate yellowish brown sandstone gravel, at 7.9m (8.2m)	
-29	9	33-0 100-0	SANDSTONE (Graywacke) (RX), moderate yellowish brown, intensely weathered, soft to moderately hard, thickly to very thickly bedded, fine to medium grained, moderately to well sorted, subangular to subrounded -intensely fractured into pieces of 25mm to 75mm long	V
-30	10	90-27	-moderately fractured, slightly to moderately rough surfaces, very thin clay filling on 20- to 80-degree fractures, below 9.8m (11.0m)	
-31	11	0-0	Interbedded SILTSTONE (RX), CLAYSTONE (RX),and SANDSTONE (Graywacke) (RX), medium to dark gray, intensely to moderately weathered, moderately soft, thinly to thickly bedded, very intensely fractured	VI
-32	12	Ref /10cm	-slightly cemented siltstone, dark gray with iron oxide and trace organics (13.4m)	
-33	13	90-0 100-0	CLAYSTONE (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) [5:1], moderately to slightly weathered, moderately to intensely fractured, with thin clay infilling along fractures	VII
-34	14	100-40	-claystone: dark gray -sandstone: medium dark gray, hard (15.2m)	
-35	15	100-90	SANDSTONE (Graywacke) (RX) with thinly interbedded CLAYSTONE (RX) [4:1], medium to dark gray, slightly weathered, moderately hard to hard, thinly to thickly bedded, fine grained, well sorted, moderately to slightly fractured	VIII
-36	16		-moderately rough fractures inclined at 40 to 50 degrees, slightly rough fractures inclined at 70 degrees with thin, discontinuous, gray filling and thin yellowish red staining -with thin, moderately hard claystone beds dipping 20 to 25 degrees, smooth, polished fracture/ bedding-plane surfaces -sandstone has numerous very thin, closed, calcite/quartz-filled fractures dipping at near vertical angle, wavy to partially linear	
-37	17	100-75		
-38	18	90-85		
-39	19	100-65	-beds dipping 20 degrees, 19.2m to 20.4m -with a medium gray, slightly weathered, moderately hard siltstone bed,19.5m to 19.8m -medium gray fresh sandstone below 19.8m	



LOG OF BORING AND TEST RESULTS

BORING 98-4

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

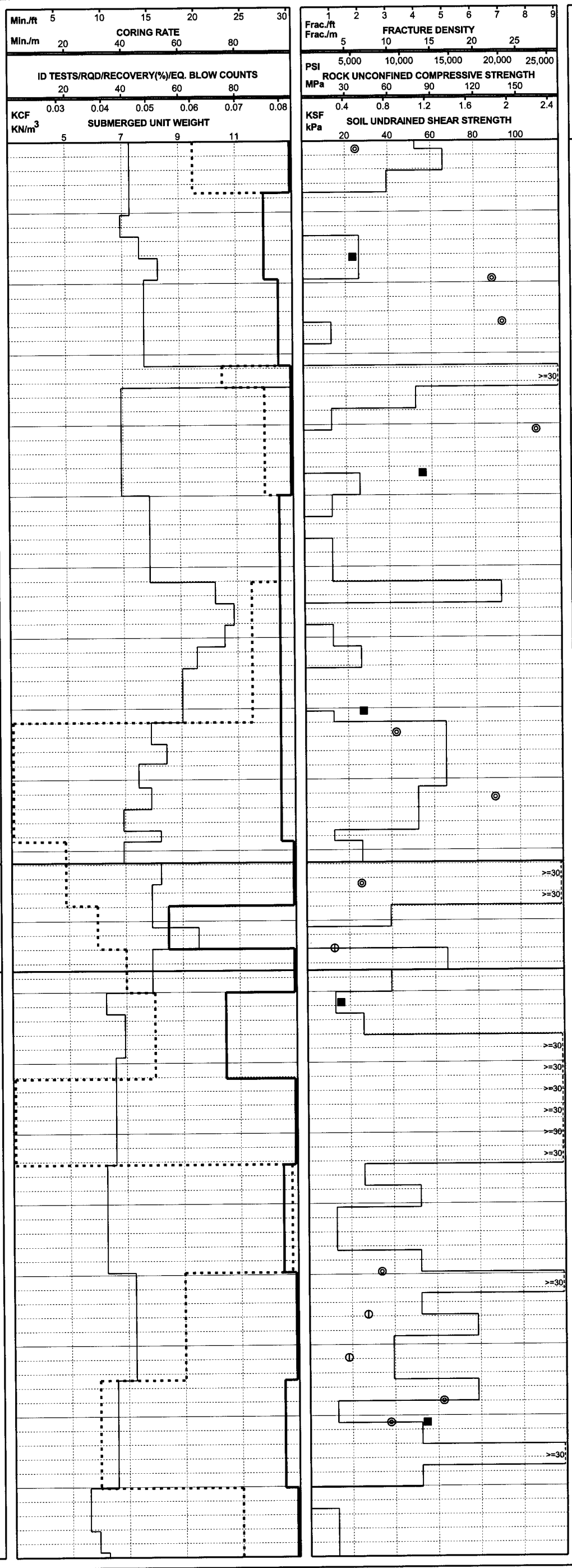
PLATE 98-4.5a

PROJECT NO: 98-42-0035
BORING: 98-4 (Northeast of Pier E2)
START DATE: 3/5/98
COMPLETION DATE: 3/10/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836387 N647629
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -19.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-40		100-65	SANDSTONE (Graywacke) (RX) with thinly interbedded CLAYSTONE (RX) [4:1], medium to dark gray, slightly weathered, moderately hard to hard, thinly to thickly bedded, fine grained, well sorted, moderately to slightly fractured -with claystone, black, grading to siltstone, dark gray, 20.1m to 20.4m	
-41	21	90-90	-50mm-thick intensely fractured claystone layer with highly polished surfaces, at 20.7m -erosional contact, silty sandstone beneath coarse sandstone with 3mm clay clast, at 21.0m -with a dark gray, slightly fractured claystone layer, 21.3m to 21.9m	
-42	22	95-95	SANDSTONE (Graywacke) (RX), moderate dark gray, fresh, hard, slightly fractured -moderately rough fractures inclined at 40 to 60 degrees with patchy calcite/quartz filling, and thin, healed, calcite/quartz joints inclined at 70-degrees	
-43	23	100-75	-slightly open moderately rough fractures inclined 40 degrees (subparallel to 45 degree erosional contact) with patchy quartz/calcite filling, at 23.2m -with a claystone bed dipping 25 degrees, 23.3m to 23.8m	
-44	24	100-90	-thin 75mm-thick claystone bed dipping 25 degrees with thin calcite filled fractures, at 24.7m	
-45	25	95-95	-with claystone lenses at 25.0m -closed, healed fractures dipping at 60 to 80 degrees, with moderately thin calcite/quartz mineralization, at 25.6m	VIII
-46	26		-150mm-thick intensely fractured claystone bed dipping 20 degrees, at 26.4m	
-47	27	95-85		
-48	28		-near vertical to vertical fractures with thin clay filling, 28.0m to 29.9m -some calcite/quartz mineralization along fractures, at 28.7m	
-49	29	95-0		
-50	30	100-19	(30.2m) CLAYSTONE (RX), dark gray to black, slightly weathered, moderately hard, intensely to very intensely fractured -fractures inclined at 20 to 25 degrees with smooth, polished bedding-plane partings and calcite filling -with a few thin (to 100mm-thick) sandstone beds at 30.5m	
-51	31	55-30	(31.7m)	IX
-52	32	100-40	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered to fresh, hard, massive, moderately fractured, with a few thin interbedded siltstone and claystone layers	
-53	33	75-50	-fractures dipping at 50 degrees, with white mineralization and gray mottling along fractures, at 32.6m -intensely to very intensely fractured, with claystone lenses and high-angle, very thin, healed, calcite/quartz-filled fractures, 32.6m to 34.4m	
-54	34	100-0	-interbedded claystone, dipping 20 degrees, dark gray, moderately hard, intensely fractured, with 3mm- to 13mm-thick clay filling, 34.1m to 34.4m -with 40-degree, thin, healed, calcite/quartz-filled fractures, 34.4m to 36.3m	
-55	35	95-98		
-56	36		-slightly fractured, slightly rough fractures dipping at 35 to 45 degrees with thin calcite filling and pyrite flakes, 35.0m to 37.5m -with a 125mm-thick closed fracture zone (sandstone fragments in a calcite matrix) inclined 80 degrees, at 36.3m -6mm-thick very intensely fractured zone with clayey sand filling, at 36.6m	X
-57	37	100-60		
-58	38	95-30	-225mm-thick very intensely fractured zone inclined 45 degrees, at 38.4m	
-59	39	100-80	-moderately rough fractures dipping 30 and 80 degrees with very thin calcite filling and up to 10% pyrite flakes, at 39.0m	



LOG OF BORING AND TEST RESULTS

BORING 98-4

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

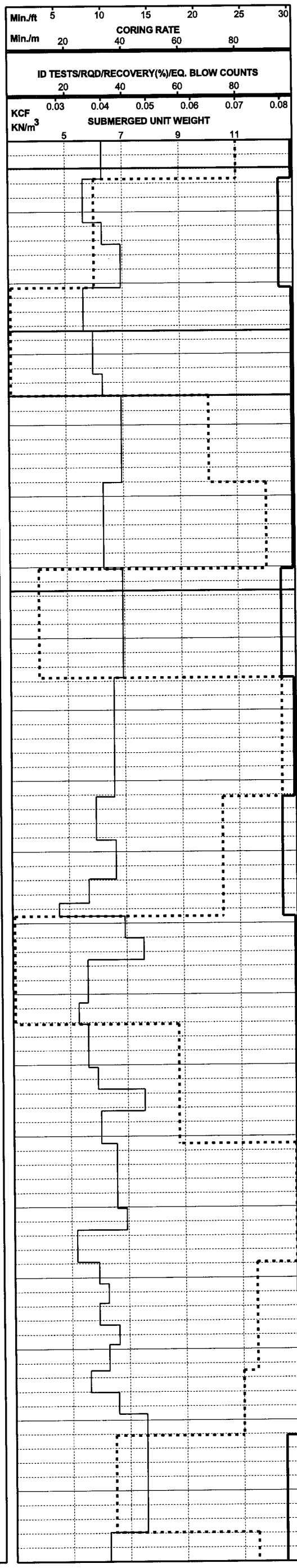
PLATE 98-4.5b

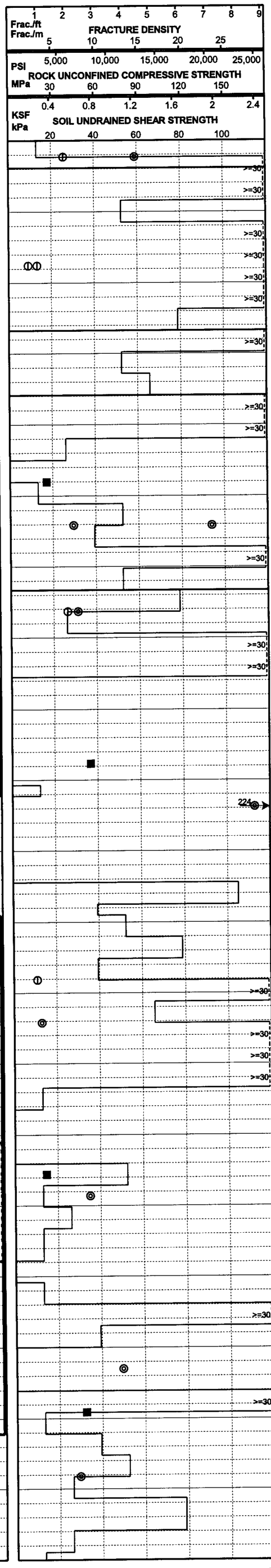
PROJECT NO:	98-42-0035	**START DATE:**	3/5/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-4 (Northeast of Pier E2)	**COMPLETION DATE:**	3/10/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836387 N647629
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -19.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-60		100-80	SANDSTONE (Graywacke) (RX), dark gray, slightly weathered to fresh, hard, massive, moderately fractured, with a few thin interbedded siltstone and claystone layers (40.4m)	X
-61	41	95-30	CLAYSTONE (RX) with interbedded SANDSTONE (Graywacke) (RX) [3:1], fresh, intensely fractured -claystone: dark gray, moderately hard, thinly interbedded to laminated, smooth, polished bedding plane surfaces -sandstone: medium gray, hard, moderately fractured, stepped, moderately rough to rough, thin to moderately thin, calcite/quartz filling (42.7m)	XI
-62	42			
-63	43	100-0	SANDSTONE (Graywacke) (RX), moderate dark gray, fresh, hard, moderately fractured -very thin tight moderately rough to slightly rough fractures dipping 30 and 80 degrees with calcite filling and up to 10 percent pyrite flakes (43.6m)	XII
-64	44	100-70	CLAYSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [1:1], fresh -claystone: dark gray, moderately to intensely fractured, very thin fractures, slightly rough to smooth fracture and bedding plane surfaces -sandstone: moderate dark gray, hard, fine grained, moderately fractured, very thin fractures, moderately rough, with calcite and pyrite infilling	XIII
-65	45	100-90		
-66	46		(46.3m)	
-67	47	95-10	SANDSTONE (Graywacke) (RX), moderately dark gray, fresh to slightly weathered, hard to very hard, fine grained, moderately to intensely fractured -primarily moderately rough to rough stepped fracture surfaces inclined at 40 to 50 degrees -intensely to very intensely fractured zone, smooth to moderately rough with thin calcite/quartz filling, 47.2m to 47.5m -hard to very hard, slightly fractured sandstone, with 60-degree, thin, healed, calcite/quartz-filled fractures, 47.5m to 50.6m	XIV
-68	48	100-95		
-69	49			
-70	50	95-74	-intensely to very intensely fractured sandstone, with thinly interbedded claystone and calcite-filled fractures inclined 30, 50, 60, and 80 degrees, 50.6m to 53.0m	
-71	51			
-72	52	100-0		
-73	53	100-58	-with a 25mm-thick calcite filled fracture dipping at 80 degrees, 53.0m to 53.6m	
-74	54		-with thin, healed, calcite/quartz-filled fractures, 53.9m to 55.8m	
-75	55	100-99	-with claystone lenses, 54.9m to 55.5m	
-76	56			
-77	57	100-85	-thin very intensely fractured claystone beds with polished fracture surfaces, 57.0m to 58.8m	
-78	58	100-80	-with a dark gray, hard, moderately to intensely fractured claystone bed, 57.8m to 58.1m -intensely fractured, slightly to moderately rough, 58.1m to 61.6m -intensely to moderately fractured (variable spacing form 50mm to 300mm), with tight, closed, calcite filled, slightly to moderately rough fracture surfaces inclined at 30, 60, and 80 degrees, 58.2m to 59.6m	
-79	59	95-35	-with healed calcite filled joints dipping at 30 to 60 degrees, below 58.8m	
		95-85	-with a dark gray claystone layer, 59.6m to 59.9m	





LOG OF BORING AND TEST RESULTS

BORING 98-4

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

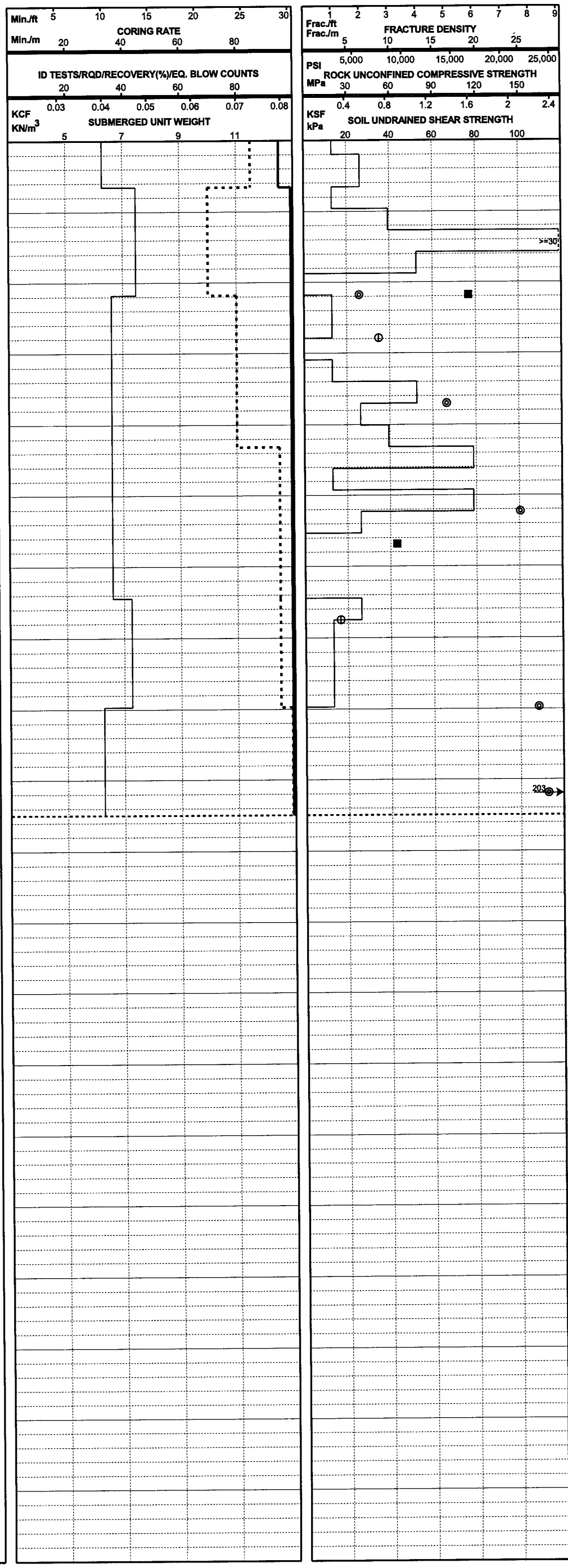
PLATE 98-4.5c

PROJECT NO: 98-42-0035
BORING: 98-4 (Northeast of Pier E2)
START DATE: 3/5/98
COMPLETION DATE: 3/10/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836387 N647629
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -19.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-80		95-85	SANDSTONE (Graywacke) (RX), moderately dark gray, fresh to slightly weathered, hard to very hard, fine grained, moderately to intensely fractured -slightly fractured, 60.0m to 61.6m	XIV
-81	61	100-70	-clay infilling along fractures at 61.3m -slightly rough thin fractures inclined at 20 to 50 degrees with calcite/quartz filling, and thin healed calcite/quartz-filled fractures inclined at 60 to 80 degrees, 61.6m to 64.3m	
-82	62		-with a few claystone laminations at 62.8m	
-83	63	100-80		
-84	64			
-85	65	100-95		
-86	66			
-87	67	100-95		
-88	68			
-89	69	100-99		
-90	70		TOTAL DEPTH: 69.5 m BACKFILLED WITH: Cement Grout	
-91	71			
-92	72			
-93	73			
-94	74			
-95	75			
-96	76			
-97	77			
-98	78			
-99	79			



LOG OF BORING AND TEST RESULTS

BORING 98-4

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-4.5d

Earth Mechanics

FUGRO

98-4		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
0.2	1						15																						
1.2	3	22	46	15	0.21	10.2					105.3																		
1.2	4										107.7																		
2.0	5	18	58	16	0.03	8.9					59.9																		
2.9	6	24				9.1																							
3.3	8	27				8.7	7																						
3.7	10	21					19																						
7.2	17						7																						
7.8	18						3																						
10.7	22b																								73.7				
10.8	22c																	4619	47							25.3	15.7	0.14	
14.0	26b																			1.4	21	5.5	18						
14.5	26a																								49.7				
14.9	27b																							30.0		26.1	22.3	0.25	
15.8	27c																							96.9		26.6	54.8	0.23	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-4
SFOBB East Span Seismic Safety Project

00035SUM(8/12/98/08:48 AM)

Earth Mechanics

FUGRO

98-4		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
16.2	27																								156.1				
16.8	28a																								105.0				
17.7	28b																								96.7				
18.0	29a																			15.2	40	17.2	32						
18.3	29b																							63.2		26.6	40.1	0.20	
18.6	29c																								132.6				
20.1	30b																	4826	44						37.3				
20.1	30b																	4826	44							26.2	13.0	0.18	
21.3	31a																			11.0	44	15.9	31						
21.6	31b																							35.0		26.6	43.8		
21.9	32b																								132.6				
22.6	32a																								139.5				
24.1	34a																								163.0				
24.7	34b																							83.2		26.6	53.0	0.30	
28.0	36b																							40.6		26.4	53.9	0.20	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-4
SFOBB East Span Seismic Safety Project

3003SSMA(8/12/98/09:48 AM)

Earth Mechanics

FUGRO

98-4		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
28.2	36																								63.6				
29.3	37b																								132.6				
30.5	38a																								38.7				
31.1	39a																			19.3	14	31.7	12						
31.4	41b																								19.3				
32.2	41b																							23.4		26.4	55.6	0.35	
35.1	43b																	2620	56							26.1	58.9		
36.0	43																								51.1				
36.6	44																								41.4				
37.2	44b																								27.6				
37.8	45a																								93.9				
37.9	45b																								56.6				
38.1	45c																			101.4	47	32.4	33						
38.1	45d																							82.1		26.4	30.0		
40.1	46b																								88.4				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
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Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-4
SFOBB East Span Seismic Safety Project

PLATE 98-4.6c

8003SSMA(8/12/98/09:46 AM)

98-4		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
40.1	46a																								38.7				
41.8	47a																								13.8				
41.8	47b																								20.0				
44.2	49a2																	3792	55								220.0	0.23	
44.2	49a2																	3792	55							26.6	22.0	0.23	
44.8	49a																							25.5		26.4	22.6	0.15	
45.3	50a																								44.2				
45.4	50b																								140.9				
46.6	51a																								39.9				
46.6	51b																								47.0				
48.8	52b																							54.9		26.7	50.0	0.28	
49.2	52																								223.8				
51.5	54c																	1172	52							26.7	0.0		
51.5	54c																	1172	52								222.8	0.57	
51.8	54b																								16.6				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-4
SFOBB East Span Seismic Safety Project

Earth Mechanics

FUGRO

PLATE 98-4.6d

(MY 98-42-0054)SSS3000

Earth Mechanics

FUGRO

98-4		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
52.4	54a																								19.3				
54.6	56b																							22.0		26.7	21.9	0.15	
54.9	55																								52.5				
57.3	56																								74.6				
57.9	58b																							48.6		26.6	51.5	0.24	
58.8	59																								44.2				
62.2	61																								38.7				
62.2	61b																							115.0		26.7			
62.8	63a																								52.4				
63.7	63b																								99.5				
65.2	63																								150.6				
65.7	63b																							64.4		26.4	44.8	0.19	
66.8	64a																								24.9				
68.0	64b																								162.8				
69.2	65																								202.7				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-4
SFOBB East Span Seismic Safety Project

PLATE 98-4.6e

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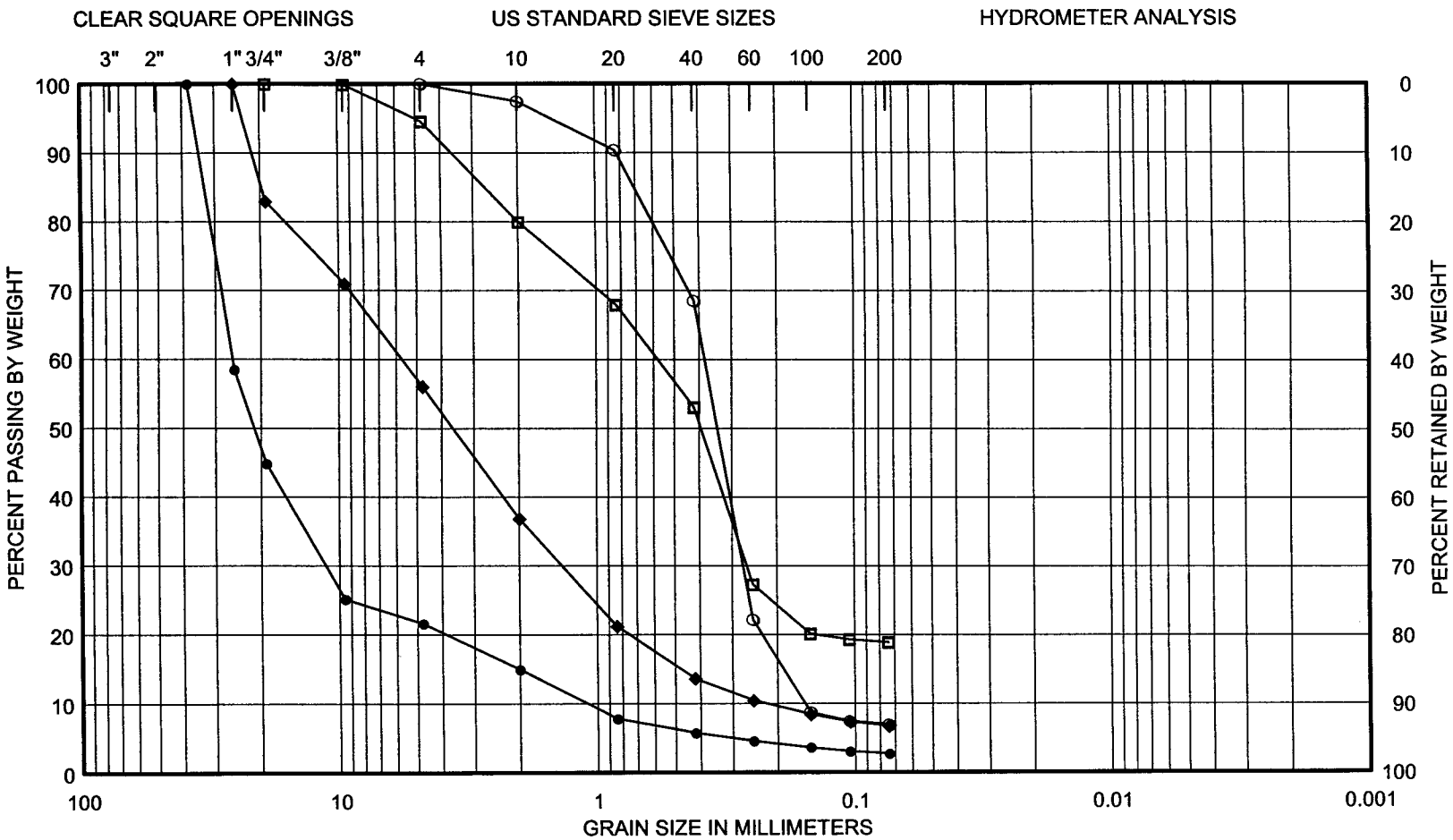


GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
8	3.3	○—○	FINE TO MEDIUM SAND (SP-SM) with silt
10	3.7	□—□	SILTY FINE TO MEDIUM SAND (SM) with coarse sand
17	7.2	◆—◆	MEDIUM TO COARSE SAND (SW-SM) with fine to coarse gravel and clay
18	7.8	●—●	SANDY GRAVEL (GP)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-4

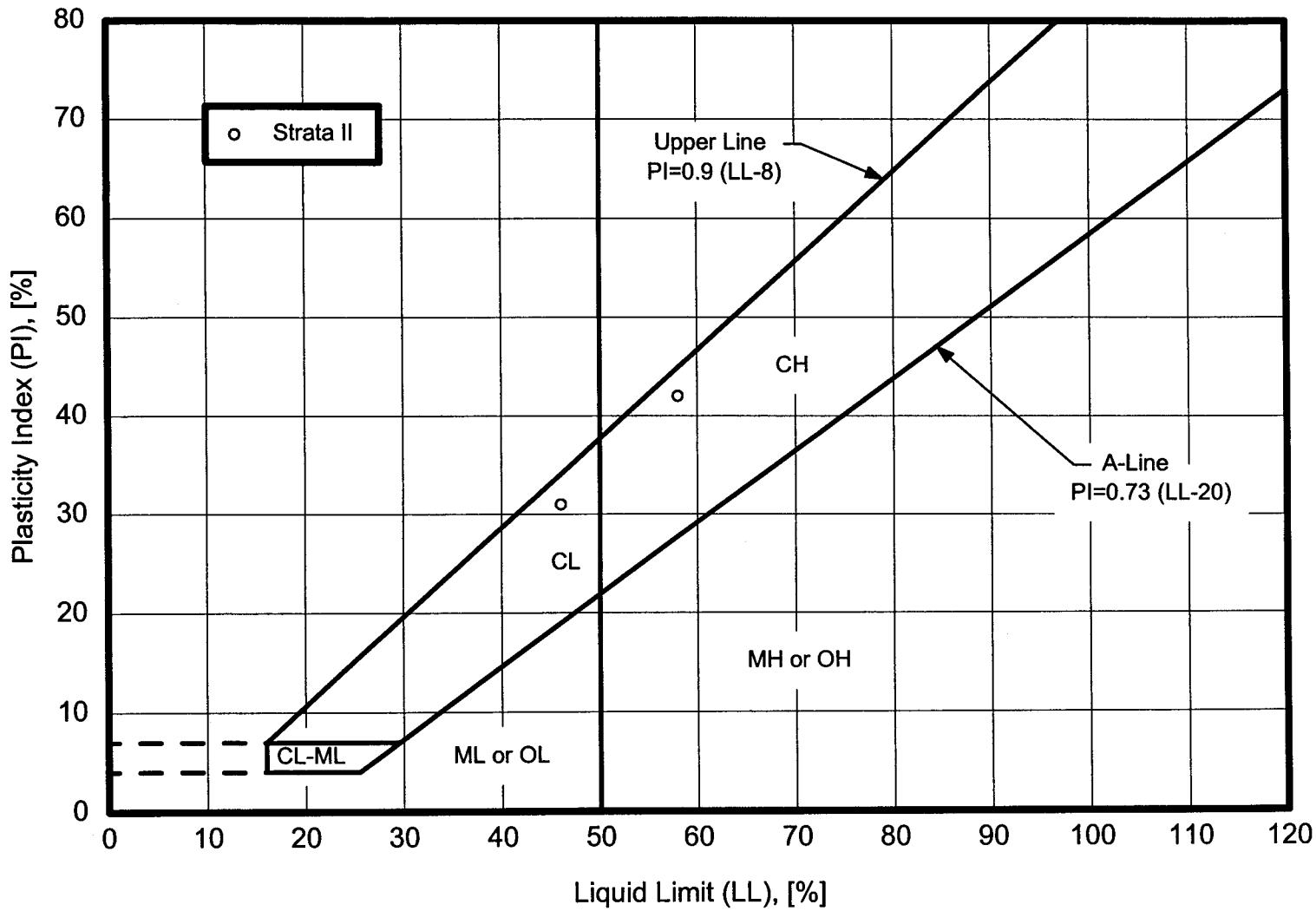
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-4.7



PLASTICITY CHART
Boring 98-4
SFOBB East Span Seismic Safety Project

Earth Mechanics
FUGRO

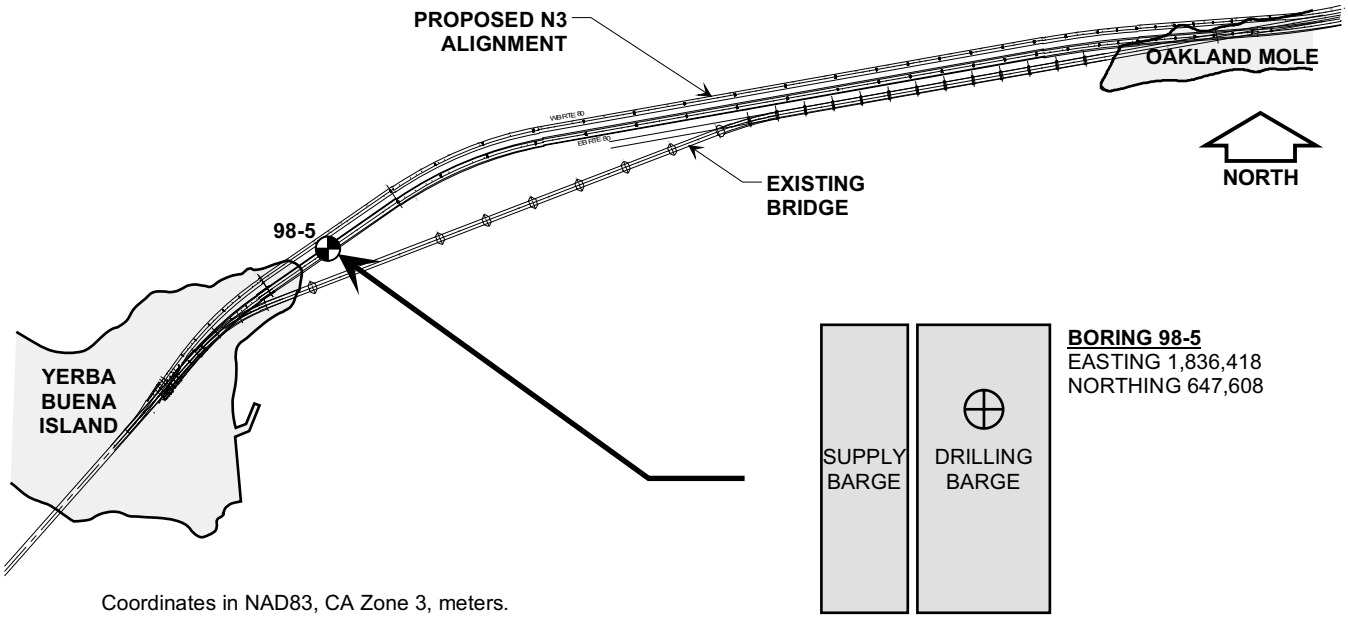
BORING 98-5

Date	Time From	Time To	Description of Activity
March 12, 1998	1100	1330	Move barge to 98-5 location.
	1330	1415	Measure water depth of 23.5m (77 ft) using wireline method.
	1415	1520	Run pipe to hole and measure water depth of 23.1m (76 ft) using bottom sensor. Current tide level is approximately 0m (0 ft) MSL. Calculate mudline elevation of -23.2m (-76 ft) MSL.
	1520	1640	Drill and sample from mudline to 1.5m (5 ft).
	1640	1730	Encounter stiff clay at 1.5m (5 ft). Pull out of hole to run casing.
	1730	1930	Run casing.
	1930	2030	Drive casing.
	2030	2130	Secure casing and build flow.
	2130	2200	Rig-up pumps and run pipe in hole.
	2200	2315	Mix mud.
	2315	2400	Drill and sample at 1.8m (6 ft).
March 13, 1998	0000	0230	Drill and sample 1.8m (6 ft) to 7.3m (24 ft).
	0230	0300	Secure mud circulation pipe.
	0300	0700	Drill and sample 7.3m (24 ft) to 14.3m (47 ft).
	0700	0830	Pull drill pipe. Prepare for rock coring. Run 12.7 cm (5 inch) pipe to 14.3m (47 ft).
	0830	0945	Run core pipe to bottom of hole.
	0945	1330	Rock core 14.3m (47 ft) to 17.7m (58 ft).
	1330	1430	Pull pipe. Re-drive casing.
	1430	1530	Weld casing.
	1530	1715	Run pipe into hole at 17.7m (58 ft).
	1715	2400	Rock core 17.7m (58 ft) to 24.7m (81 ft).
March 14, 1998	0000	2050	Rock core 24.7m (81 ft) to 45.1m (148 ft).
	2050	2230	Attempt to recover lost 0.2m (2 ft) of final core.
	2230	2300	Clean out borehole.
	2300	2330	Pull pipe.
	2330	2400	Downhole logging.
March 15, 1998	0000	0115	Downhole logging 16.5m (64 ft) to 45.1m (148 ft).
	0115	0215	Pull core pipe and 5-in pipe.
	0215	0400	Downhole logging 1.8m (6 ft) to 14m (46 ft). Hole blocked off at 14m (46 ft).
	0400	0445	Mix and grout boring 98-5.
	0445	0530	Pull pipe.

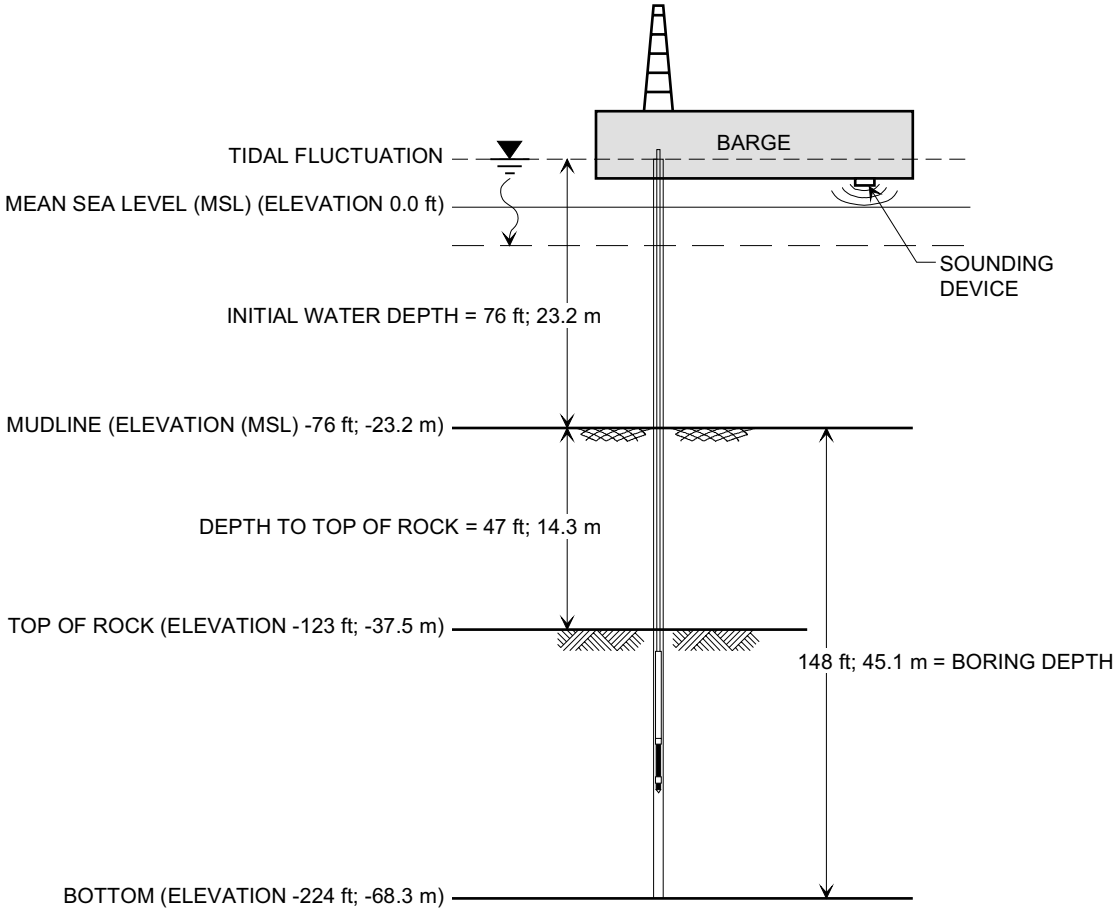
SUMMARY OF FIELD OPERATIONS
Boring 98-5
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
	0530	0800	Pull casing.
March 15, 1998	0800	0830	Preparing to move barge to location 98-2.
	0830	1000	Pull anchors. Position barge on boring location 98-2, north of Pier E2, and set four-point anchor spread.

SUMMARY OF FIELD OPERATIONS
Boring 98-5
SFOBB East Span Seismic Safety Project



Coordinates in NAD83, CA Zone 3, meters.



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BORING 98-5 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-5.2

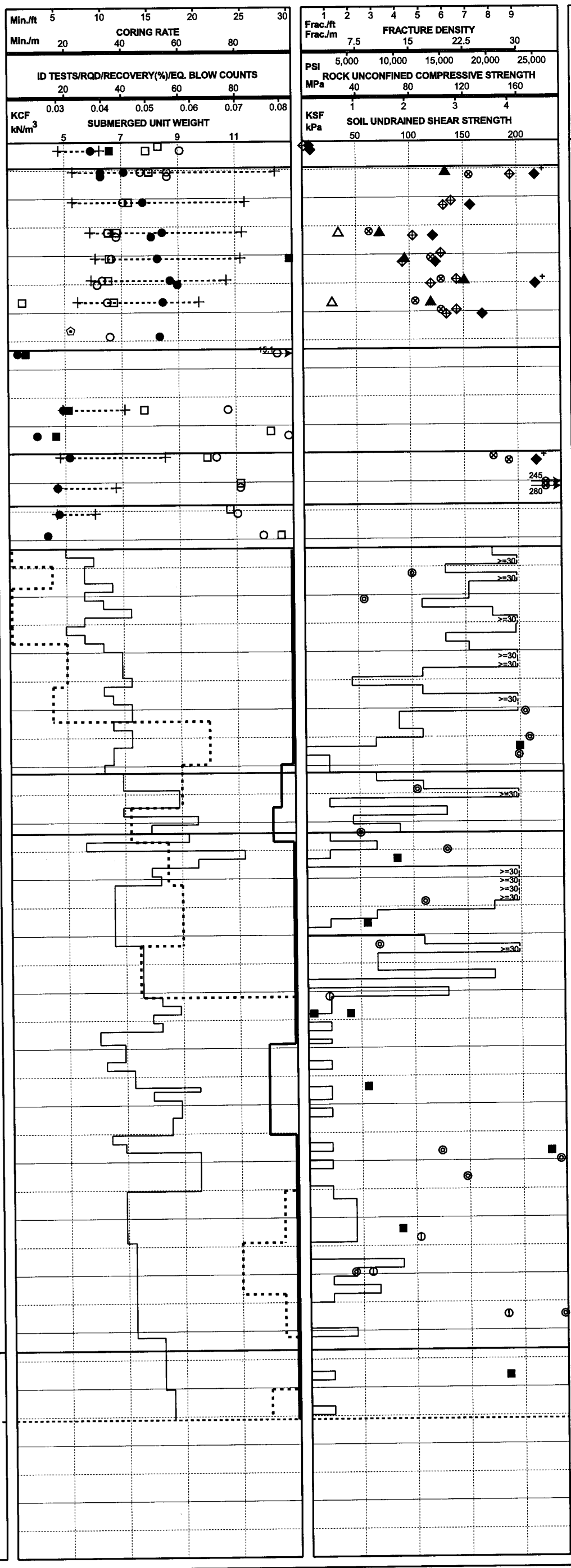
PROJECT NO:	98-42-0035	**START DATE:**	3/12/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-5 (Northeast of Pier E2)	**COMPLETION DATE:**	3/15/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836418 N647608
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -23.2 m (MSL)

Elevation, m.	Depth, m.	Blow Count	Material Description	Stratum No.
		WOH	Sandy fat CLAY (CH), very soft, olive gray, with shell fragments (0.9m)	I
		15/45cm, 12/45cm, 16/60cm, 28/60cm, PUSH, PUSH, 22	Fat CLAY (CH), very stiff to hard, olive green -with shell fragments and mica -with sand pockets to 2.4m -with silt pockets below 2.7m -with silt partings at 5.5m (7.3m)	II
		50/25cm, 47/30cm, 60/30cm, 30/30cm	Coarse GRAVEL with clay (GP-GC) to clayey coarse GRAVEL (GC), hard, olive green -with shell fragments -with interbedded, dark gray intensely weathered, soft to very soft sandstone deposits, to 9.4m -silty coarse gravel (GM) with fine sand and clay pockets, 10.1m to 10.4m (11.0m)	III
		19/30cm, 30/30cm	Lean to fat CLAY (CH), hard, olive brown -with silt and sand pockets (12.8m)	IV
		30/25cm, 30/15cm, 30/5cm	Lean CLAY (CL), hard , moderate yellowish brown -with sandstone pockets -with vertical sand seams and poorly graded cemented sand, at 13.7m (14.3m)	V
		100-0, 100-15, 100-0, 100-0, 100-20, 100-15, 100-70	SANDSTONE (Graywacke)(RX), moderate brown, intensely weathered, soft, intensely fractured into 50mm to 100mm-long pieces See Plate 98-5.6 for detailed stratigraphy below 14.3m (22.3m)	VI
		95-60, 92-42	SILTSTONE (RX) thinly interbedded with CLAYSTONE (RX) and SANDSTONE (Graywacke)(RX) dark gray, slightly weathered, moderately hard to hard, moderately fractured (24.4m)	VII
		100-55, 100-60, 100-45, 100-100, 90-90, 90-90, 100-100, 100-100, 100-95, 100-80, 100-95	SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, slightly to moderately fractured -with a very intensely fractured claystone bed, 25.9m to 26.2m -moderately fractured with intensely fractured intervals, 20, 50, and 60 degrees, slightly to moderately rough, clean to thin patchy calcite/quartz filling, 26.2m to 30.2m (42.7m)	VIII
		100-100, 100-90	SANDSTONE (RX), medium dark gray, slightly weathered, hard, very slightly to slightly fractured	IX

TOTAL DEPTH: 45.1 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-5

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

PLATE 98-5.3

PROJECT NO:	98-42-0035	**START DATE:**	3/12/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-5 (Northeast of Pier E2)	**COMPLETION DATE:**	3/15/98	**DRILLING METHOD:**	Mud Rotary Boring

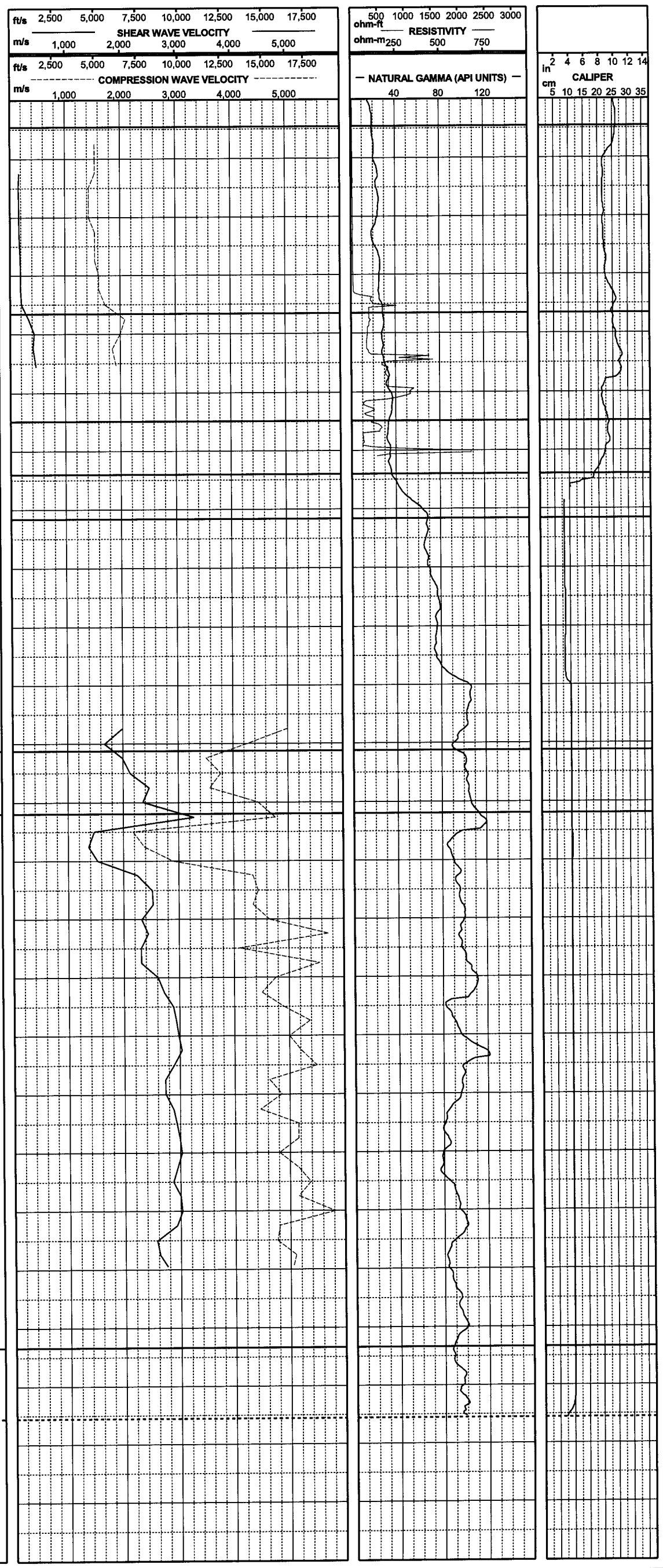
Coordinates: E1836418 N647608
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -23.2 m (MSL)

STRATUM NO.	MATERIAL DESCRIPTION
I	Sandy fat CLAY (CH), very soft, olive gray, with shell fragments (0.9m)
II	Fat CLAY (CH), very stiff to hard, olive green -with shell fragments and mica -with sand pockets to 2.4m -with silt pockets below 2.7m -with silt partings at 5.5m (7.3m)
III	Coarse GRAVEL with clay (GP-GC) to clayey coarse GRAVEL (GC), hard, olive green -with shell fragments -with interbedded, dark gray intensely weathered, soft to very soft sandstone deposits, to 9.4m -silty coarse gravel (GM) with fine sand and clay pockets, 10.1m to 10.4m (11.0m)
IV	Lean to fat CLAY (CH), hard, olive brown -with silt and sand pockets (12.8m)
V	Lean CLAY (CL), hard , moderate yellowish brown -with sandstone pockets -with vertical sand seams and poorly graded cemented sand, at 13.7m (14.3m)
VI	SANDSTONE (Graywacke)(RX), moderate brown, intensely weathered, soft, intensely fractured into 50mm to 100mm-long pieces See Plate 98-5.6 for detailed stratigraphy below 14.3m (22.3m)
VII	SILTSTONE (RX) thinly interbedded with CLAYSTONE (RX) and SANDSTONE (Graywacke)(RX) dark gray, slightly weathered, moderately hard to hard, moderately fractured (24.4m)
VIII	SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, slightly to moderately fractured -with a very intensely fractured claystone bed, 25.9m to 26.2m -moderately fractured with intensely fractured intervals, 20, 50, and 60 degrees, slightly to moderately rough, clean to thin patchy calcite/quartz filling, 26.2m to 30.2m (42.7m)
IX	SANDSTONE (RX), medium dark gray, slightly weathered, hard, very slightly to slightly fractured

TOTAL DEPTH: 45.1 m

BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-5

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

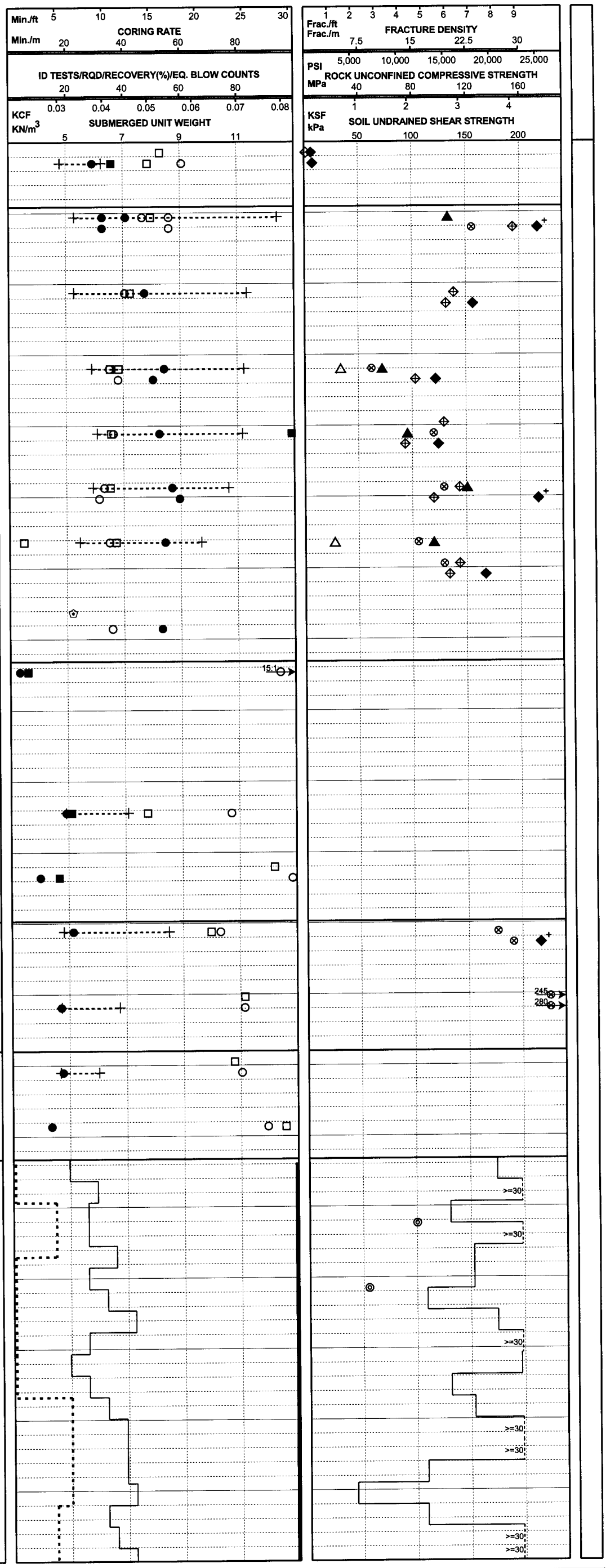
PLATE 98-5.4

PROJECT NO:	98-42-0035	**START DATE:**	3/12/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-5 (Northeast of Pier E2)	**COMPLETION DATE:**	3/15/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836418 N647608
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -23.2 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		WOH	Sandy fat CLAY (CH), very soft, olive gray, with shell fragments (0.9m)	I
-24	1	15/45cm	Fat CLAY (CH), very stiff to hard, olive green -with shell fragments and mica -with sand pockets to 2.4m	II
-25	2	12/45cm		
-26	3	16/60cm	-with silt pockets below 2.7m	
-27	4	28/60cm		
-28	5	PUSH		
-29	6	PUSH	-with silt partings at 5.5m (7.3m)	
-30	7	22		
-31	8	50/25cm 47/30cm	Coarse GRAVEL with clay (GP-GC) to clayey coarse GRAVEL (GC), hard, olive green -with shell fragments -with interbedded, dark gray intensely weathered, soft to very soft sandstone deposits, to 9.4m	III
-32	9	60/30cm		
-33	10	30/30cm	-silty coarse gravel (GM) with fine sand and clay pockets, 10.1m to 10.4m (11.0m)	
-34	11	19/30cm	Lean to fat CLAY (CH), hard, olive brown -with silt and sand pockets	IV
-35	12	30/30cm	(12.8m)	
-36	13	30/25cm	Lean CLAY (CL), hard , moderate yellowish brown -with sandstone pockets	V
-37	14	30/15cm	-with vertical sand seams and poorly graded cemented sand, at 13.7m (14.3m)	
-38	15	30/5cm 100-0 100-15	SANDSTONE (Graywacke)(RX), moderate brown, intensely weathered, soft, intensely fractured into 50mm to 100mm-long pieces -with a few claystone lenses -yellowish brown, moderately weathered, moderately hard, with slightly rough fractures orientated at 20, 30, 40 and 60 degrees with thin clay filling and reddish brown staining, 14.6m to 19.5m -very intensely fractured, with thin clay filling, at 15.5m	VI
-39	16	100-0	-very intensely fractured, with thin clay filling, at 16.5m	
-40	17	100-0	-slightly rough fractures inclined at 80 degrees, 25mm spacing, with reddish orange staining and thin clay filling, 17.1m to 17.7m -fractures inclined at 25 degrees, 17.7m to 19.2m	
-41	18	100-20	-fractures inclined at 70 to 80 degrees, 18.0m to 18.9m -very intensely fractured within thin discontinuous calcite filling, 18.3m to 18.6m	
-42	19	100-15	-fractures at 30 degrees, with thin clay filling, 19.2m to 20.4m -medium dark gray, slightly weathered, moderately hard to hard, below 19.5m	
-43				



LOG OF BORING AND TEST RESULTS

BORING 98-5

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

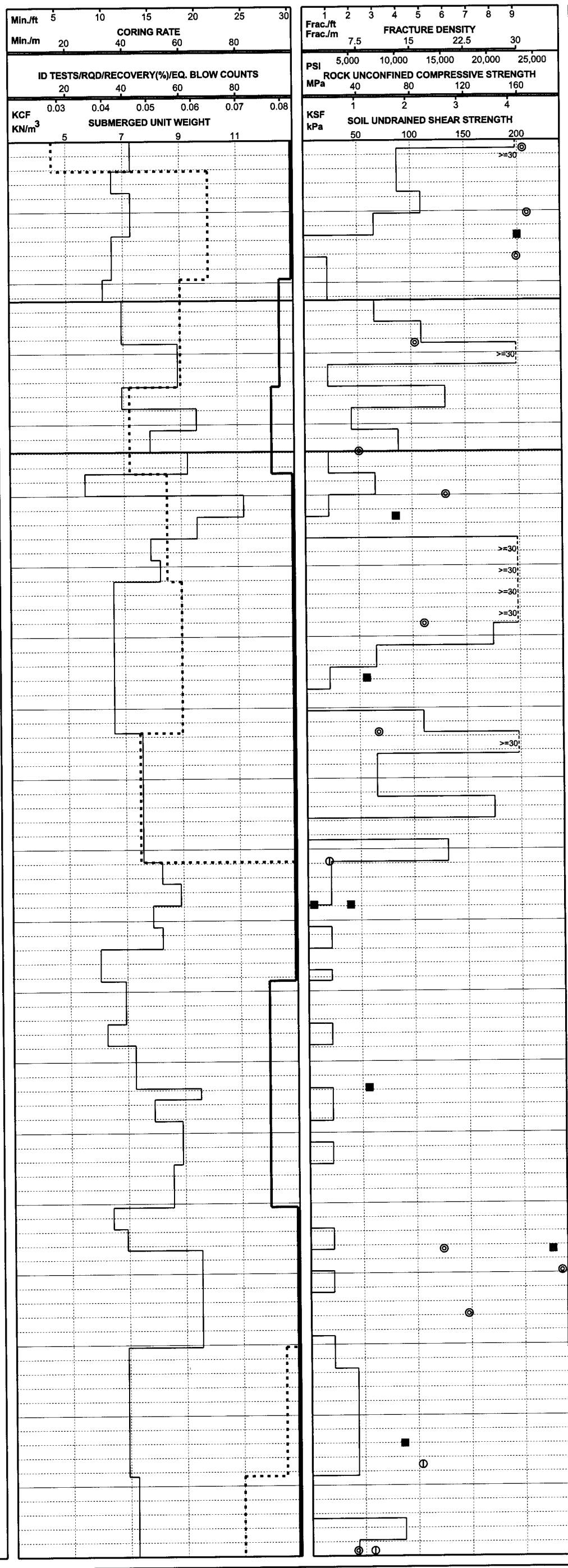
PLATE 98-5.5a

PROJECT NO: 98-42-0035
BORING: 98-5 (Northeast of Pier E2)
START DATE: 3/12/98
COMPLETION DATE: 3/15/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836418 N647608
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -23.2 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		100-15	SANDSTONE (Graywacke)(RX), moderate brown, intensely weathered, soft, intensely fractured into 50mm to 100mm-long pieces	VI
-44	21	100-70	-moderately to slightly fractured, tight moderately rough to slightly rough fractures at 50 degrees and 70 to 80 degrees with thin calcite filling, below 20.4m	
-45	22		-with a 150mm-thick claystone bed dipping 20 degrees, at 21.9m (22.3m)	
-46	23	95-60	SILTSTONE (RX) thinly interbedded with CLAYSTONE (RX) and SANDSTONE (Graywacke)(RX) dark gray, slightly weathered, moderately hard to hard, moderately fractured -spacing 50mm to 200mm, polished fractures (bedding plane) surfaces in siltstone and claystone -with a 150mm-thick sandstone bed at 22.6m -bedding at 20 degrees, 22.6m to 24.7m	VII
-47	24	92-42	(24.4m)	
-48	25		SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, slightly to moderately fractured -with thin, slightly rough fractures -with a few very thin to thin claystone lenses,25.1m to 25.8m	VIII
		100-55		
-49	26		-with a very intensely fractured claystone bed, 25.9m to 26.2m -moderately fractured with intensely fractured intervals, 20, 50, and 60 degrees, slightly to moderately rough, clean to thin patchy calcite/quartz filling, 26.2m to 30.2m -thin healed calcite-filled fracture, 26.2m to 30.2m	
-50	27	100-60		
-51	28			
-52	29		-with several moderately thick (to 13mm) calcite/quartz filled fractures at 70 degrees, 28.7m to 29.3m	
		100-45		
-53	30		-with pyrite flakes at 30.2m	
-54	31	100-100		
-55	32			
		90-90		
-56	33		- with a 50mm-thick claystone bed dipping at 25 degrees, at 33.5m and 33.8m	
-57	34		-with a very thin 50mm-thick claystone bed dipping at 25 degrees, at 34.3m	
		90-90		
-58	35			
		100-100		
-59	36			
		100-100		
-60	37		-fractures at 30 degrees, moderately rough, clean with some discontinuous calcite/ quartz filling, 36.9m to 40.8m -near vertical moderately rough, stepped, clean fracture, 37.5m to 38.1m	
-61	38	100-95		
-62	39			
		100-80	-with a 50mm-thick, intensely fractured siltstone bed at 39.6m	
-63				



LOG OF BORING AND TEST RESULTS

BORING 98-5

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

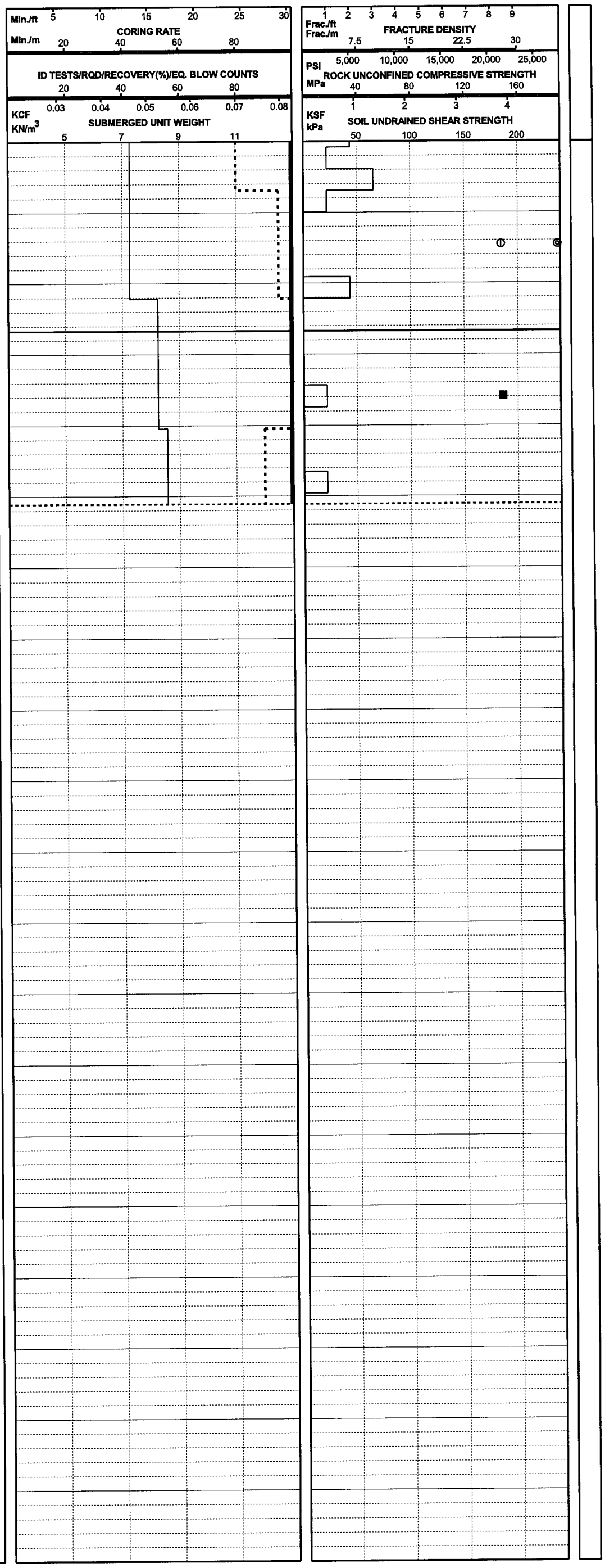
PLATE 98-5.5b

PROJECT NO:	98-42-0035	**START DATE:**	3/12/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-5 (Northeast of Pier E2)	**COMPLETION DATE:**	3/15/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836418 N647608
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -23.2 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		100-80	SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, slightly to moderately fractured	VIII
-64	41		-near vertical calcite-filled fracture at 40.8m -slightly to very slightly fractured, with very thin, healed, closed calcite-/ quartz-filled fractures, 40.8m to 45.1m	
		100-95		
-65	42		(42.7m)	
-66	43	100-100	SANDSTONE (RX), medium dark gray, slightly weathered, hard, very slightly to slightly fractured -with thin, healed, closed, calcite-/ quartz-filled fracture at 20, 30, 40, 60, and 70 degrees	IX
-67	44			
		100-90		
-68	45		TOTAL DEPTH: 45.1 m BACKFILLED WITH: Cement Grout	
-69	46			
-70	47			
-71	48			
-72	49			
-73	50			
-74	51			
-75	52			
-76	53			
-77	54			
-78	55			
-79	56			
-80	57			
-81	58			
-82	59			
-83				



LOG OF BORING AND TEST RESULTS

BORING 98-5

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-5.5c

Earth Mechanics

FUGRO

98-5		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
0.2	1					8.3						6.4		1.3															
0.3	2	29	32	18	0.78	7.9	36					7.7																	
1.1	3	33	94	23	0.14																								
1.1	3	41				8.0										133.4													
1.2	4	33								193.9	155.6	216.9																	
2.1	6	47	84	23	0.41	7.2				138.9																			
2.3	7									131.7		156.7																	
3.2	9	54	82	29	0.47						62.2																		
3.2	9	54				6.8										72.0													
3.2	9					6.5											33.4												
3.4	10	50								102.9		121.7																	
4.0	11									129.3																			
4.1	12	53	82	31	0.42		99				119.7																		H
4.1	12	53				6.6										95.4													
4.3	13									93.4		124.1																	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-5
SFOBB East Span Seismic Safety Project

8003SSMA(8/12/98/09:47 AM)

Earth Mechanics

FUGRO

98-5		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
4.9	15	57	77	29	0.58					143.6	129.3																		
4.9	15	57				6.5										150.8													
5.0	16	60								119.7		216.9																	
5.6	17	55	67	25	0.70						105.3																		
5.6	17	54				6.7										119.6													
5.6	17					3.5											27.2												
5.9	18									143.6	129.3																		
6.1	19									134.1		167.5																	
6.9	20	53																											
7.5	21	3					6																						
9.4	23	19	41	19		7.8	21																						
10.2	24					12.2																							
10.4	25	10					17																						
11.1	26	21	55	18	0.09	10.0					177.2																		
11.3	27										191.5	216.9																	

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-5
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/09:47 AM)

Earth Mechanics

FUGRO

98-5		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
12.0	28					11.2					245.3																		
12.2	29	17	38	17							280.4																		
13.0	30					10.8																							
13.1	31	18	30	17	0.05																								
13.9	32	14				12.6																							
15.2	35																								80.1				
15.5	35b																			22.8	37	11.7	32						
16.2	36a																								44.2				
16.2	36b																			48.3	42	7.6	32						
20.1	39																								164.0				
21.0	40a																								167.2				
21.3	40d																							159.5		26.6	70.4	0.29	
21.3	40c																			29.6	40	22.1	34						
21.6	40b																								159.0				
22.9	41																								82.9				

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-5
SFOBB East Span Seismic Safety Project

50035SMA(8/12/98/08:47 AM)

Earth Mechanics

FUGRO

98-5		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
24.4	42																								40.4				
25.0	43c																								105.0				
25.3	43a1																							67.6		26.4	24.6	0.34	
25.6	43a2																	6550	41							26.6	23.8	0.37	
25.6	43a2																	6550	41	24.8	33	-2.8	27						
26.8	44b																								88.4				
27.6	44a																							45.0		26.6	46.0	0.28	
28.3	45b																								53.9				
30.2	45a																								16.2				
30.8	48a2																							4.3		26.7	40.6	0.26	
30.8	48a1																							31.9		26.6	21.6		
31.1	48b																			47.6	39	22.1	40						
33.4	47b																							44.7		26.9	80.2	0.26	
35.7	50b																							180.9		26.9	59.5	0.25	
35.7	50b																								99.5				

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-5
SFOBB East Span Seismic Safety Project

8003SSMA(8/12/98/10:47 AM)

Earth Mechanics

FUGRO

98-5		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
36.0	50a																								187.9				
36.6	50b																								118.0				
38.4	51b																							69.3		26.9	54.8	0.25	
38.7	51a																								82.9				
39.9	52a																								47.0				
39.9	52b																								34.0				
41.5	53a																								147.8				
41.5	53b																								189.9				
43.6	54a																							148.7		26.9	57.5	0.27	

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Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
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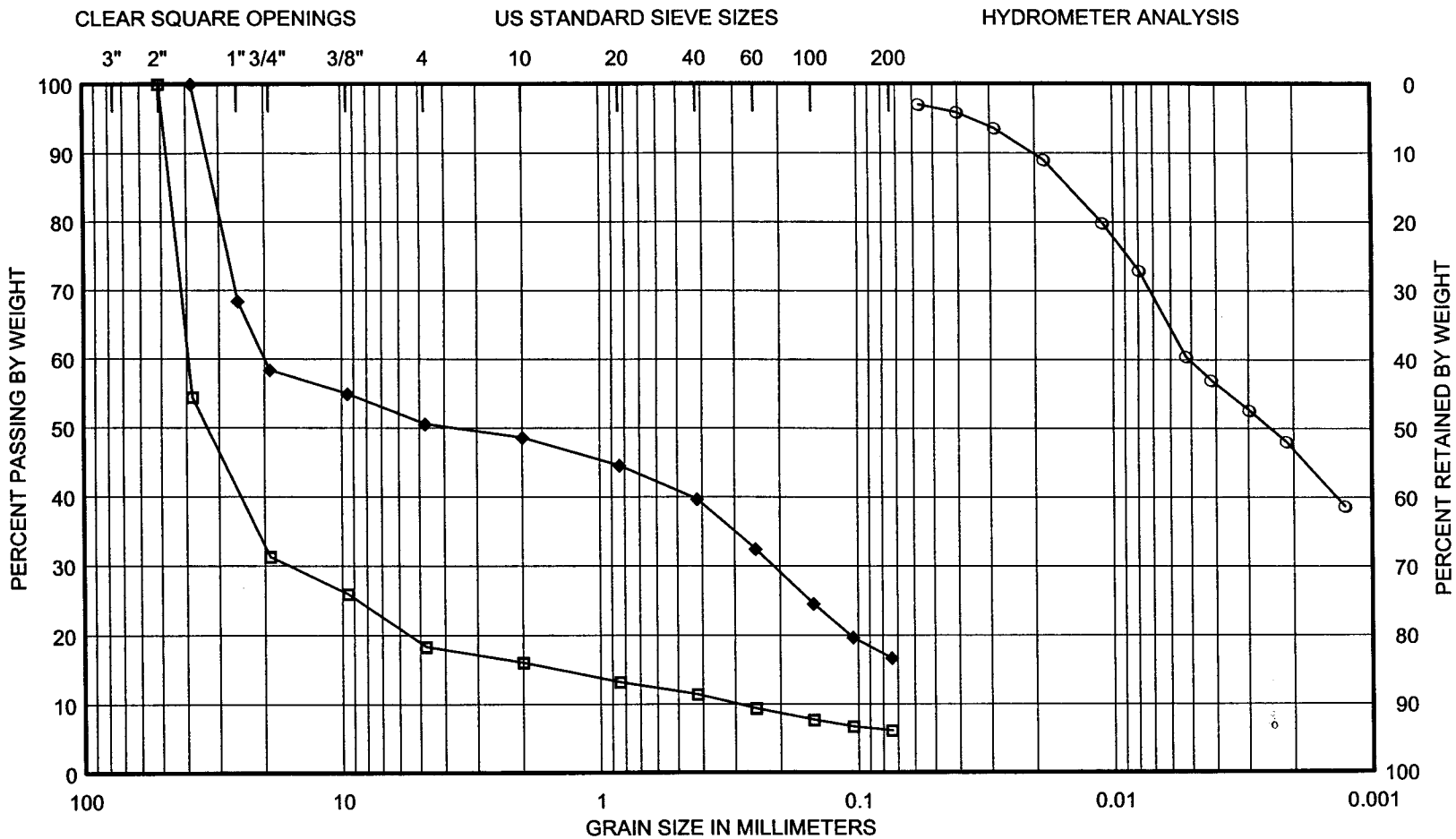
SUMMARY OF LABORATORY TEST RESULTS
BORING 98-5
SFOBB East Span Seismic Safety Project

8003SSMAT(8/12/98/08:47 AM)



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
12	4.1	○—○	FAT CLAY (CH)
21	7.5	□—□	COARSE GRAVEL (GP-GC) with clay
25	10.4	◆—◆	SILTY COARSE GRAVEL (GM) with fine sand

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-5

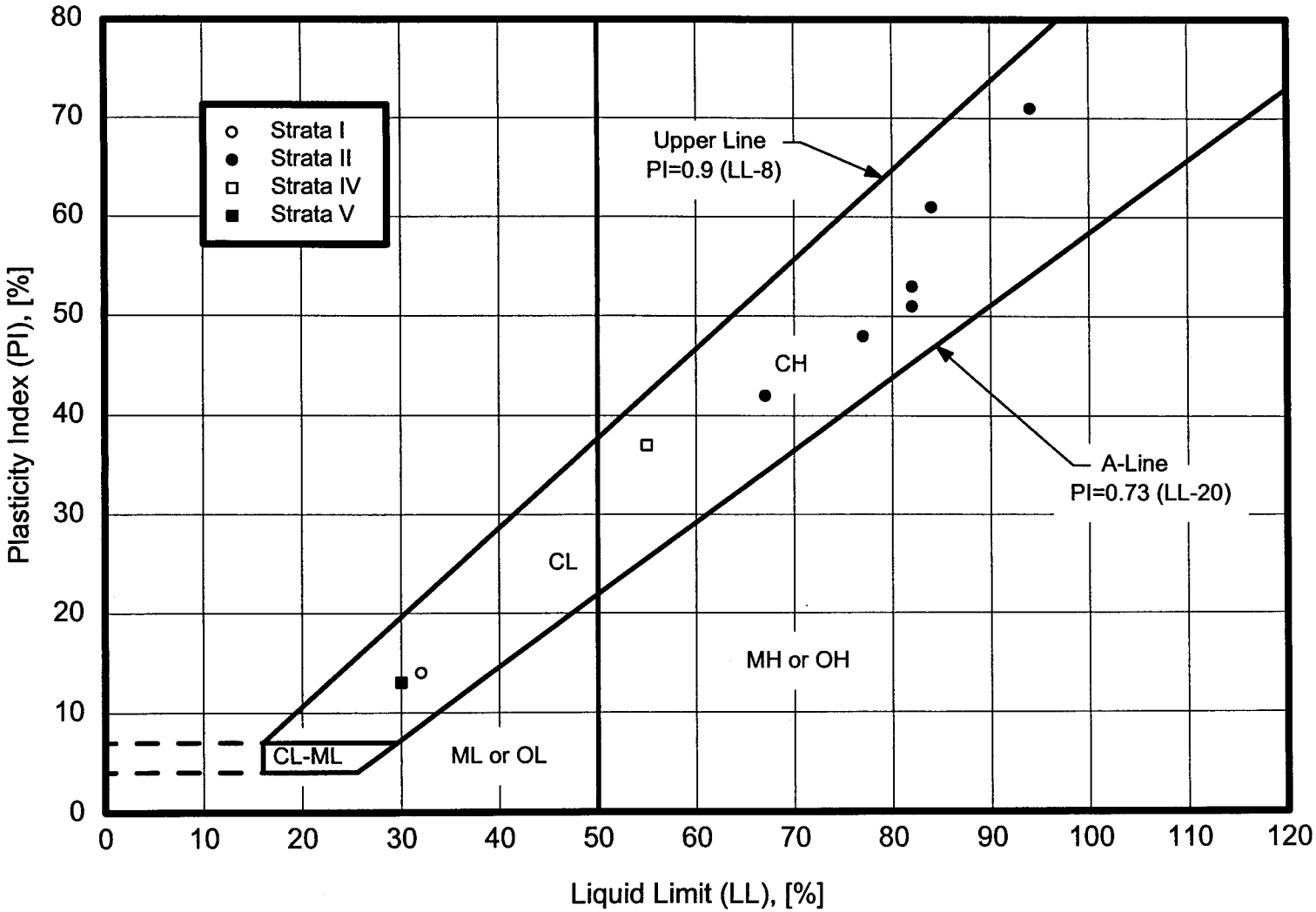
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

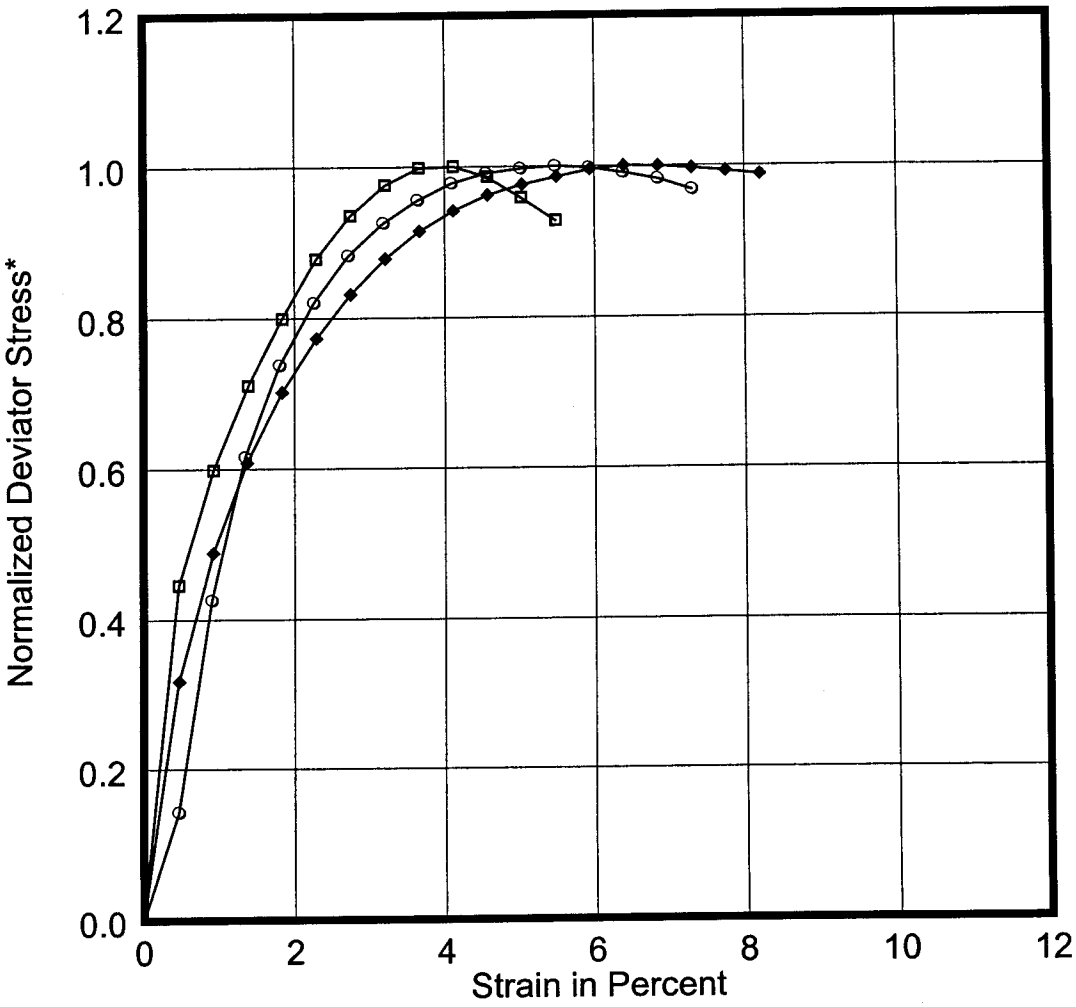
Earth Mechanics

FUGRO

PLATE 98-5.7



PLASTICITY CHART
Boring 98-5
SFOBB East Span Seismic Safety Project

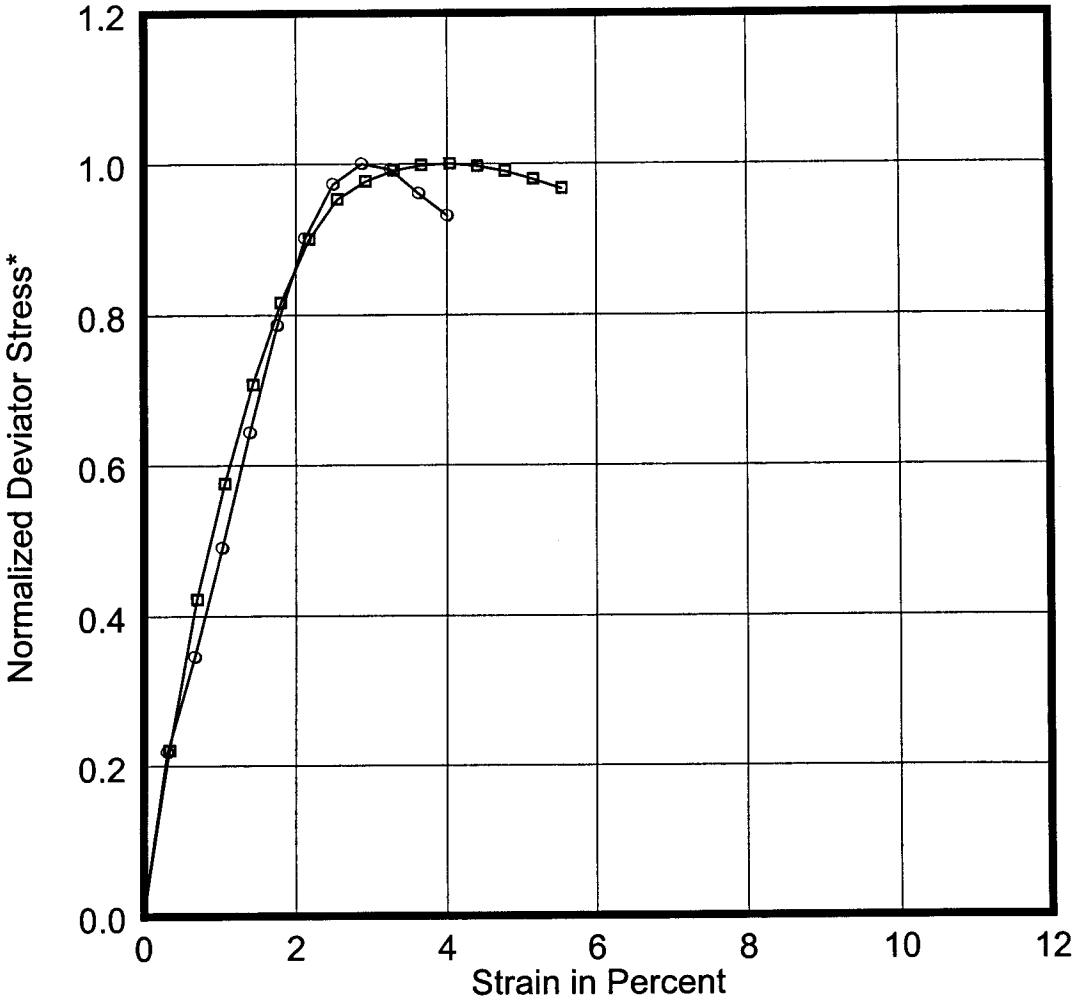


Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	3	1.1	UU	827	267	1.1
□——□	9	3.2	UU	827	144	0.6
◆——◆	12	4.1	UU	827	191	1.0

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-5
SFOBB - East Span Seismic Safety Project



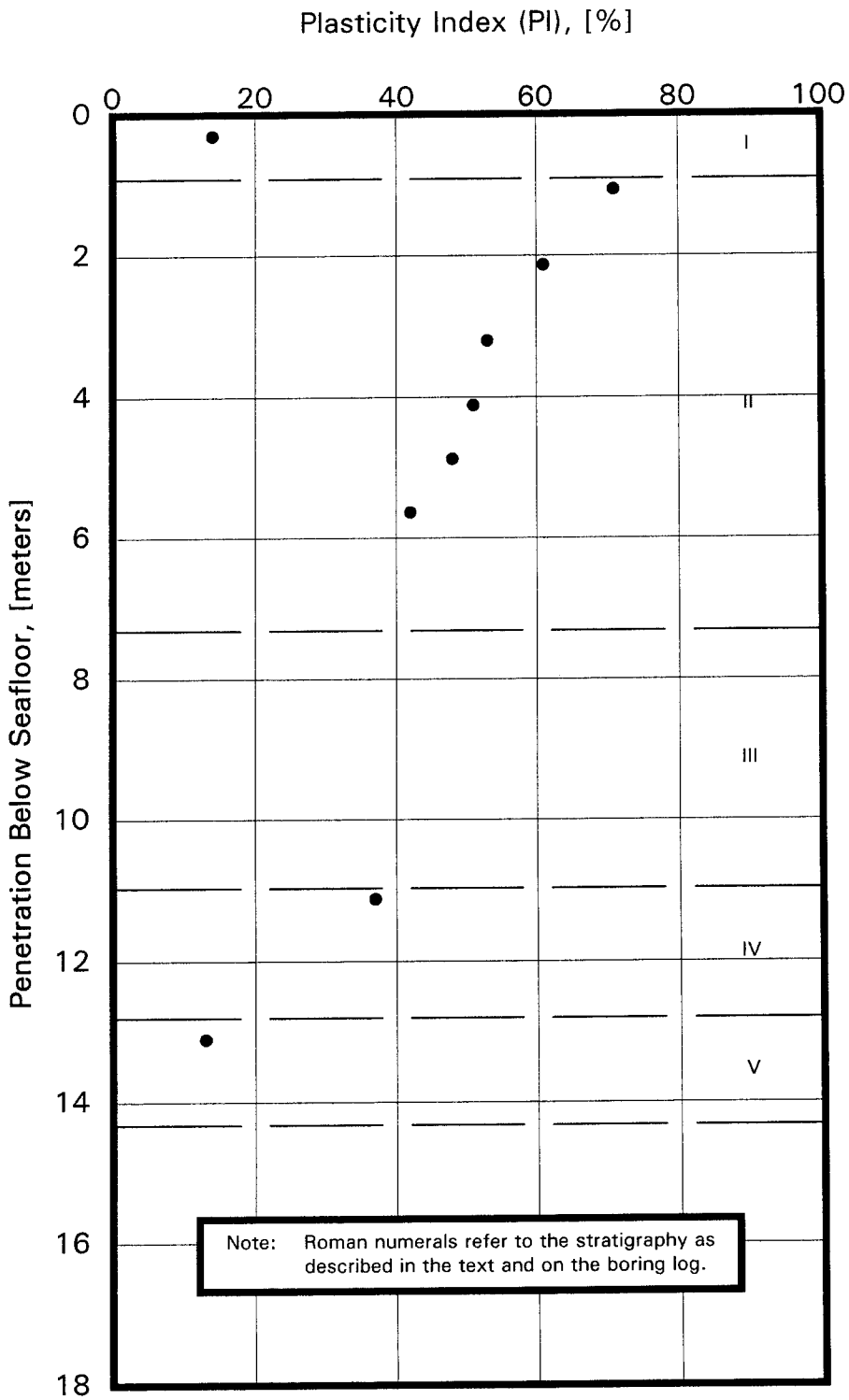
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	15	4.9	UU	827	302	1.1
□——□	17	5.6	UU	827	239	0.9

* Normalized with respect to maximum deviator stress.

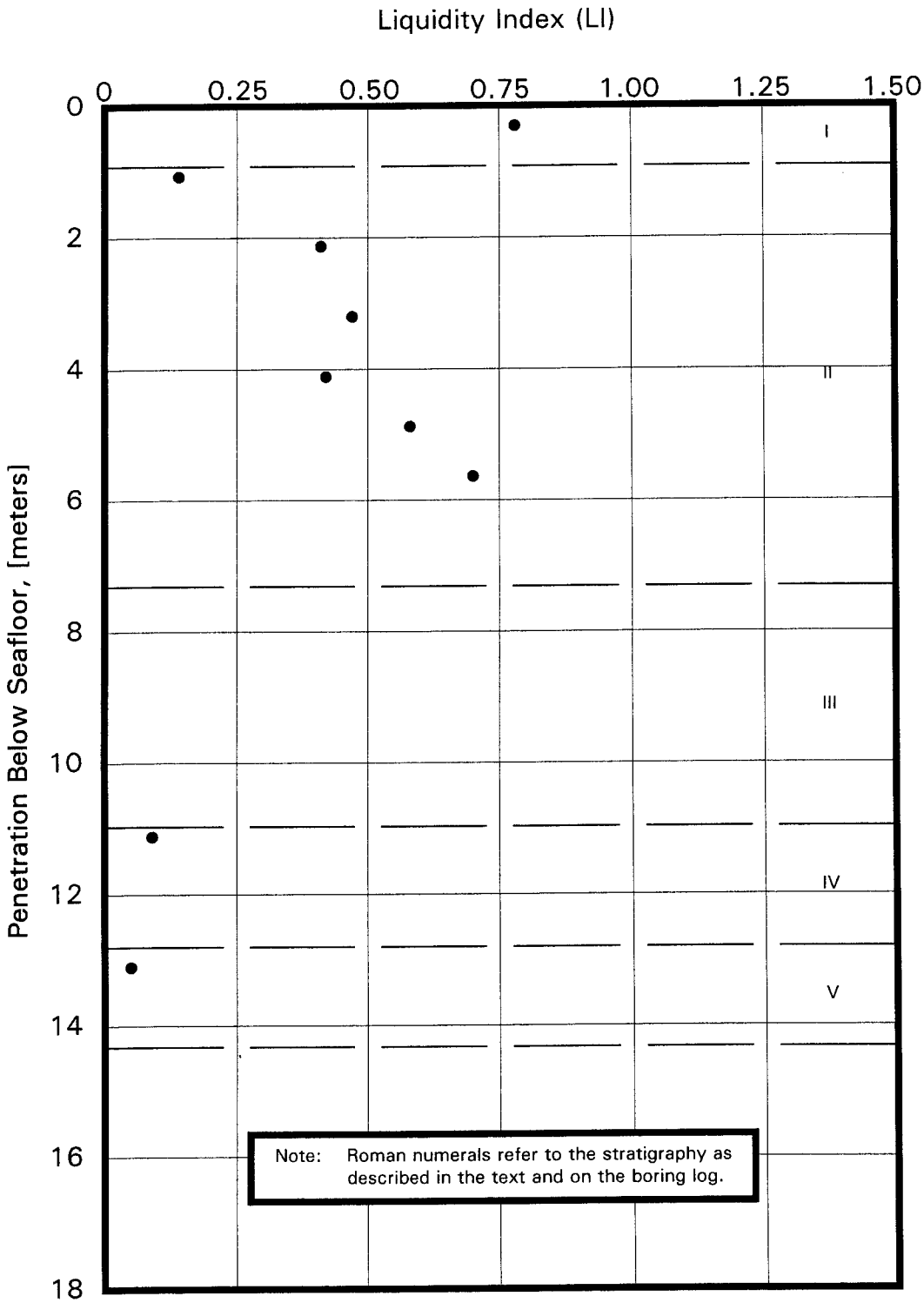
STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-5
SFOBB - East Span Seismic Safety Project

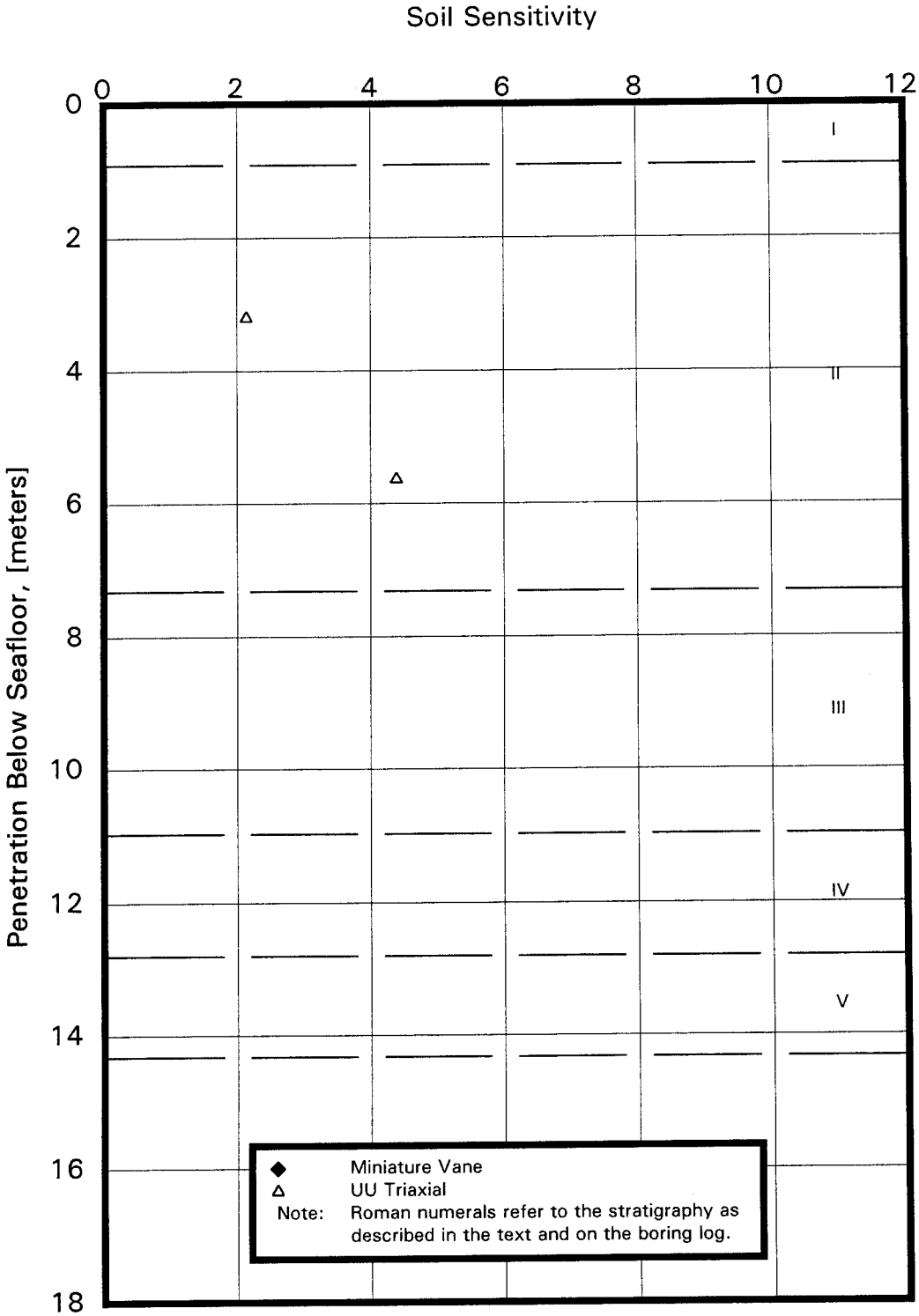
PLATE 98-5.9b



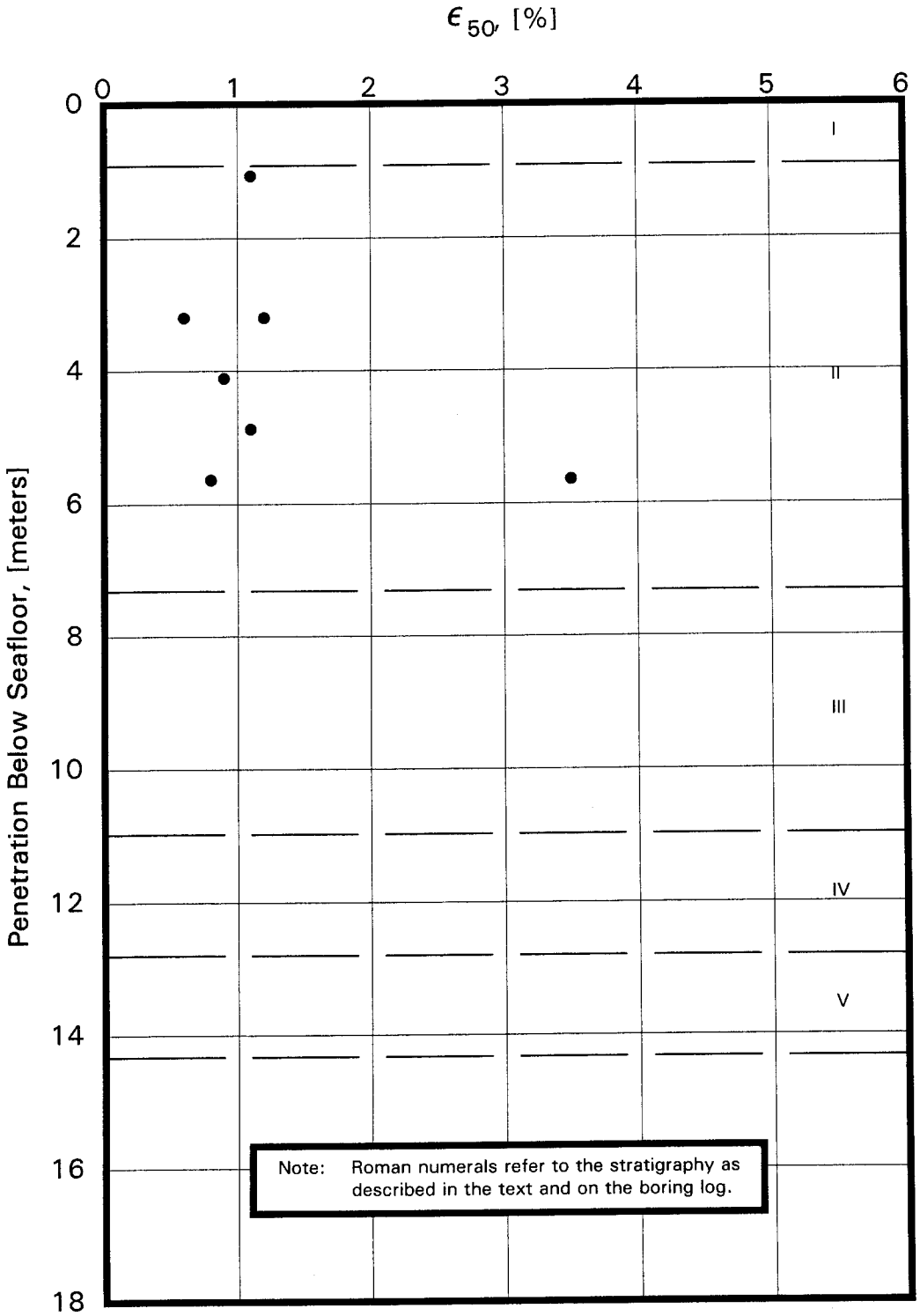
PLASTICITY INDEX PROFILE
Boring 98-5
SFOBB East Span Seismic Safety Project



LIQUIDITY INDEX PROFILE
Boring 98-5
SFOBB East Span Seismic Safety Project



SOIL SENSITIVITY PROFILE
Boring 98-5
SFOBB East Span Seismic Safety Project



ϵ_{50} PROFILE
Boring 98-5
SFOBB East Span Seismic Safety Project

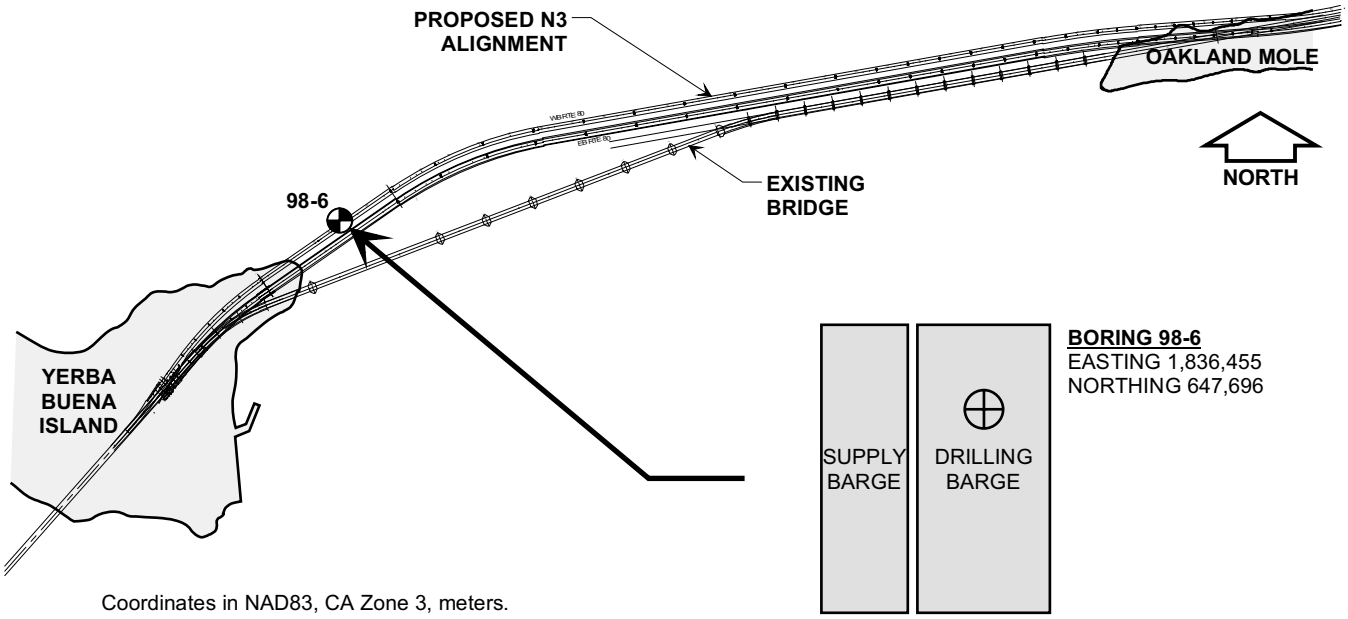
BORING 98-6

Date	Time From	Time To	Description of Activity
March 20, 1998	0830	1030	Move barge into location for Boring 98-6 (northeast of Pier E2)
	1030	1130	Run pipe to mudline.
	1130	1200	Measure water depth of 24.4m (80 ft) using bottom sensor. Current tide level is approximately 0m (0 ft) MSL. Calculate mudline elevation of –24.4m (-80 ft) MSL.
	1200	1830	Drill and sample, 0m (0 ft) to 11.3m (37 ft).
	1830	1900	Break (lunch).
	1900	2030	Drill and sample 11.3m (37 ft) to 12.8m (42 ft).
	2030	2200	Mix cement / gel and grout hole.
	2200	2230	Clean out tanks / pumps.
	2230	2300	Pull pipe and prepare to winch over and run casing.
	2300	2400	Crew change/winch to new location about 7 meters southwest of original location.
March 21, 1998	0000	0300	Run casing to 2.1m (7 ft) below mudline.
	0300	0815	Unable to achieve sufficient casing penetration. Pull 12.2m (40 ft) of casing and remove 3m (10 ft) section. Rerun casing and set at 2.1m (7 ft) below mudline.
	0815	0930	Set-up flowline, run in hole with drill pipe and wash down to 12.8m (42 ft).
	0930	1100	Lose circulation at 2.1m (7 ft), pull casing above seafloor and move rig.
	1100	1345	Run 12.7 cm (5 inch) pipe.
	1345	1730	Drill and sample 12.8m (42 ft) to 21.6m (71 ft).
	1730	1830	Encounter gravel at 21.5m (70.5 ft). Unable to advance rock bit. Pull pipe to run HC core barrel.
	1830	1900	Break (Lunch).
	1900	2145	Run core pipe.
	2145	2205	Advance core barrel from 21.5m (70.5 ft) to 23m (75.5 ft). No recovery.
	2205	2300	Redrill 21.5m (70.5 ft) to 23m (75.5 ft).
	2300	2400	Perform SPT sample from 23.3m (76.5 ft) to 23.7m (78 ft).
March 22, 1998	0000	0100	Switch over to mud system and prepare to advance core barrel with inner rock bit.
	0100	0500	Drill/sample at 1.5-meter (5-foot) intervals from 24.7m (81 ft) to 34.9m (114.5 ft). Encounter sandstone bedrock at 34.9m (114.5 ft).
	0500	0530	Prepare to rock core. Switch to saltwater.
	0530	1100	Rock core from 35m (115 ft) to 43.6 (143 ft).
	1130	1130	Crew change.

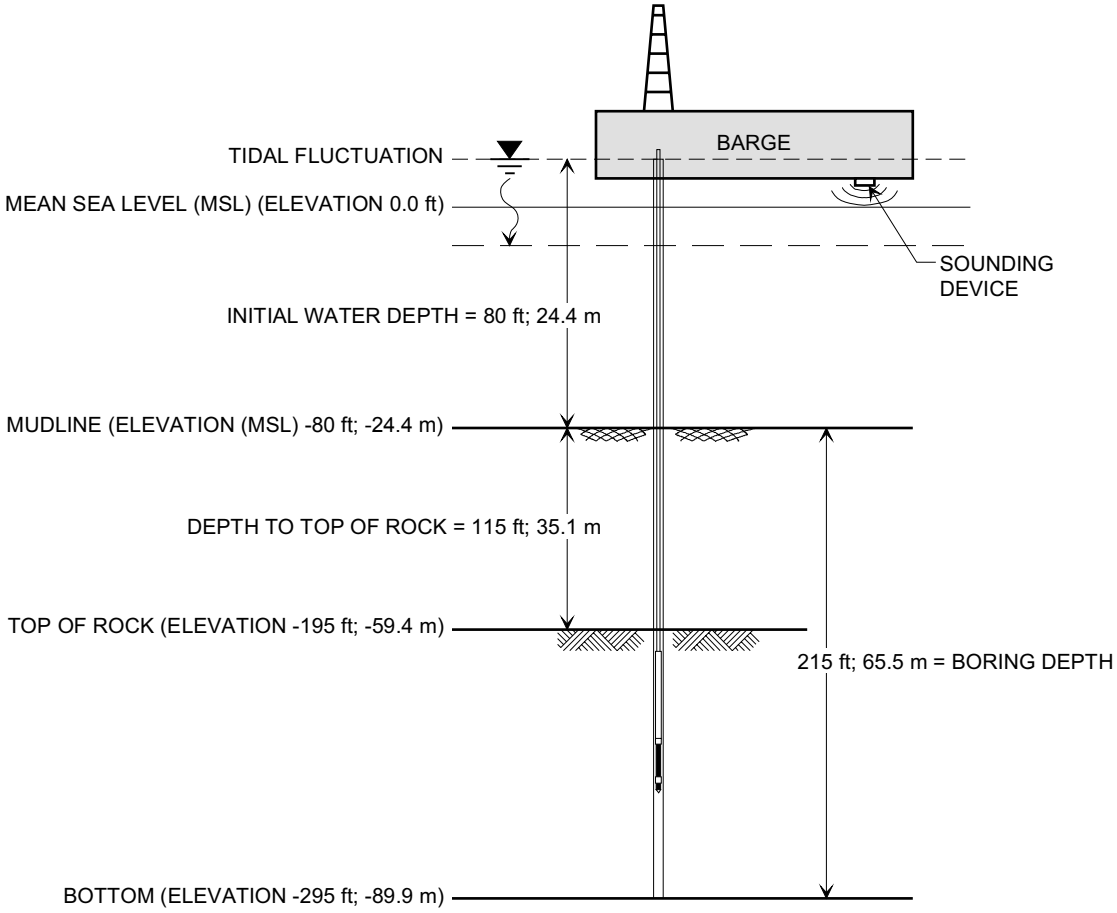
SUMMARY OF FIELD OPERATIONS
Boring 98-6
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
March 22, 1998	1100	1830	Rock core from 43.6m (143 ft) to 53.3m (175 ft).
	1830	1900	Break (Lunch).
	1900	1930	Rock core at 53.3m (175 ft). Bit jams constantly.
	1930	2400	Pull core pipe and advance 12.7 cm (5-inch) drill pipe/casing to 37.2m (122 ft) (2.1m [7 ft] into bedrock).
March 23, 1998	0000	0100	Run in hole with HC core barrel/pipe to clean out hole to 53.3m (175 ft).
	0100	0930	Rock core from 53.3m (175 ft) to 65.5m (215 ft).
	0930	1130	Run E-Logs (suspension, acoustic, and gamma/resistively logs).
	1130	2100	Downhole logging.
	2100	2400	Mix cement and pull pipe.
March 24, 1998	0000	0600	Grout hole and pull casing to deck.
	0600	0630	Pull anchors and depart location for CS Marine yard on Mare Island.

SUMMARY OF FIELD OPERATIONS
Boring 98-6
SFOBB East Span Seismic Safety Project



Coordinates in NAD83, CA Zone 3, meters.



BORING 98-6 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-6.2

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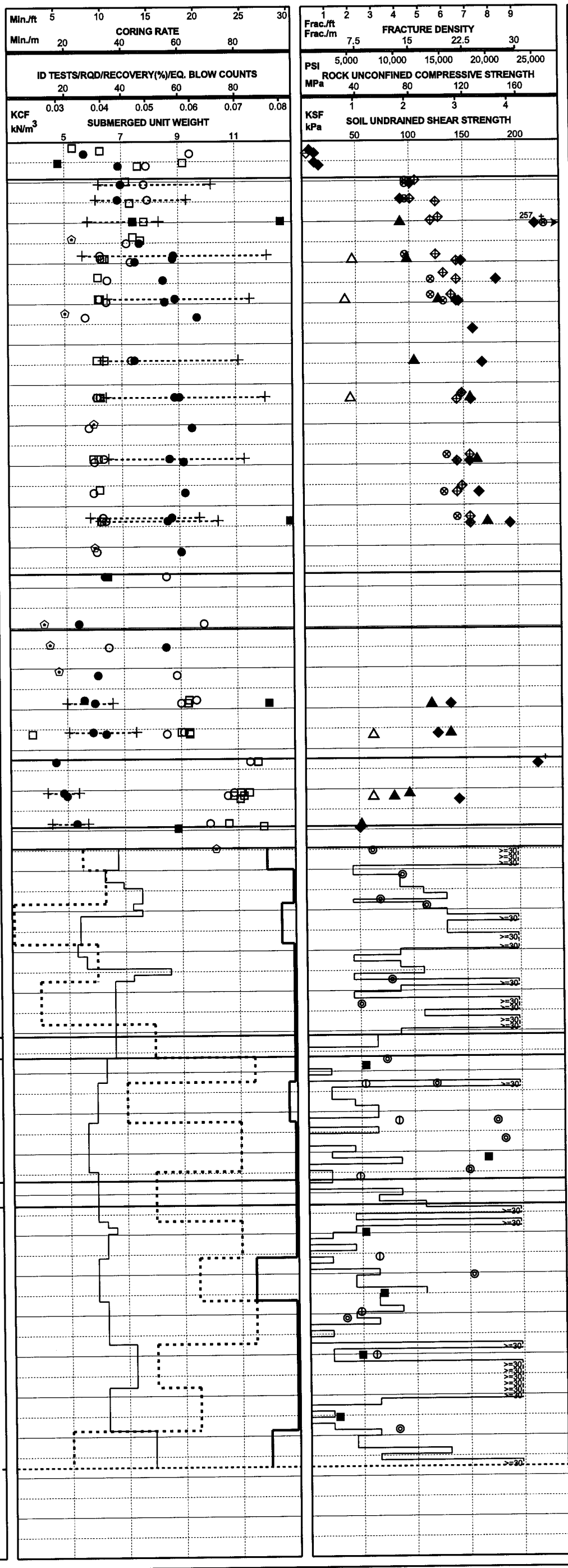
PROJECT NO:	98-42-0035	**START DATE:**	3/20/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-6 (Northeast of Pier E2)	**COMPLETION DATE:**	3/24/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836455 N647696
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -24.4 m (MSL)

Elevation, m.	Depth, m.	Blow Count	Material Description	Stratum No.
		WOH	Fat CLAY (CH), very soft, olive gray	I
		WOH	-with organic matter pockets at 0.2m	
			-sand layer with clay pockets and shell fragments, 0.3m to 1.1m (1.8m)	
-26	2	5/30cm	-with sand pockets and shell fragments, at 1.2m	
		8/30cm	Fat CLAY (CH), greenish gray to olive gray, stiff to hard	II
-28	4	22/45cm	-with a few silt partings and seams, at 2.1m	
		36	-with silt partings at 3.0m	
-30	6	PUSH	-greenish gray, 3.7m to 6.1m	
		PUSH	-with cemented sand pockets, 3.7m to 5.2m	
-32	8	PUSH	-with sand pockets at 4.9m	
		20	-with shell fragments, 7.3m to 15.8m	
-34	10	PUSH	-with silt partings at 7.6m	
		PUSH		
-36	12	PUSH		
-38	14	30		
-40	16	PUSH		
-42	18	PUSH	-with silt partings at 17.1m	
		PUSH		
-44	20	30	-with silt partings and shell fragments, at 20.1m (21.3m)	
-46	22	PUSH	Sandy Lean CLAY with gravel (CL), stiff to very stiff, grayish green	III
			-with many shell fragments and rounded gravel to 20mm-diameter	
-48	24	12	-with sand pockets and a few shell fragments, at 23.8m (24.1m)	
		14	Lean CLAY (CL), very stiff, grayish green	IV
-50	26	17	-with many shell fragments	
			-gray to dark gray, with fine sand pockets, light brown clay pockets, and with clay seams, below 25.9m	
-52	28	15/35cm	-with rounded fine to coarse gravel at 27.4m	
-54	30	30/50cm	(30.5m)	
		30/25cm	Lean CLAY (CL), very stiff, dark gray to olive gray	V
-56	32	30/45cm	-with greenish black clay pockets	
-58	34	30/50cm	(33.8m)	
		30/5cm	Clayey SAND (SC), grayish green (34.9m)	VI
-60	36	90-25	SANDSTONE-Graywacke (RX), moderate yellowish brown, moderately weathered, moderately hard, thickly to very thickly bedded, intensely fractured, fractures in sets inclined at 20, 50, 60, and 70-80 degrees	VII
		100-33		
-62	38	95-0		
-64	40	100-30	See Plate 98-6.6 for detailed stratigraphy below 34.9m	
-66	42	100-10		
-68	44	100-50	(44.2m)	
			SANDSTONE moderately to thinly interbedded with SILTSTONE (RX) [3:1], slightly weathered, moderately to intensely fractured, moderately spaced fractures, moderately thin fractures, slightly rough (45.3m)	VIII
-70	46	100-85		
-72	48	97-40	SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered to fresh, hard, thickly bedded, with closed, tight calcite filled fractures, moderately thin to thin, slightly rough	IX
-74	50	100-80	(51.4m)	
-76	52	100-50	SANDSTONE (RX) interbedded with SILTSTONE (RX)[2:1], slightly weathered, moderately to intensely fractured, moderately spaced, clean, slightly rough, with yellowish brown stains and large patches of calcite (52.6m)	X
-78	54	100-80	SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered, hard, thickly bedded, unfractured to slightly fractured, widely spaced, clean, moderately to slightly rough, with a few closed, tight, calcite and quartz filled fractures	XI
-80	56	85-65	-with laminated, dark gray, moderately hard to hard, intensely fractured siltstone, 56.8m to 57.5m	
-82	58	100-85	-with thin quartz and calcite filled fractures dipping at 30 to 80 degrees, below 57.5m	
-84	60	100-50		
-86	62	100-65		
-88	64	90-20		
-90	66		TOTAL DEPTH: 65.5 m BACKFILLED WITH: Cement Grout	
-92	68			
-94				



LOG OF BORING AND TEST RESULTS

BORING 98-6

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

FUGRO

PLATE 98-6.3

PROJECT NO: 98-42-0035
BORING: 98-6 (Northeast of Pier E2)
START DATE: 3/20/98
COMPLETION DATE: 3/24/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836455 N647696
CA State Plane Zone 3, NAD83, Meters

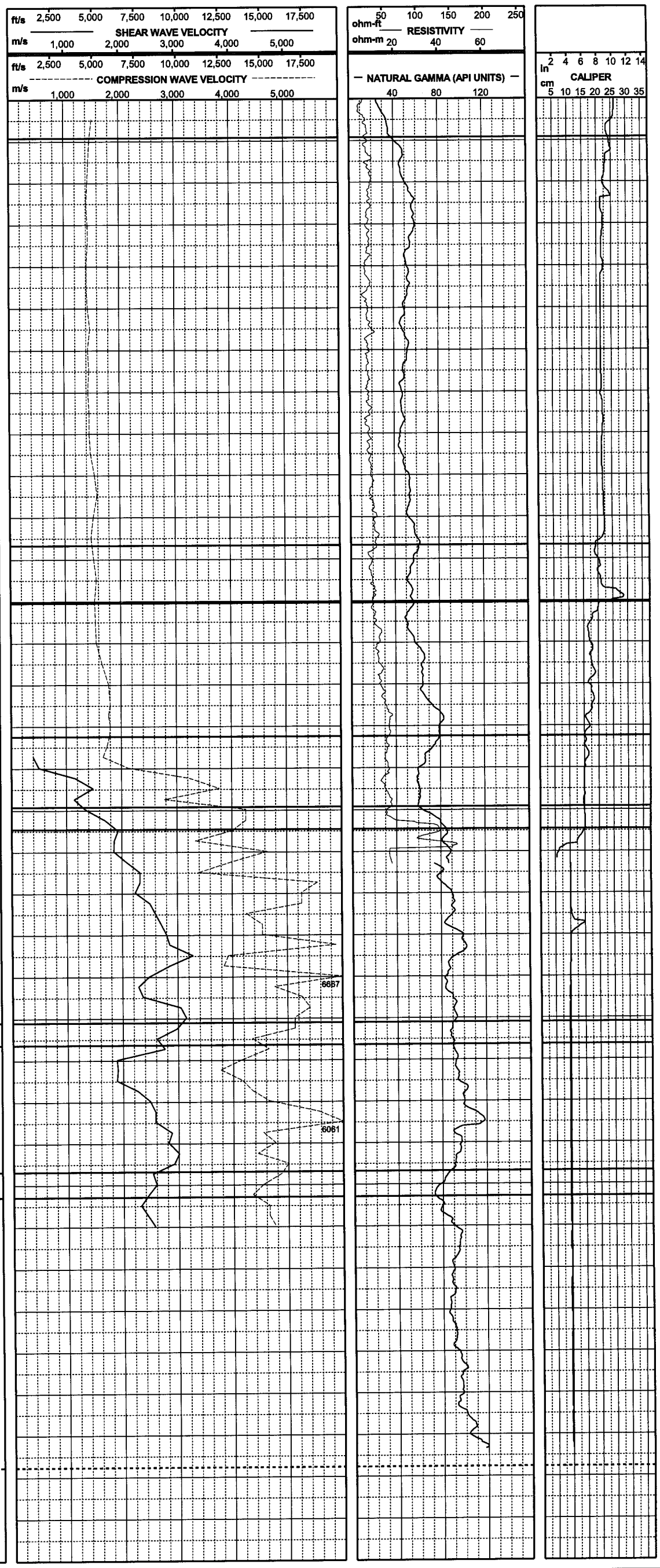
MUDLINE ELEVATION: -24.4 m (MSL)

STRATUM NO.	MATERIAL DESCRIPTION
I	Fat CLAY (CH), very soft, olive gray -with organic matter pockets at 0.2m -sand layer with clay pockets and shell fragments, 0.3m to 1.1m (1.8m) -with sand pockets and shell fragments, at 1.2m
II	Fat CLAY (CH), greenish gray to olive gray, stiff to hard -with a few silt partings and seams, at 2.1m -with silt partings at 3.0m -greenish gray, 3.7m to 6.1m -with cemented sand pockets, 3.7m to 5.2m -with sand pockets at 4.9m -with shell fragments, 7.3m to 15.8m -with silt partings at 7.6m -with silt partings at 17.1m -with silt partings and shell fragments, at 20.1m (21.3m)
III	Sandy Lean CLAY with gravel (CL), stiff to very stiff, grayish green -with many shell fragments and rounded gravel to 20mm-diameter (24.1m)
IV	-with sand pockets and a few shell fragments, at 23.8m Lean CLAY (CL), very stiff, grayish green -with many shell fragments -gray to dark gray, with fine sand pockets, light brown clay pockets, and with clay seams, below 25.9m -with rounded fine to coarse gravel at 27.4m (30.5m)
V	Lean CLAY (CL), very stiff, dark gray to olive gray -with greenish black clay pockets (33.8m)
VI	Clayey SAND (SC), grayish green (34.9m)
VII	SANDSTONE-Graywacke (RX), moderate yellowish brown, moderately weathered, moderately hard, thickly to very thickly bedded, intensely fractured, fractures in sets inclined at 20, 50, 60, and 70-80 degrees See Plate 98-6.6 for detailed stratigraphy below 34.9m (44.2m)
VIII	SANDSTONE moderately to thinly interbedded with SILTSTONE (RX) [3:1], slightly weathered, moderately to intensely fractured, moderately spaced fractures, moderately thin fractures, slightly rough (45.3m)
IX	SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered to fresh, hard, thickly bedded, with closed, tight calcite filled fractures, moderately thin to thin, slightly rough (51.4m)
X	SANDSTONE (RX) interbedded with SILTSTONE (RX)[2:1], slightly weathered, moderately to intensely fractured, moderately spaced, clean, slightly rough, with yellowish brown stains and large patches of calcite (52.6m)
XI	SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered, hard, thickly bedded, unfractured to slightly fractured, widely spaced, clean, moderately to slightly rough, with a few closed, tight, calcite and quartz filled fractures -with laminated, dark gray, moderately hard to hard, intensely fractured siltstone, 56.8m to 57.5m -with thin quartz and calcite filled fractures dipping at 30 to 80 degrees, below 57.5m

Blow counts: WOH; 5/30cm; 8/30cm; 22/45cm; 36; PUSH; PUSH; PUSH; 20; PUSH; PUSH; PUSH; 30; PUSH; PUSH; PUSH; 30; PUSH; 12; 14; 17; 15/35cm; 30/50cm; 30/25cm; 30/45cm; 30/50cm; 30/5cm; 90-25; 100-33; 95-0; 100-30; 100-10; 100-50; 100-85; 97-40; 100-80; 100-50; 100-80; 85-65; 100-85; 100-50; 100-65; 90-20

TOTAL DEPTH: 65.5 m

BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-6

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

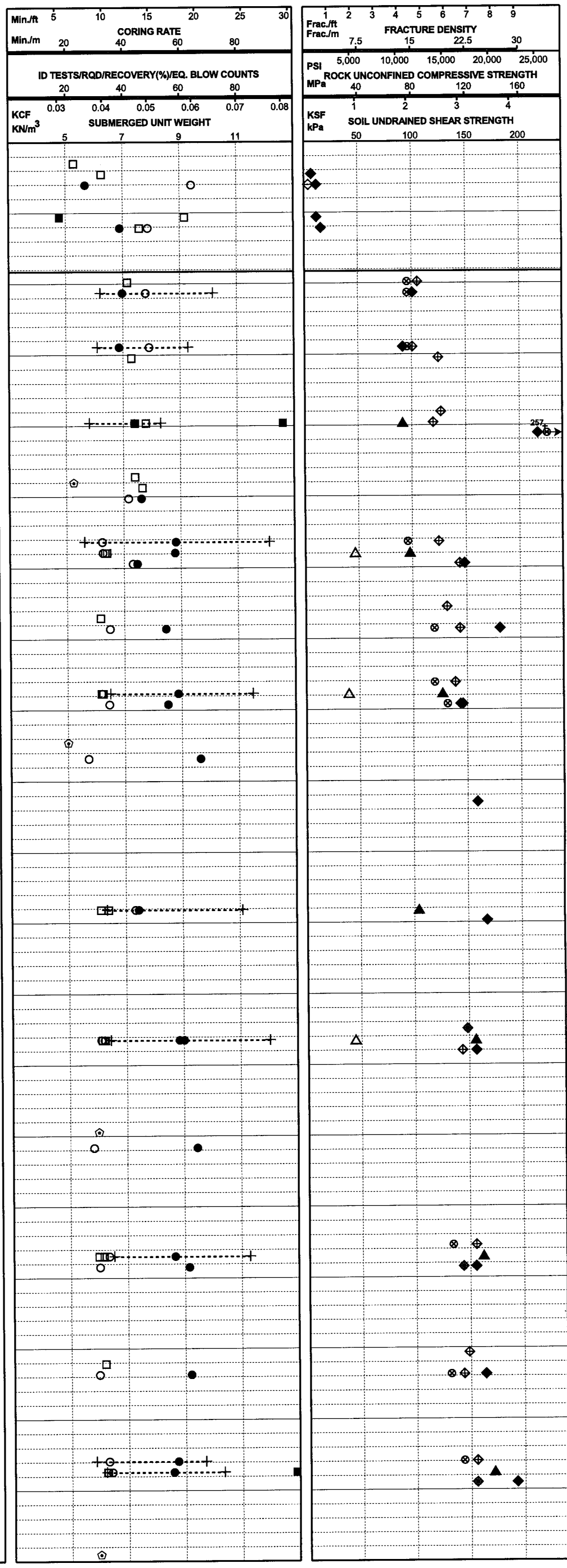
PLATE 98-6.4

PROJECT NO: 98-42-0035
BORING: 98-6 (Northeast of Pier E2)
START DATE: 3/20/98
COMPLETION DATE: 3/24/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836455 N647696
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -24.4 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		WOH	Fat CLAY (CH), very soft, olive gray -with organic matter pockets at 0.2m -sand layer with clay pockets and shell fragments, 0.3m to 1.1m	I
-25	1	WOH	-with sand pockets and shell fragments, at 1.2m	
-26			(1.8m)	
	2	5/30cm	Fat CLAY (CH), greenish gray to olive gray, stiff to hard -with a few silt partings and seams, at 2.1m	II
-27	3	8/30cm	-with silt partings at 3.0m	
-28	4	22/45cm	-greenish gray, 3.7m to 6.1m -with cemented sand pockets, 3.7m to 5.2m	
-29	5	36	-with sand pockets at 4.9m	
-30	6	PUSH		
-31	7	PUSH		
-32	8	PUSH	-with shell fragments, 7.3m to 15.8m -with silt partings at 7.6m	
-33	9	20		
-34	10	PUSH		
-35	11	PUSH		
-36	12			
-37	13	PUSH		
-38	14	30		
-39	15			
-40	16	PUSH		
-41	17	PUSH	-with silt partings at 17.1m	
-42	18			
-43	19	PUSH		
-44		30		



LOG OF BORING AND TEST RESULTS

BORING 98-6

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

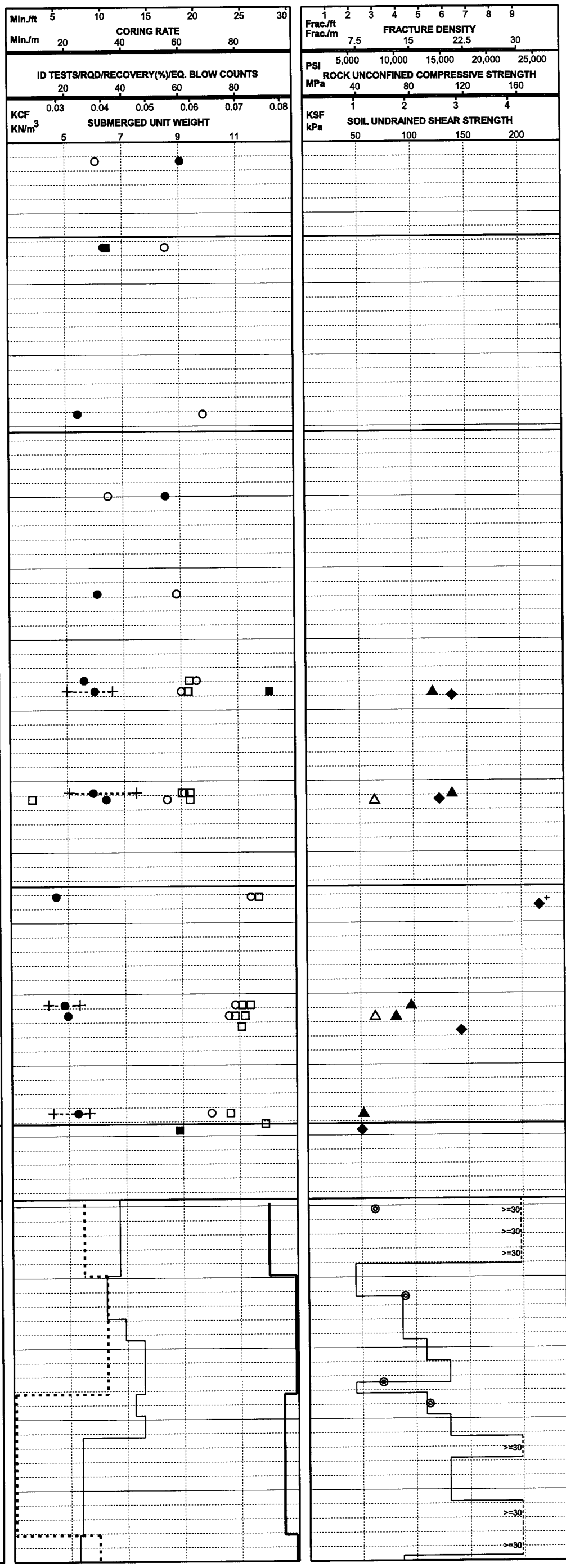
PLATE 98-6.5a

PROJECT NO:	98-42-0035	**START DATE:**	3/20/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-6 (Northeast of Pier E2)	**COMPLETION DATE:**	3/24/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836455 N647696
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -24.4 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-45	21	30	Fat CLAY (CH), greenish gray to olive gray, stiff to hard -with silt partings and shell fragments, at 20.1m (21.3m)	II
-46	22	PUSH	Sandy Lean CLAY with gravel (CL), stiff to very stiff, grayish green -with many shell fragments and rounded gravel to 20mm-diameter	III
-47	23			
-48	24	12	-with sand pockets and a few shell fragments, at 23.8m (24.1m)	
-49	25	14	Lean CLAY (CL), very stiff, grayish green -with many shell fragments	IV
-50	26	17	-gray to dark gray, with fine sand pockets, light brown clay pockets, and with clay seams, below 25.9m	
-51	27			
-52	28	15/35cm	-with rounded fine to coarse gravel at 27.4m	
-53	29	30/50cm		
-54	30		(30.5m)	
-55	31	30/25cm	Lean CLAY (CL), very stiff, dark gray to olive gray -with greenish black clay pockets	V
-56	32	30/45cm		
-57	33			
-58	34	30/50cm	(33.8m)	
-59			Clayey SAND (SC), grayish green (34.9m)	VI
-60	35	30/5cm	SANDSTONE-Graywacke (RX), moderate yellowish brown, moderately weathered, moderately hard, thickly to very thickly bedded, intensely fractured, fractures in sets inclined at 20, 50, 60, and 70-80 degrees -slightly to moderately rough fractures with yellowish orange staining, and thin clay and calcite filling on high angle fractures	VII
-61	36	90-25		
-62	37	100-33		
-63	38	95-0	-very intensely fractured, 38.4m to 38.6m -slightly to moderately rough vertical fracture with thin yellowish orange stain on fracture surface, 38.4m to 39.5m	
-64	39	100-30		



LOG OF BORING AND TEST RESULTS

BORING 98-6

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

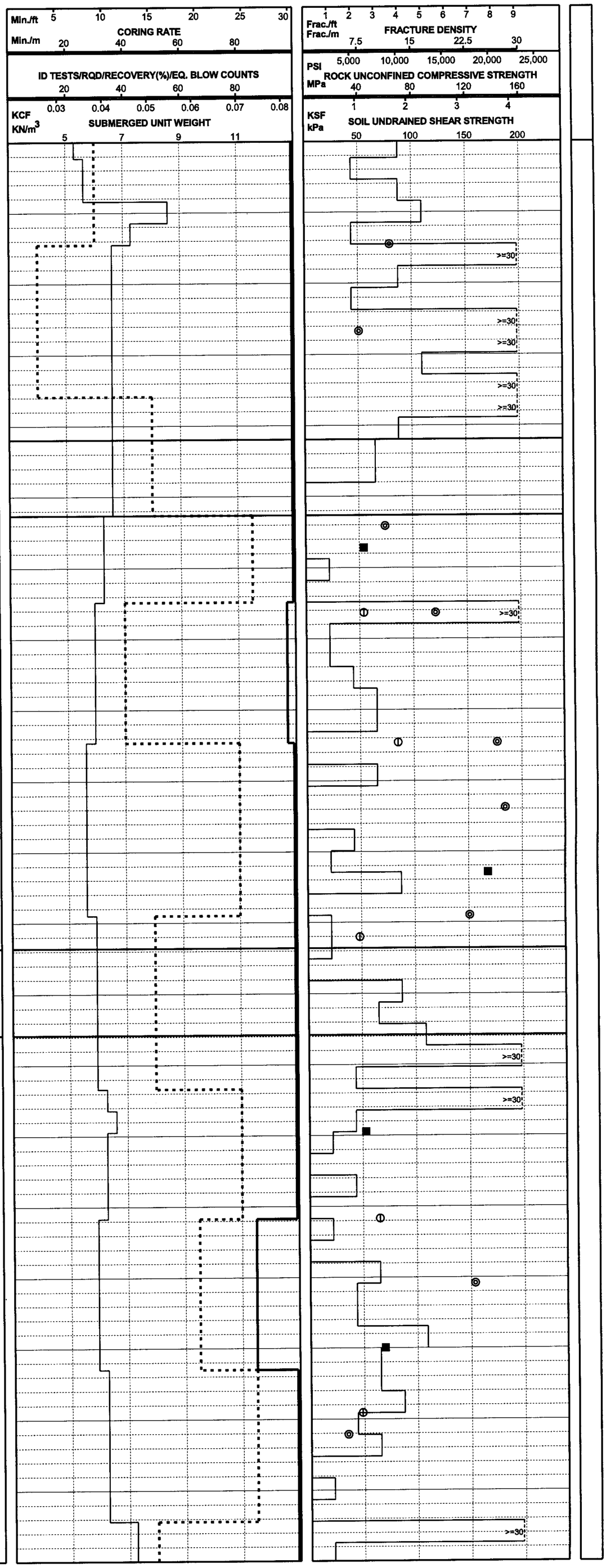
PLATE 98-6.5b

PROJECT NO:	98-42-0035	**START DATE:**	3/20/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-6 (Northeast of Pier E2)	**COMPLETION DATE:**	3/24/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836455 N647696
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -24.4 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-65	41	100-30	SANDSTONE-Graywacke (RX), moderate yellowish brown, moderately weathered, moderately hard, thickly to very thickly bedded, intensely fractured, fractures in sets inclined at 20, 50, 60, and 70-80 degrees -dark greenish gray, slightly weathered, moderately hard to hard, at 40.2m -150mm-thick dark gray moderately hard intensely fractured claystone bed, at 41.1m	VII
-66	42	100-10	-150mm-thick siltstone layer dipping 40 degrees with yellowish orange stains, at 42.4m	
-67	43			
-68	44		(44.2m)	
-69	45	100-50	SANDSTONE moderately to thinly interbedded with SILTSTONE (RX) [3:1], slightly weathered, moderately to intensely fractured, moderately spaced fractures, moderately thin fractures, slightly rough -sandstone: medium dark gray, hard -siltstone: dark gray, moderately hard (45.3m)	VIII
-70	46	100-85	SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered to fresh, hard, thickly bedded, with closed, tight calcite filled fractures, moderately thin to thin, slightly rough	IX
-71	47			
-72	48	97-40	-slighty rough fractures dipping at 60 and 70 degrees with many yellowish-brown stains, below 47.6m	
-73	49		-fresh, medium dark gray, with closed tight calcite joints, and slightly rough fractures with patchy calcite and very thin clay filling, 48.5m to 51.8m -with closed very thin fresh calcite filled fractures, at 48.8m	
-74	50	100-80		
-75	51		(51.4m)	
-76	52	100-50	SANDSTONE (RX) interbedded with SILTSTONE (RX)[2:1], slightly weathered, moderately to intensely fractured, moderately spaced, clean, slightly rough, with yellowish brown stains and large patches of calcite -sandstone: medium dark gray, hard, moderately to thinly bedded -siltstone: dark gray, moderately hard, thinly to very thinly bedded -fractures dipping at 50 to 60 degrees, with yellowish brown stains and large patches of calcite, 51.8m to 53.3m (52.6m)	X
-77	53		SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered, hard, thickly bedded, unfractured to slightly fractured, widely spaced, clean, moderately to slightly rough, with a few closed, tight, calcite and quartz filled fractures	XI
-78	54	100-80		
-79	55			
-80	56	85-65		
-81	57		-with laminated, dark gray, moderately hard to hard, intensely fractured siltstone, 56.8m to 57.5m	
-82	58		-with thin quartz and calcite filled fractures dipping at 30 to 80 degrees, below 57.5m	
-83	59	100-85	-with abundant quartz filled fractures dipping nearly vertical, 59.1m to 59.6m	
-84		100-50		



LOG OF BORING AND TEST RESULTS

BORING 98-6

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

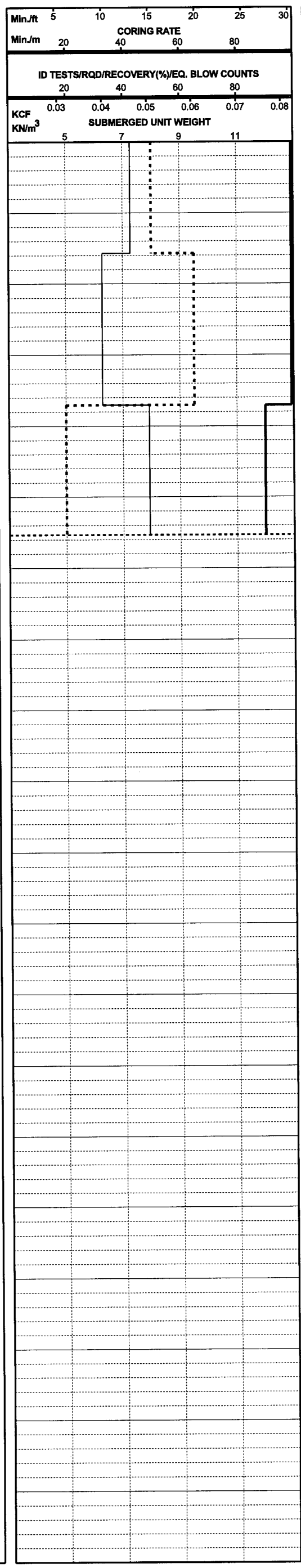
FUGRO

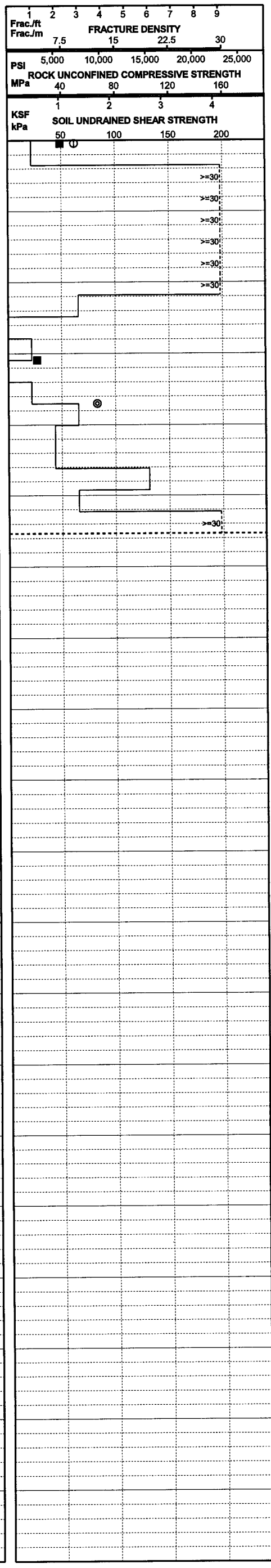
PLATE 98-6.5c

PROJECT NO:	98-42-0035	**START DATE:**	3/20/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-6 (Northeast of Pier E2)	**COMPLETION DATE:**	3/24/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836455 N647696
CA State Plane Zone 3, NAD83, Meters

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
					MUDLINE ELEVATION: -24.4 m (MSL)	
-85	61			100-50	SANDSTONE-Graywacke (RX), medium dark gray, slightly weathered, hard, thickly bedded, unfractured to slightly fractured, widely spaced, clean, moderately to slightly rough, with a few closed, tight, calcite and quartz filled fractures	
-86	62				-75mm-thick laminated siltstone layer with smooth fractures dipping 25 degrees and striations parallel to bedding, at 61.6m	
-87	63			100-65		XI
-88	64					
-89	65			90-20		
-90	66				TOTAL DEPTH: 65.5 m BACKFILLED WITH: Cement Grout	
-91	67					
-92	68					
-93	69					
-94	70					
-95	71					
-96	72					
-97	73					
-98	74					
-99	75					
-100	76					
-101	77					
-102	78					
-103	79					
-104						





LOG OF BORING AND TEST RESULTS

BORING 98-6

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-6.5d

Earth Mechanics

FUGRO

98-6		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
0.3	2					5.3																							
0.5	3					6.2						6.8																	
0.6	4	27										11.4		4.1															
1.1	5					9.2	18					11.5																	
1.2	6	39				7.6						15.7																	
2.0	7					7.1				105.3	95.8																		
2.1	8	40	72	32	0.19						95.8	100.5																	
2.9	9	39	63	31	0.24					100.5	95.8	91.6																	
3.0	10					7.3				124.5																			
3.8	11									126.9																			
4.0	12	44	53	28	0.63	7.8	96		2.71	119.7																			H
4.0	12	44				7.4										91.4													
4.1	13										257.0	216.9																	
4.7	14					7.4																							
4.9	15					7.7																							

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

8003SSMA(8/12/98/09:47 AM)

Earth Mechanics

FUGRO

98-6		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
5.0	16	46																											
5.6	17	58	91	26	0.49					124.5	95.8																		C
5.8	18	58				6.4										97.6													
5.8	18					6.3											46.4												
5.9	19	45								143.6		148.2																	
6.6	20									131.7																			
6.7	21					6.2																							
6.9	22	55								143.6	119.7	180.7																	
7.6	23									138.9	119.7																		
7.8	24	59	85	35	0.47																								
7.8	24	59				6.2										126.8													
7.8	24					6.2											39.6												
7.9	25	55								143.6	131.7	145.8																	
8.7	26	67																											
9.3	27											159.1																	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

PLATE 98-6.6b

80035SMA(8/12/98/05:48 AM)

Earth Mechanics

FUGRO

98-6

DEPTH (m)	Sample No.	IDENTIFICATION TESTS: Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	STRENGTH ESTIMATE (kPa): Torvane	Pocket Pen.	MINIATURE VANE TESTS (kPa): Undist.	Remold.	Resid.	REMOTE VANE (kPa)	UU TRIAXIAL (kPa): Undist.	Remold.	MULTI-STAGE TRIAXIAL: c (kPa)	ϕ (deg.)	DIRECT SHEAR TESTS: Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	q_u TESTS (MPa): UC	Point Load Test	OTHER ROCK PARAMETERS: Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	ADDITIONAL TESTS
10.8	28	44	81	33	0.23	6.4																							
10.8	28	44				6.1										104.0													
11.0	29											167.5																	
12.5	30									148.4	148.4																		
12.6	31	60	90	35	0.46																								
12.6	31	58				6.1										156.2													
12.6	31					6.2											44.2												
12.8	32									143.6		156.7																	
14.2	33	65																											
15.5	34									155.6	134.1																		
15.7	35	57	83	35	0.45	6.2																							
15.7	35	57				6.0										162.2													
15.8	36	62								143.6	143.6	155.5																	
17.1	37									148.4																			
17.2	38					6.2																							

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

PLATE 98-6.6c

8003SSMA(6/12/98/10:57:48 AM)

Earth Mechanics

FUGRO

98-6		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
17.4	39	62								143.6	131.7	163.9																	
18.6	40	57	67	29	0.74					155.6	143.6																		C
18.7	41	56	74	32	0.57	6.2	99		2.67																				H
18.7	41	56				6.3										171.7													
18.9	42									155.6	155.6	192.8																	
20.3	43	61																											
21.5	44	33					35		2.72																				H
23.8	45	24																											
25.0	46	55																											
26.4	47	31																											
27.6	48	26				9.3																							
27.7	49	30	36	20	0.60	9.3	91		2.72																				H
27.7	49	30				9.2										118.2													
27.8	50											136.2																	
29.2	52	29	44	21	0.35	9.3																							

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/09:48 AM)

Earth Mechanics

FUGRO

98-6

DEPTH (m)	Sample No.	IDENTIFICATION TESTS: Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	STRENGTH ESTIMATE (kPa): Torvane	Pocket Pen.	MINIATURE VANE TESTS (kPa): Undist.	Remold.	Resid.	REMOTE VANE (kPa)	UU TRIAXIAL (kPa): Undist.	Remold.	MULTI-STAGE TRIAXIAL: c (kPa)	ϕ (deg.)	DIRECT SHEAR TESTS: Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	q_u TESTS (MPa): UC	Point Load Test	OTHER ROCK PARAMETERS: Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	ADDITIONAL TESTS
29.2	52	29				9.0										136.0													
29.3	53	34				9.3						124.1																	
29.3	53					3.8											63.6												
30.6	54	16				11.7																							
30.8	55											216.9																	
32.2	56	19	24	13	0.50	11.1																							
32.2	56	19				11.4										97.1													
32.3	57	20				11.2										82.9													
32.3	57					10.8											63.3												
32.5	58					11.1																							
32.5	59											143.4																	
33.7	60	23	27	15	0.68																								
33.7	60	23				10.7										52.1													
33.8	61					11.9																							
33.9	62						59					50.6																	

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

8003SSMA(8/12/98/09:48 AM)

Earth Mechanics

FUGRO

98-6		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
35.1	64a																								49.7				
36.0	64b																			188.2	48	46.9	24						
36.3	65b																								71.8				
37.5	65a																								55.2				
37.8	66																								89.8				
40.4	67b																	2827	49							25.9	26.0	0.32	
41.5	67																								63.6				
41.8	68b																	241	43							25.8	12.8	0.27	
42.7	68a																								40.4				
45.3	69																								59.3				
45.7	70																							43.3		26.7	60.0		
46.5	70a																								43.1				
46.5	70b																								96.4				
48.5	71a																								68.0				
48.5	71b																								141.7				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

PLATE 98-6.6f

8003SSMA(8/12/98)/09:48 AM)

Earth Mechanics

FUGRO

98-6		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)		MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		OTHER ROCK PARAMETERS			ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	Total Unit Weight (kN/m³)	E (GPa)	Poisson Ratio	
49.4	72b																								147.4				
50.3	72c																							134.3		26.6	60.5	0.24	
50.9	72a																								120.5				
51.2	73																								38.7				
53.9	74c																							42.2		26.4	38.8	0.28	
55.2	74a																								52.5				
56.1	75a																								123.0				
57.0	75b																							55.7		26.6	65.0	0.31	
57.9	76a																								38.7				
58.2	76b																								27.6				
60.0	77b																							39.0		26.2	32.8		
60.0	77a																								49.7				
63.1	78b																							21.5		26.4	60.5		
63.7	79																								66.3				

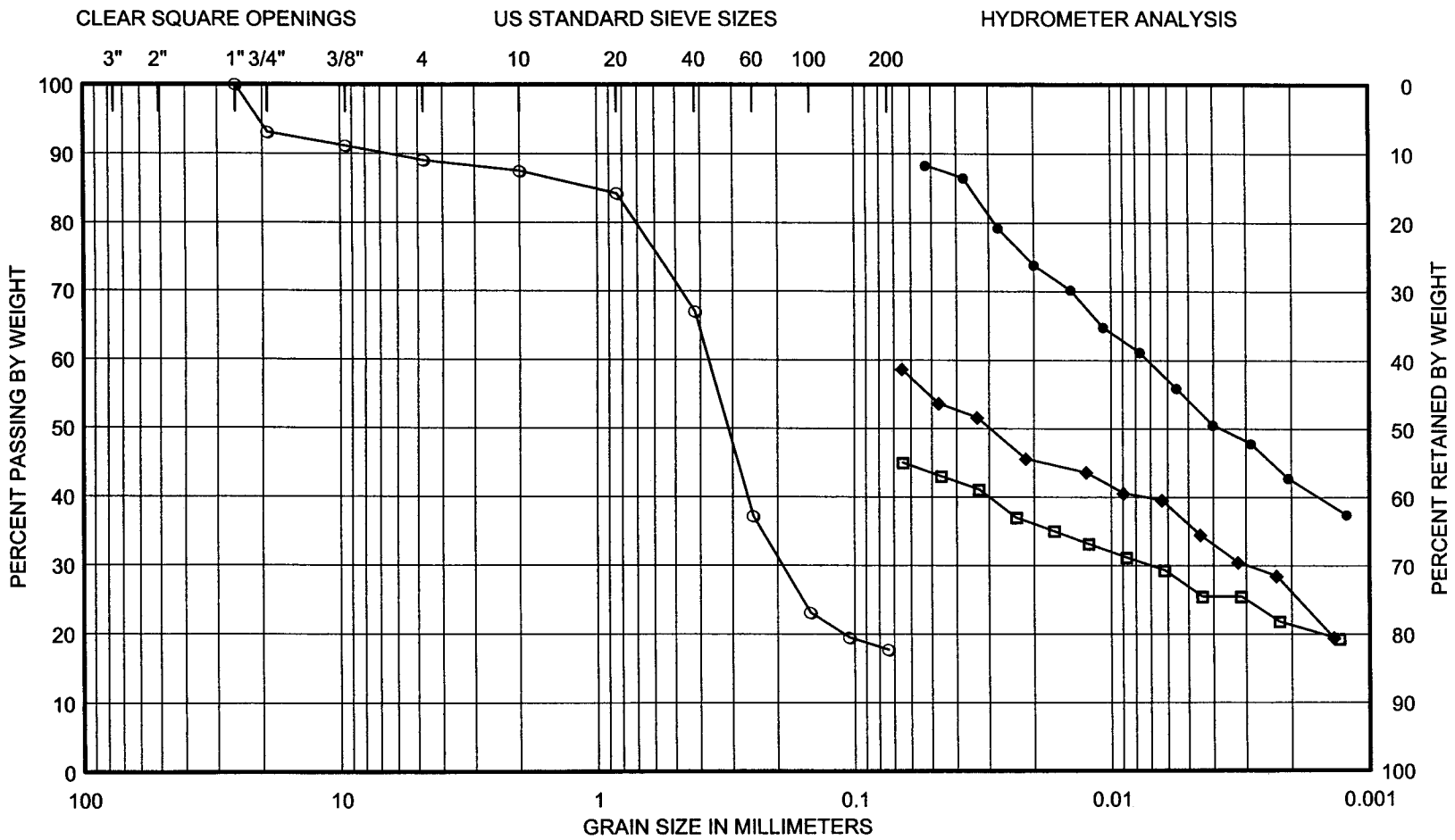
Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle
E = Young's Modulus

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-6
SFOBB East Span Seismic Safety Project

80035SMA(8/12/98/08:48 AM)



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
5	1.1		SILTY FINE SAND (SM) with medium sand, and a trace of coarse sand and
12	4.0		FAT CLAY (CH)
41	18.7		FAT CLAY (CH)
44	21.5		CLAYEY SAND (SC)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-6

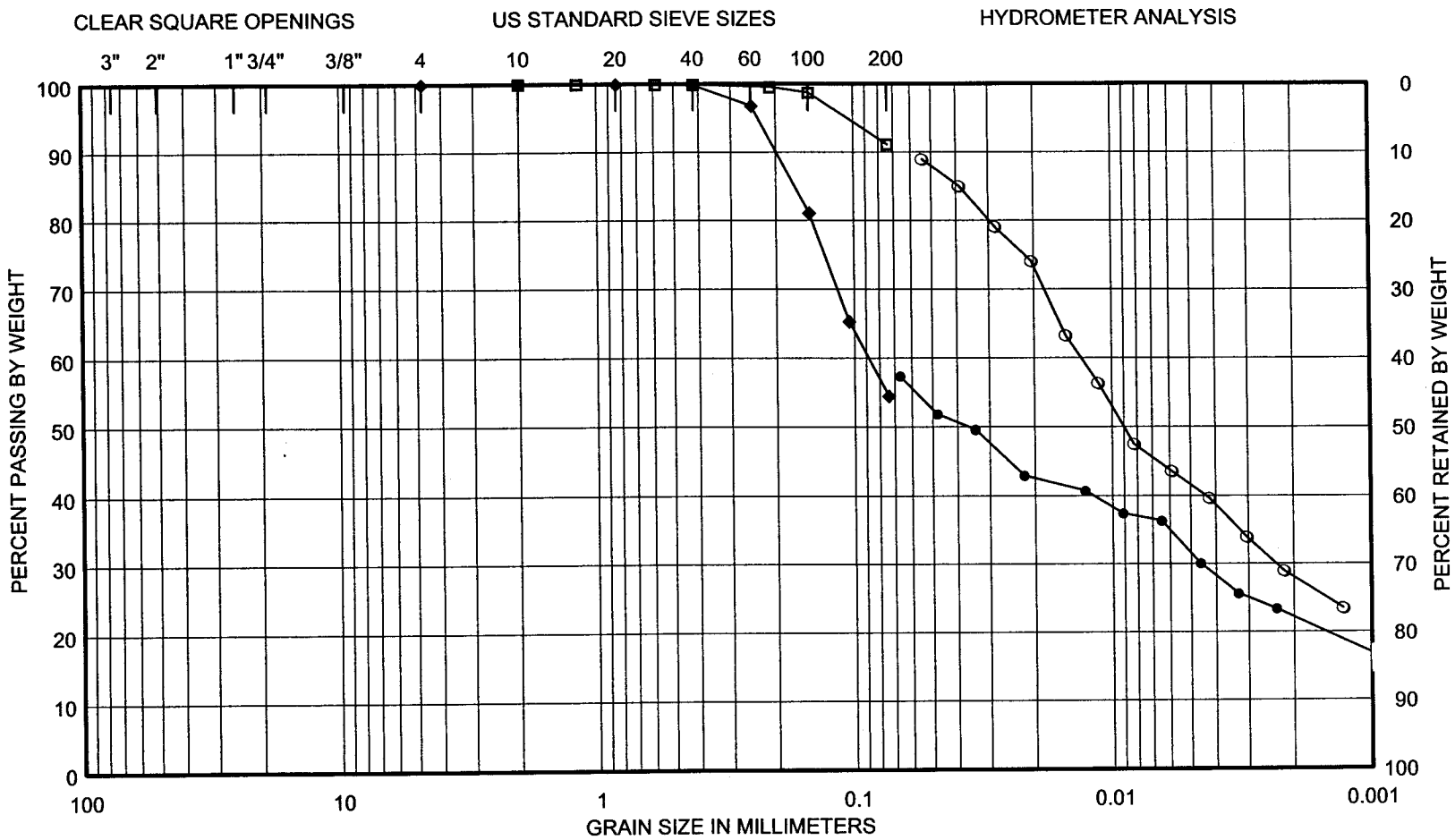
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-6.7a



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
49	27.7	○—○	LEAN CLAY (CL)
49	27.7	□—□	LEAN CLAY (CL)
62	33.9	◆—◆	CLAYEY SAND (SC)
62	33.9	●—●	CLAYEY SAND (SC)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-6

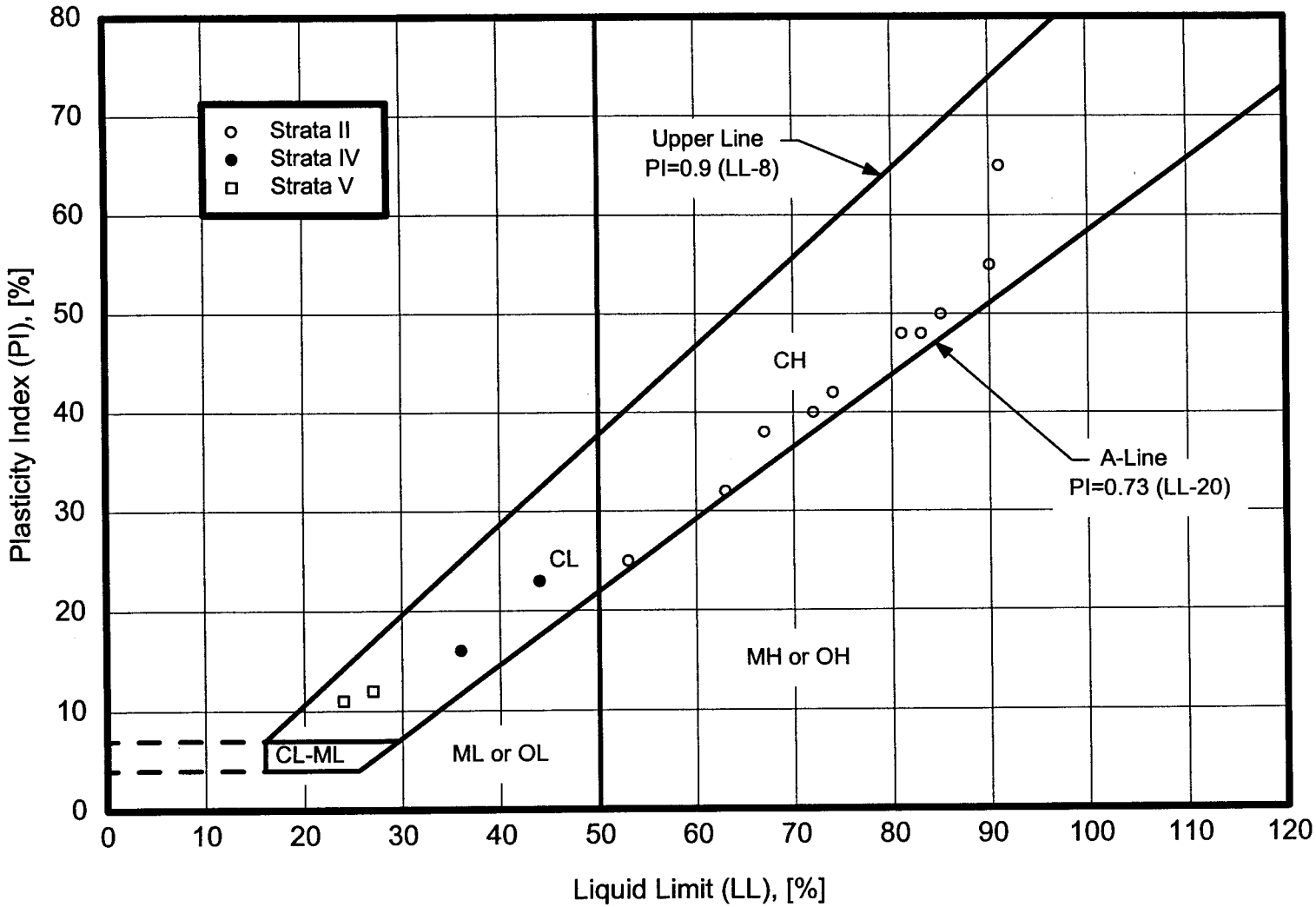
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

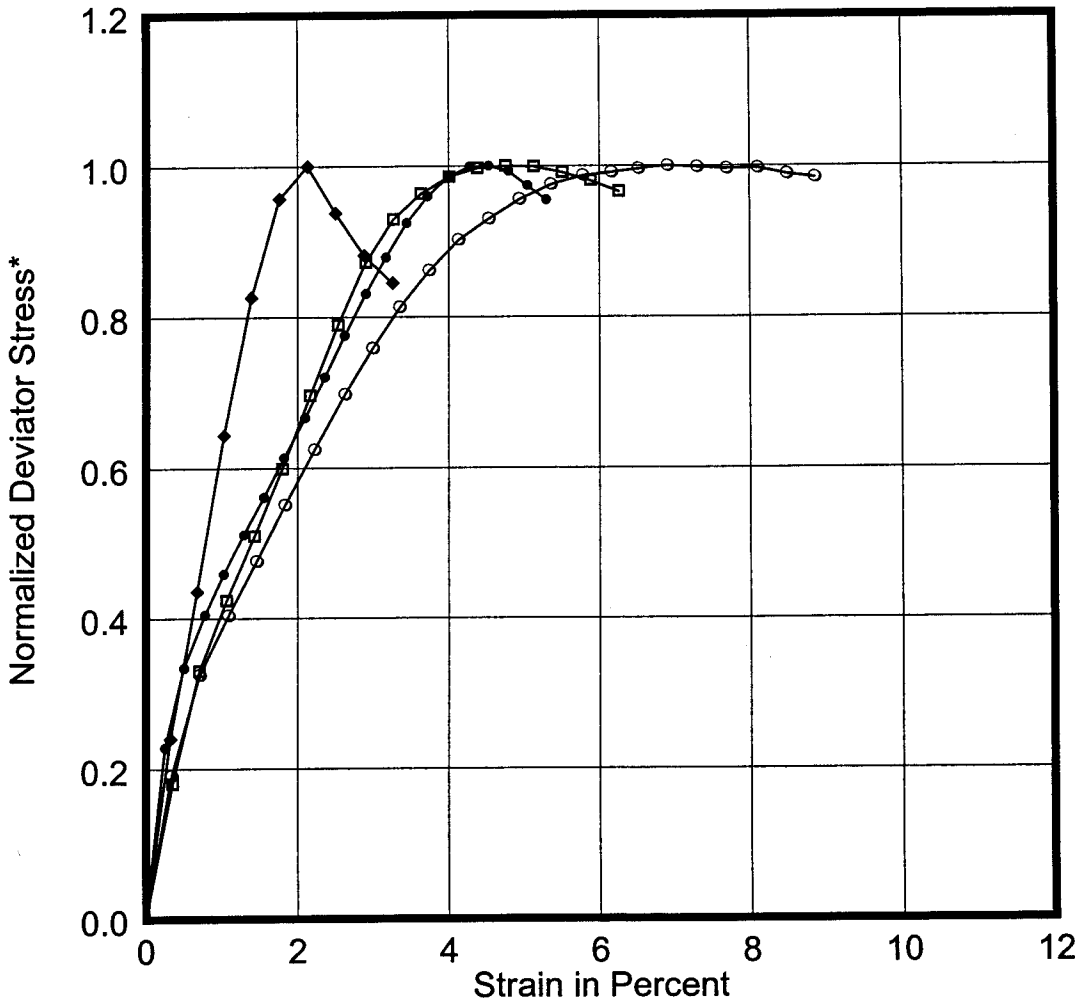
FUGRO

PLATE 98-6.7b



PLASTICITY CHART
Boring 98-6
SFOBB East Span Seismic Safety Project

Earth Mechanics
FUGRO

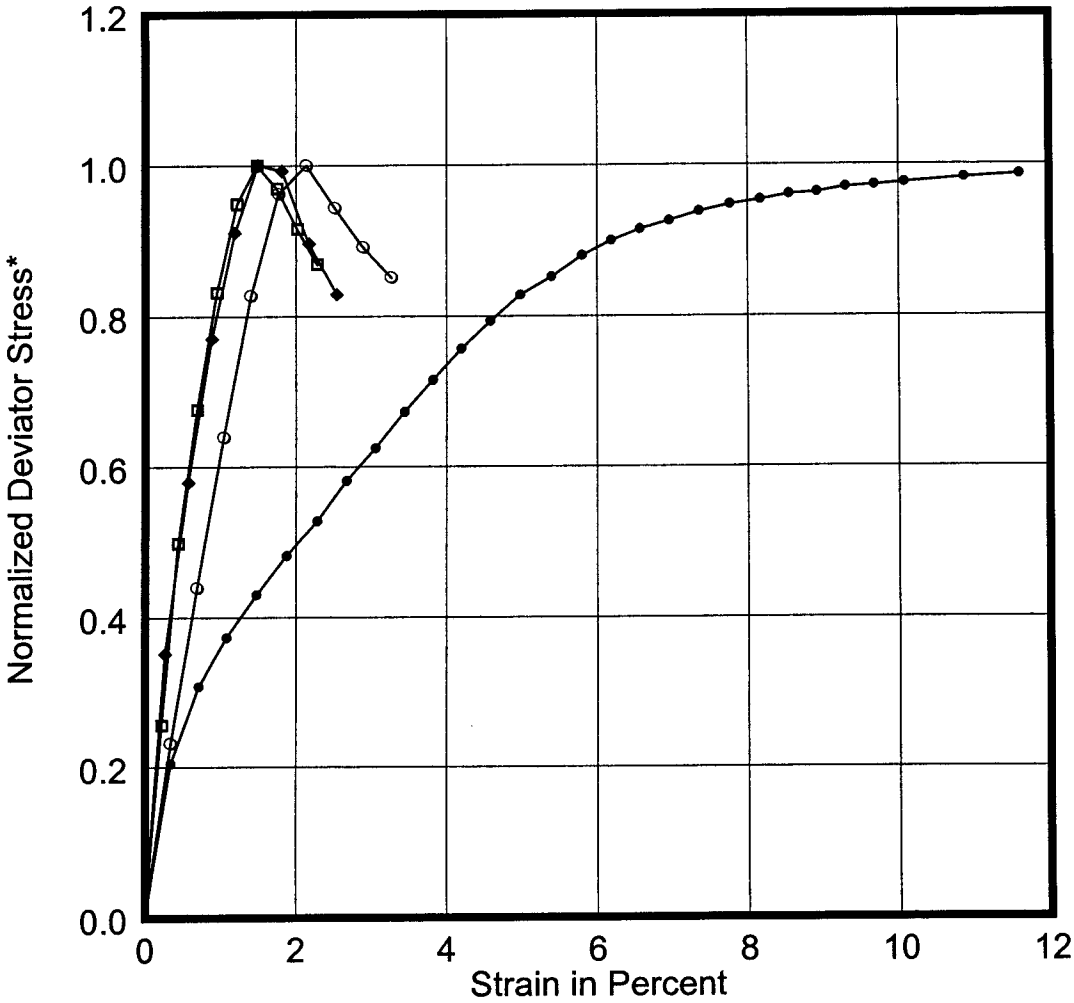


Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	12	4.0	UU	827	183	1.6
□——□	18	5.8	UU	827	195	1.4
◆——◆	24	7.8	UU	827	254	0.8
●——●	28	10.8	UU	827	208	1.2

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-6
SFOBB - East Span Seismic Safety Project



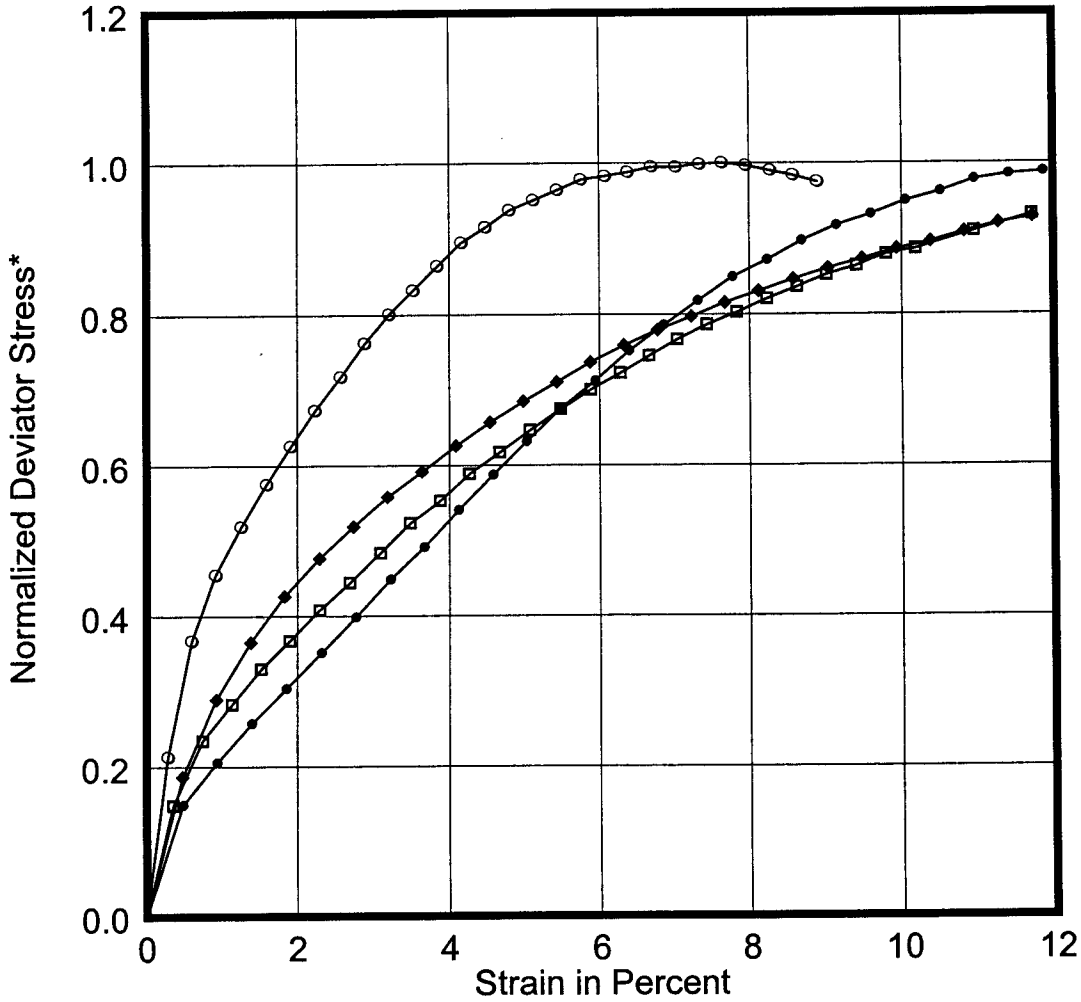
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	31	12.6	UU	827	312	0.8
□——□	35	15.7	UU	827	324	0.4
◆——◆	41	18.7	UU	827	343	0.5
●——●	49	27.7	UU	827	236	2.0

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-6
SFOBB - East Span Seismic Safety Project

PLATE 98-6.9b

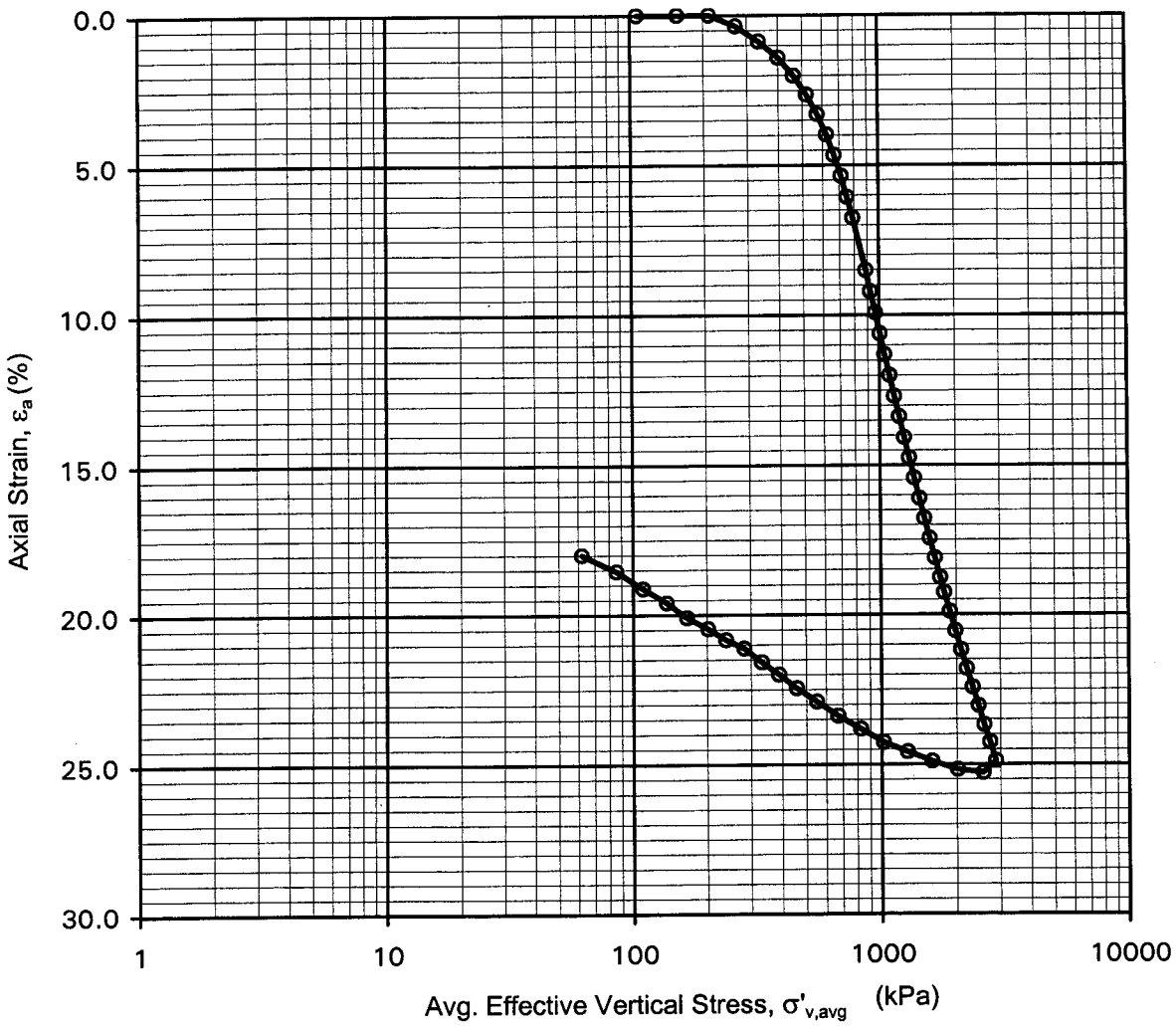


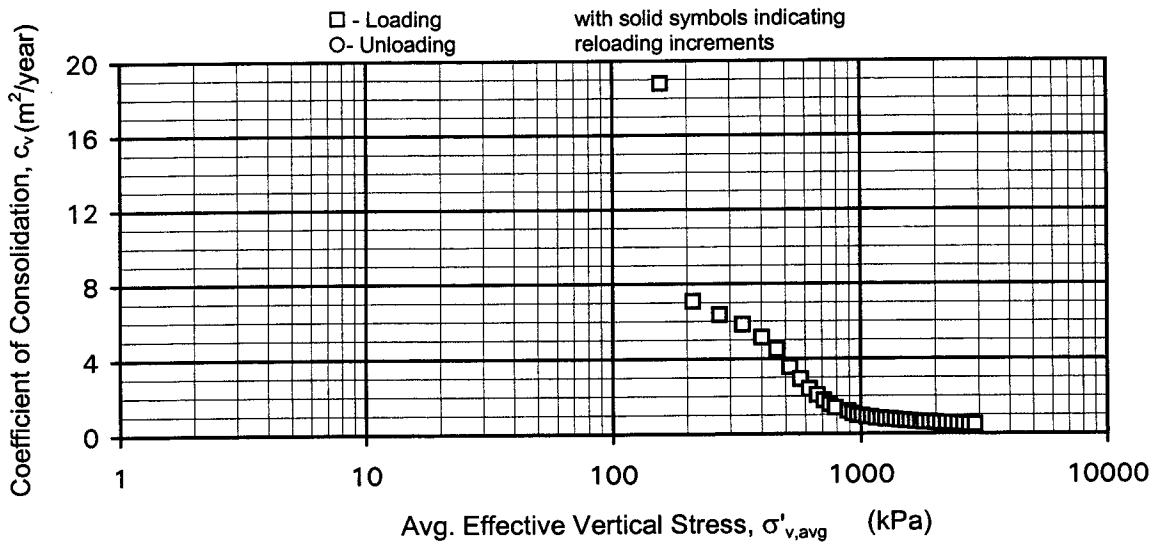
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	52	29.2	UU	827	272	1.2
□——□	56	32.2	UU	827	194	3.3
◆——◆	57	32.3	UU	827	166	2.5
●——●	60	33.7	UU	827	104	3.8

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

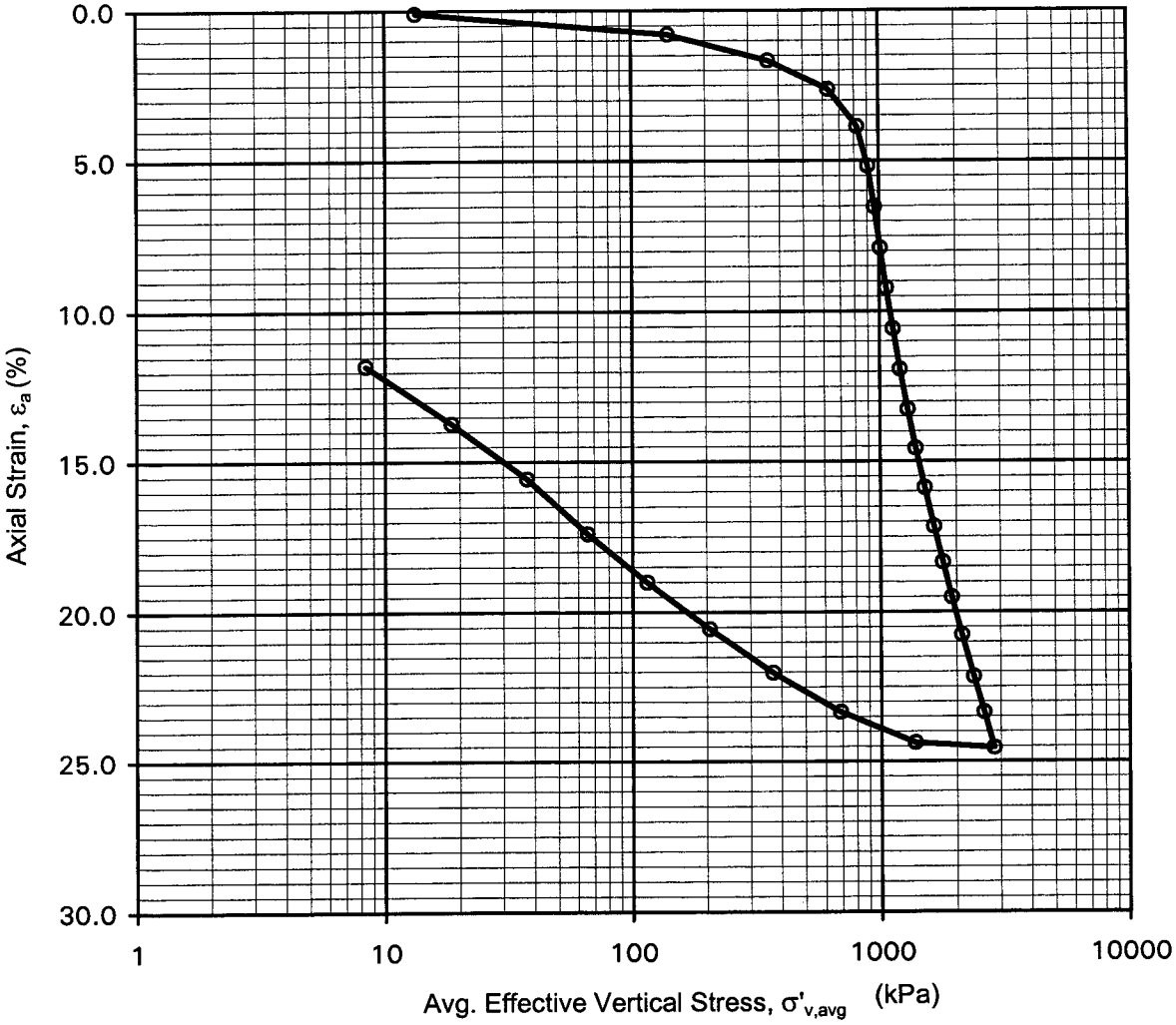
Boring 98-6
SFOBB - East Span Seismic Safety Project

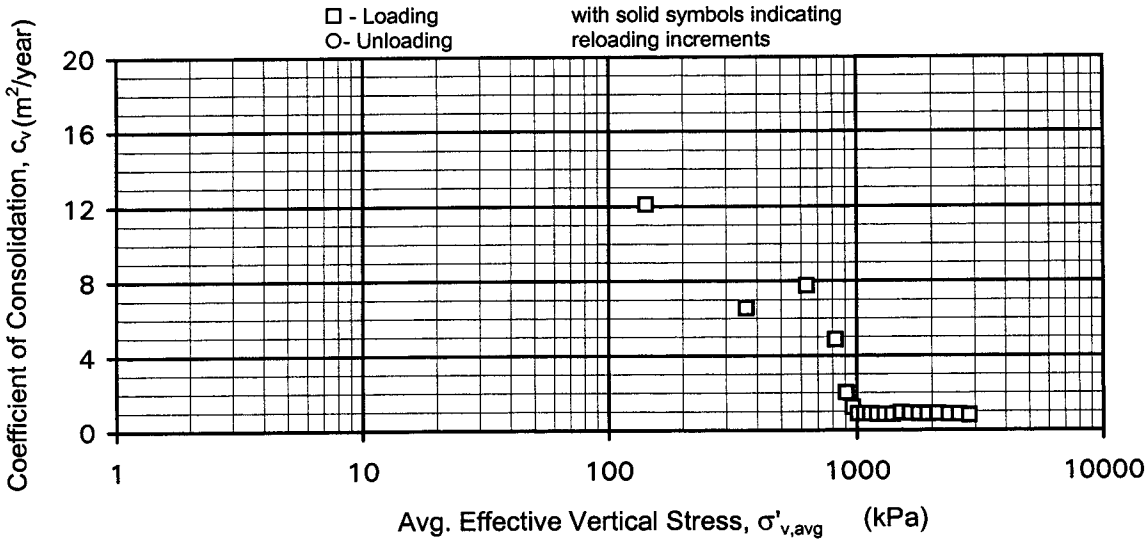




CRS CONSOLIDATION TEST RESULTS

Sample No. 17 - Penetration: 5.6 m
Boring 98-6
SFOBB East Span Seismic Safety Project

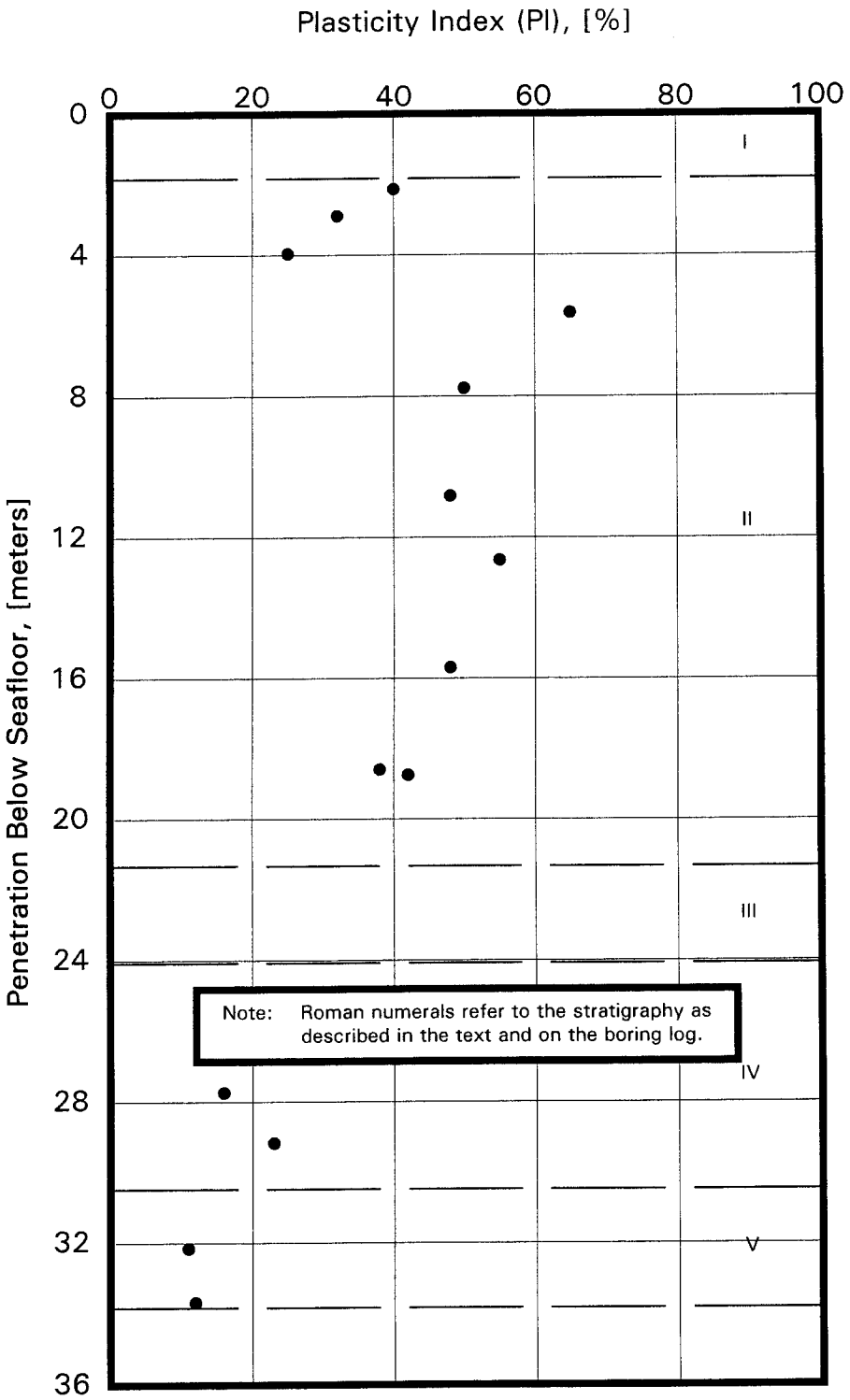




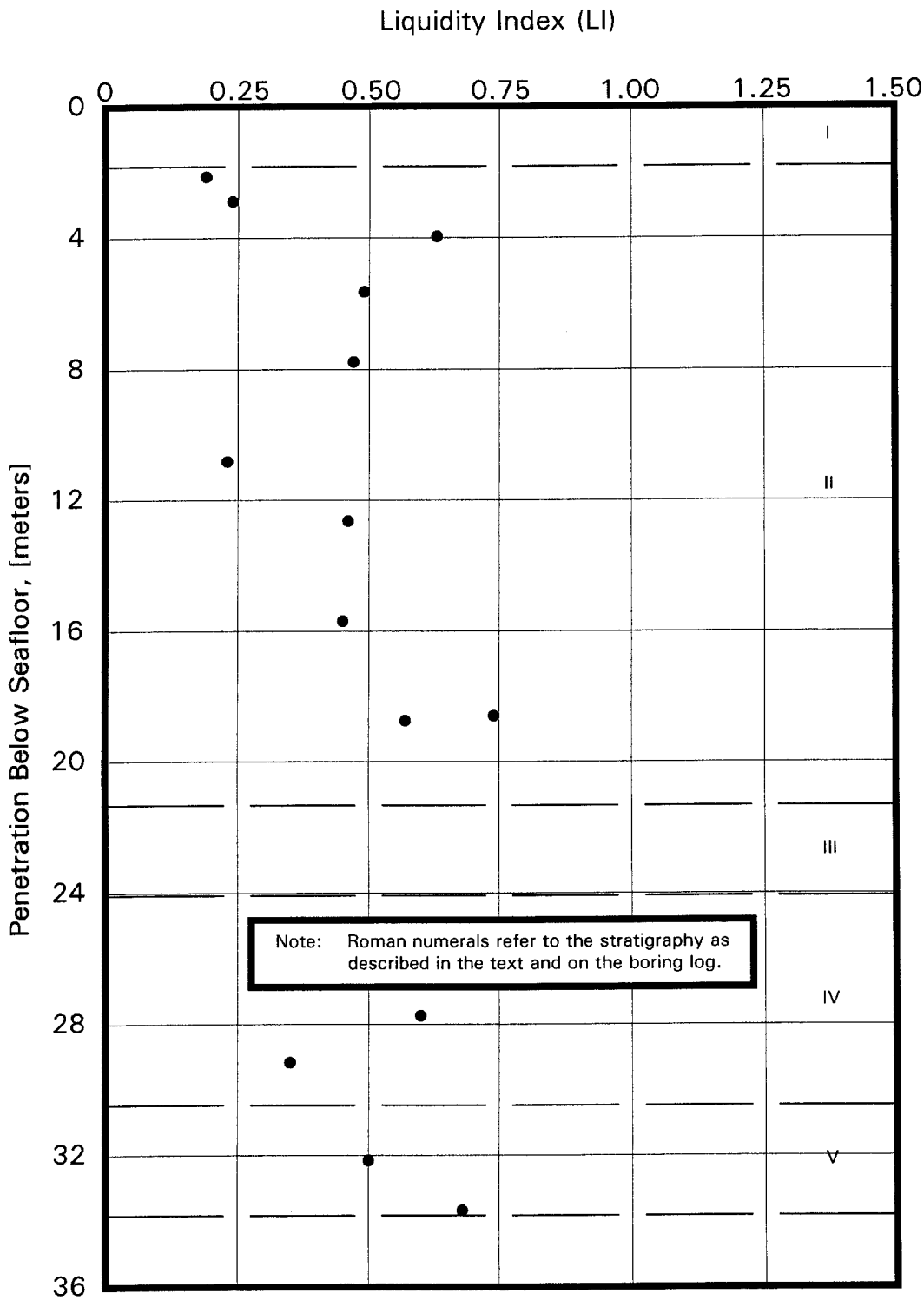
CRS CONSOLIDATION TEST RESULTS

Sample No. 40 - Penetration: 18.6 m
Boring 98-6
SFOBB East Span Seismic Safety Project

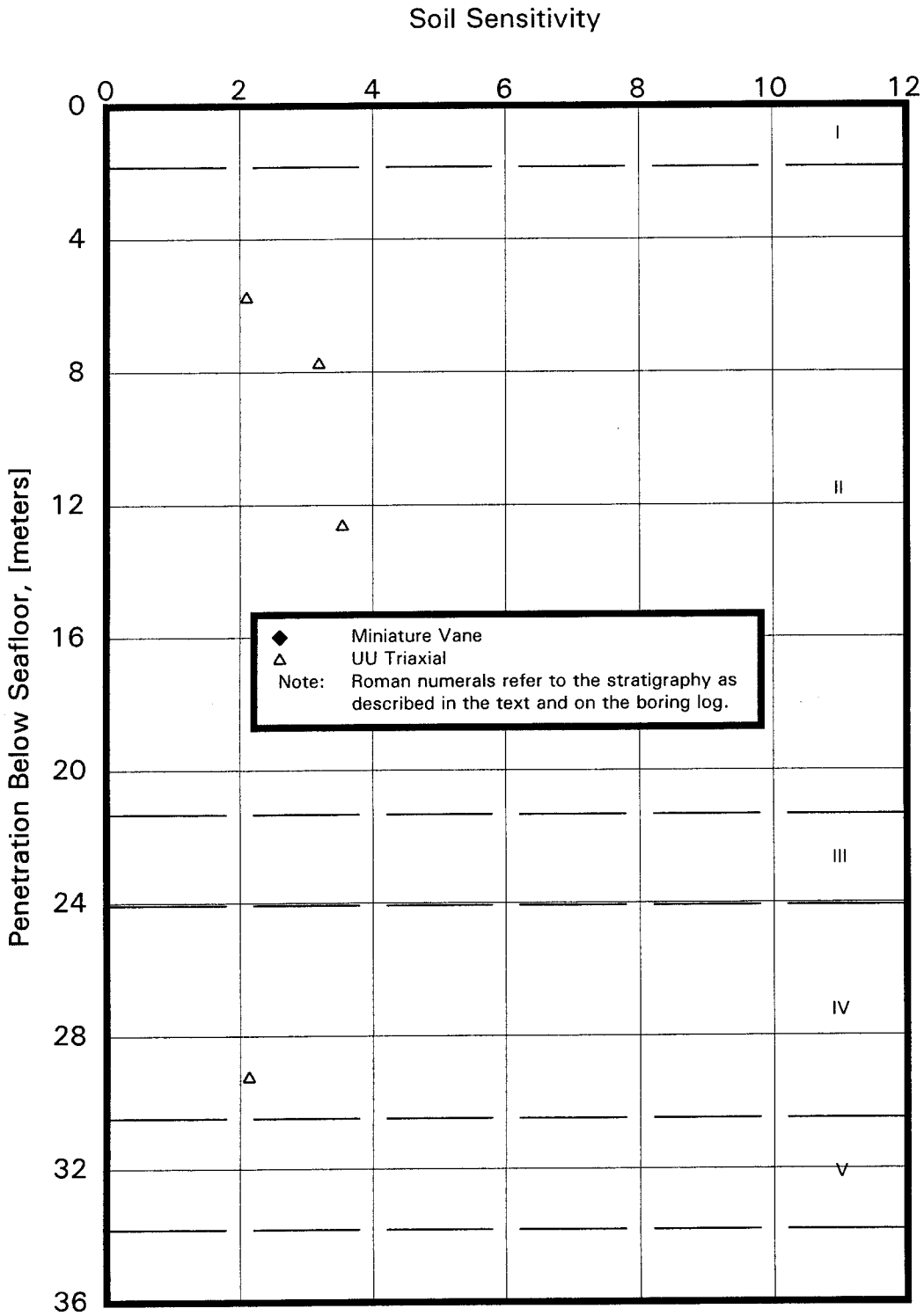
PLATE 98-6.10b



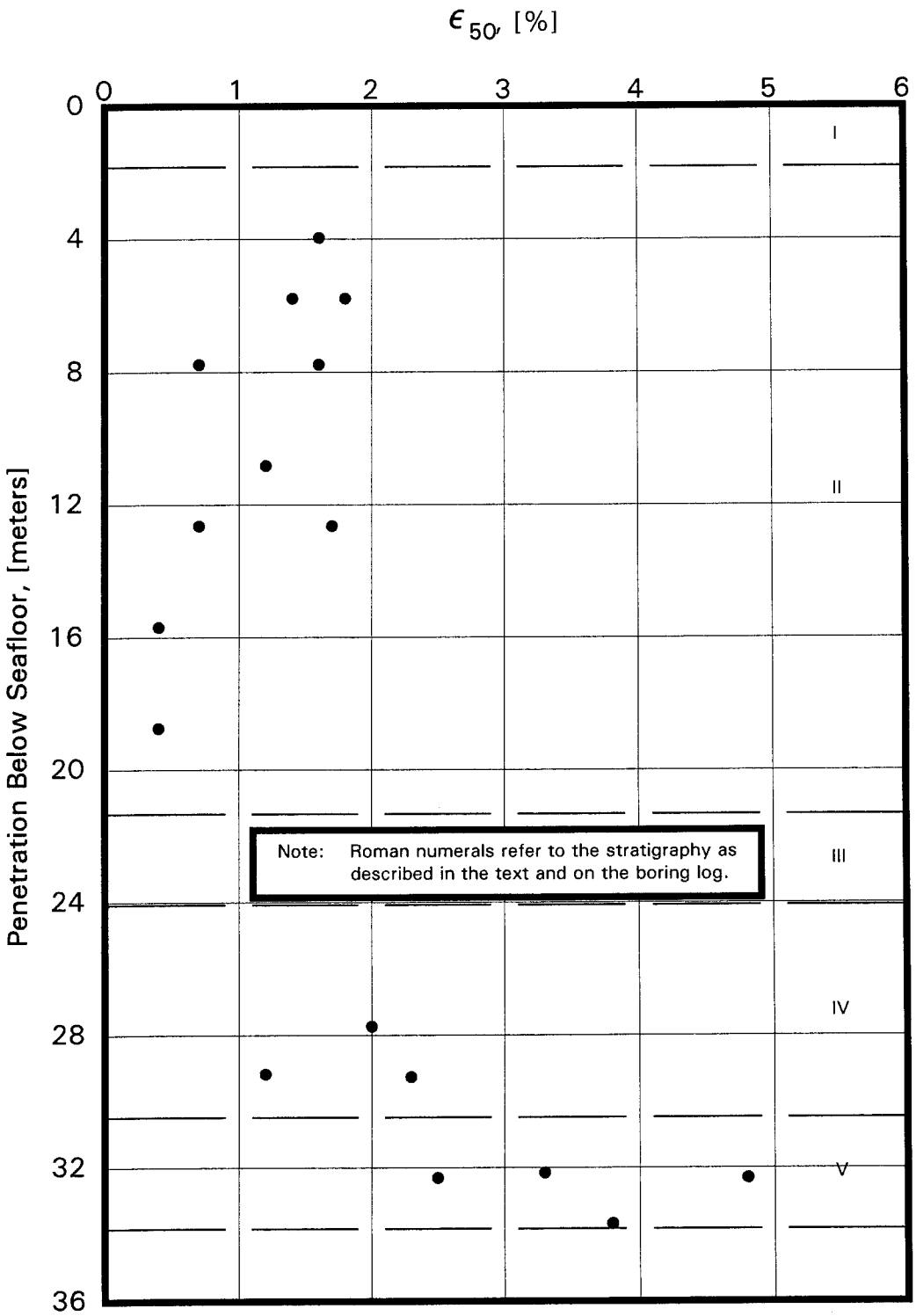
PLASTICITY INDEX PROFILE
Boring 98-6
SFOBB East Span Seismic Safety Project



LIQUIDITY INDEX PROFILE
Boring 98-6
SFOBB East Span Seismic Safety Project



SOIL SENSITIVITY PROFILE
Boring 98-6
SFOBB East Span Seismic Safety Project



ϵ_{50} PROFILE
Boring 98-6
SFOBB East Span Seismic Safety Project

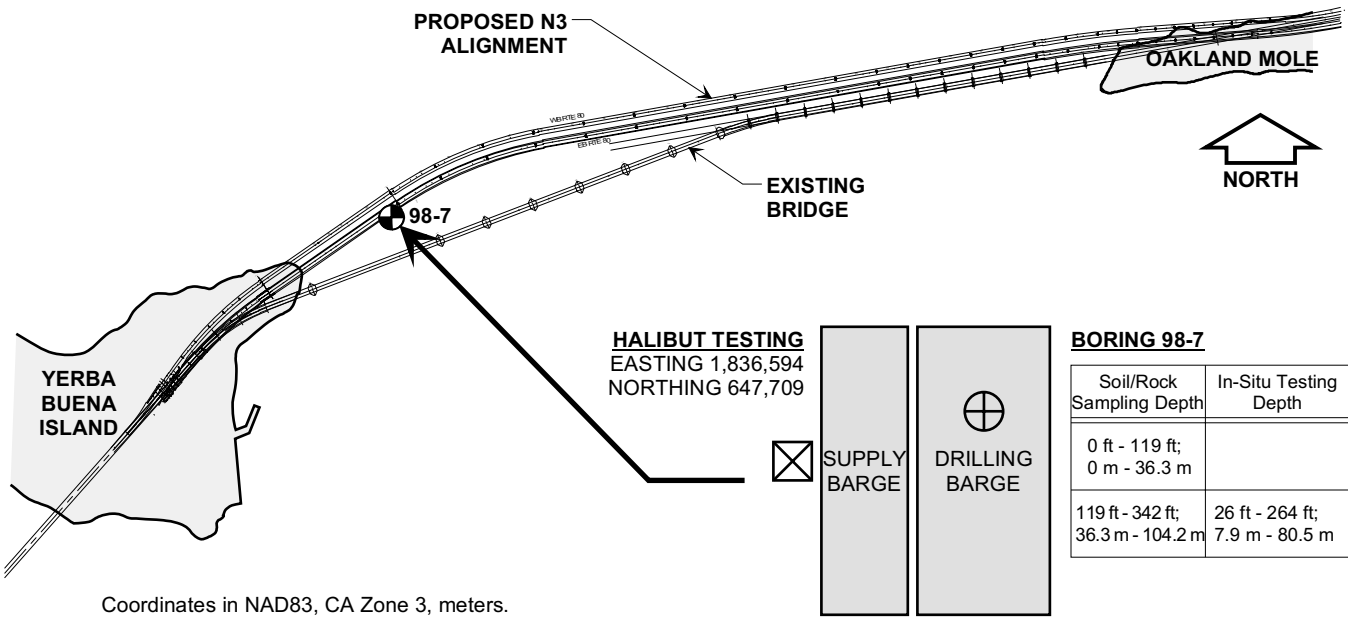
BORING 98-7

Date	Time From	Time To	Description of Activity
March 11, 1998	0030	0300	Lift two spuds at boring location 98-8. Reposition four-point anchor spread at boring location 98-7. Set two spuds.
	0300	0430	Rig up to drill and sample.
	0430	0500	Lower drill pipe to mudline.
	0500	0515	Measure water depth of 15.2m (50 ft) using bottom sensor. Current tide level is approximately -0.3m (-1 ft) MSL. Calculate mudline elevation of -15.5m (-51 ft) MSL.
	****	0515	Estimate water depth of 15.2m (50 ft) using echo sounder.
	0515	2100	Drill and sample, 0m (0 ft) to 36.6m (119 ft).
	2100	2215	Mix grout. Grout hole. Pull drill pipe to deck.
	2215	2245	Reposition vessel.
	2245	2400	Set casing.
March 12, 1998	0000	0800	Set casing.
	0800	1000	Lower drill pipe to mudline. Drill to 7.9m (26 ft) penetration.
	1000	2400	Drill, sample, and perform in-situ testing from 7.9m (26 ft) to 50.6m (166 ft).
March 13, 1998	0000	2200	Drill, sample, and perform in-situ testing from 50.6m (166 ft) to 80.5m (264 ft).
	2200	2400	Raise drill pipe to deck. Remove thruster and drill bit.
March 14, 1998	0000	0215	Lower drill pipe to top of rock.
	0215	0400	Lower rock core pipe to 79.8m (262 ft).
	0400	2400	Perform rock coring from 79.8m (262 ft) to 94.5m (310 ft).
		* * * * * * *	
	0500	0600	Rig up for Halibut vane testing.
	0600	1200	Perform Halibut vane testing at 0.6m (2 ft), 1.2m (4 ft), 1.8m (6 ft), 2.4m (8 ft), 3m (10 ft), 3.7m (12 ft), 4.3m (14 ft), and 4.9m (16 ft). Suspend testing due to presence of sand seams and layers in the clay stratum below 5.5m (18 ft).
	1200	1400	Rig down Halibut vane testing.
		* * * * * * *	
March 15, 1998	0000	1100	Perform rock coring from 94.5m (310 ft) to 104.2m (342 ft).
	1100	1200	Raise rock core pipe to 79.9m (262 ft).
	1200	1600	Perform E-logging and suspension logging from 79.9m (262 ft) to 104.2m (342 ft).
	1600	1830	Raise rock core pipe and drill pipe to deck.
	1830	2130	Perform E-logging and suspension logging from 0m (0 ft) to 85m (280 ft).

SUMMARY OF FIELD OPERATIONS
Boring 98-7
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
March 15, 1998	2130	2215	Lower N-rod.
	2215	2400	Mix grout. Grout hole and raise N-rod to deck.
March 16, 1998	0000	0400	Pull casing to deck.
	0400	0600	Lift two spuds. Raise four anchors.
	0600	****	Conclude work at boring location 98-7.

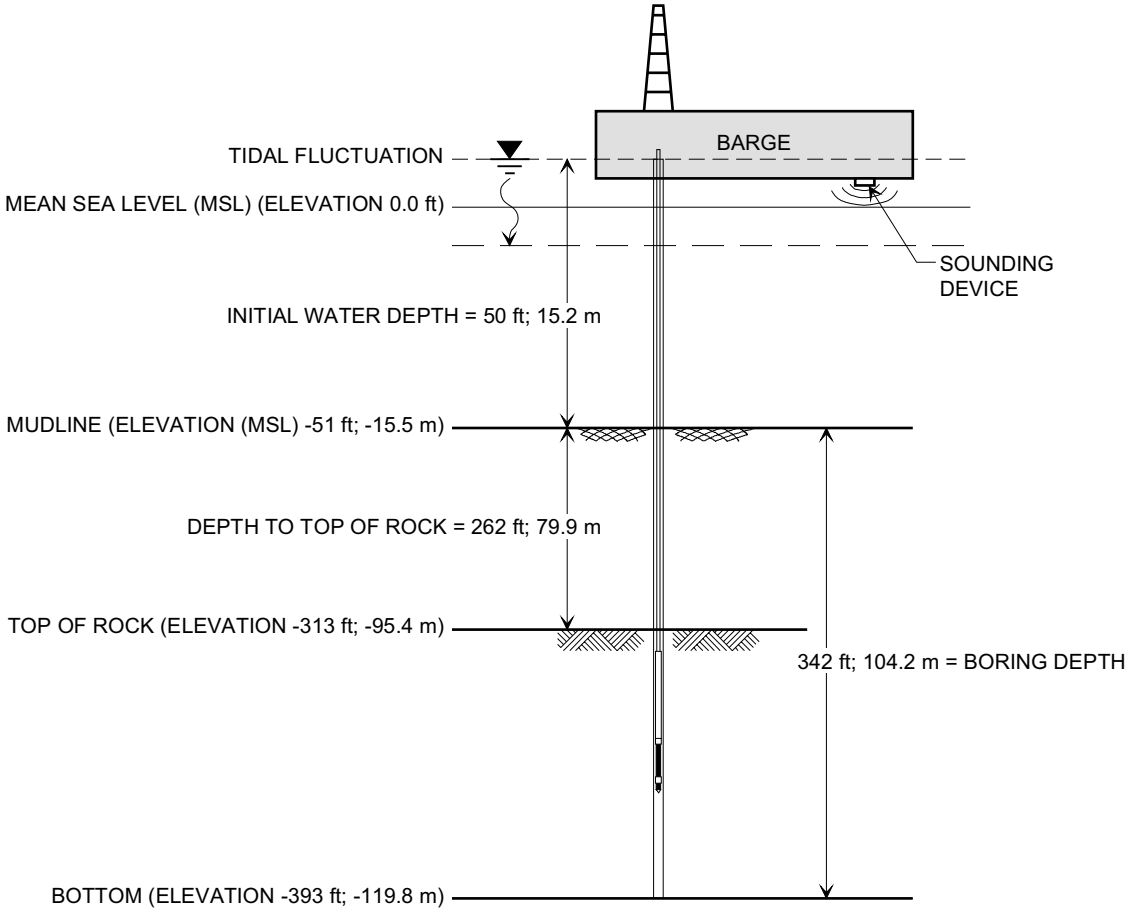
SUMMARY OF FIELD OPERATIONS
Boring 98-7
SFOBB East Span Seismic Safety Project



Coordinates in NAD83, CA Zone 3, meters.

BORING 98-7

Soil/Rock Sampling Depth	In-Situ Testing Depth	Coordinates
0 ft - 119 ft; 0 m - 36.3 m		E = 1,836,620 N = 647,716
119 ft - 342 ft; 36.3 m - 104.2 m	26 ft - 264 ft; 7.9 m - 80.5 m	E = 1,836,618 N = 647,712



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BORING 98-7 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-7.2

PROJECT NO: 98-42-0015
BORING: 98-7 (Northwest of Pier E3)
START DATE: 3/11/98
COMPLETION DATE: 3/16/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

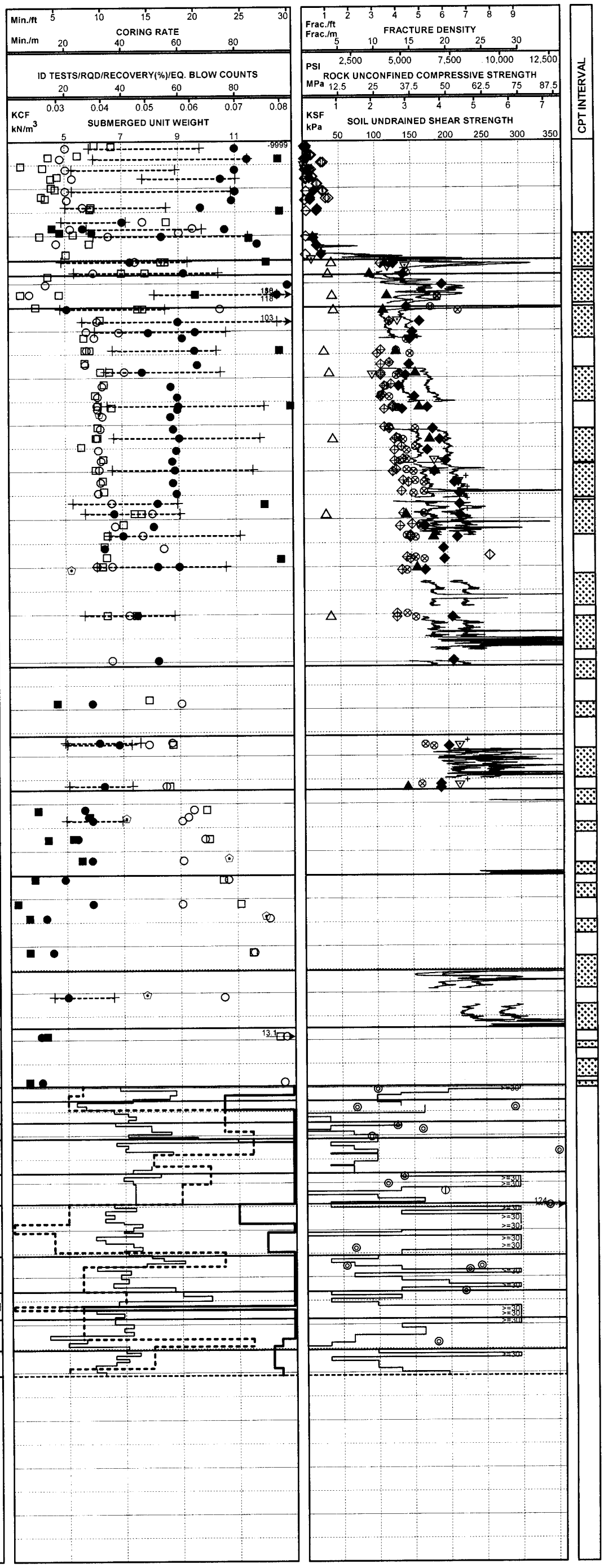
Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

Geology	Material Description
I	Fat CLAY (CH), very soft to soft, olive gray -with silt pockets and partings and shell fragments -with sand pocket, partings and seams, to 1.5m -with organic pockets at 1.2m -with light gray streaks at 2.1m -with many gray sand pockets, partings, seams, layers and gas blisters, below 5.5m -with a silty fine sand layer at 7.5m -with a silty fine sand layer at 7.8m -with silt pockets and partings, at 8.5m (10.1m)
II	Fat CLAY (CH), very stiff, greenish gray to grayish green (11.3m)
III	-with a few sand pockets at 10.2m -olive gray with organic pockets at, 11.1m
IV	Sandy organic CLAY (OH), very stiff, mottled with brown and gray, with an organic odor (14.0m) Fat CLAY (CH), very stiff to hard, gray -with a sand layer at 14.0m -greenish gray, expansive, desiccated and with a few silt pockets and gas blisters, to 15.5m -with shell fragments and shells, below 15.5m -with silt partings, 16.5m to 18.0m -expansive and with gas blisters, 17.4m to 22.6m -with mica flakes, 19.2m to 29.0m -with silt pockets at 19.5m -with a few silt pockets and partings, at 23.2m -with sand pockets and partings, below 23.8m -with many shells at 29.9m -with sand seams, 33.8m to 36.6m -with shell fragments at 36.0m -with sand layers, 36.6m to 37.2m -with a very dense sand layer, 38.4m to 38.7m -with a few shell fragments and mica flakes, below 39.6m -with sand seams, 41.5m to 42.7m (44.3m)
V	Silty fine to medium SAND (SM),dense, gray -with many clay pockets, partings, and seams, many shell fragments and mica flakes (50.3m)
VI	Lean CLAY (CL), hard, gray -with silt and sand pockets, partings and seams -with organic pockets and mica flakes, below 54.3m (54.9m)
VII	Silty fine SAND (SM), dense, gray to dark gray -with clay pockets and seams -with a clay layer at 55.2m -with a clay layer, 55.6m to 55.9m -with organic partings at 57.0m -with a lean clay layer, 57.2m to 57.5m -clay layer with organic partings, below 61.6m (62.0m)
VIII	Fine to medium SAND (SP), with coarse sand, silt and a trace of fine gravel, very dense, gray (70.1m)
IX	Lean CLAY (CL), hard, gray -with sand seams at 70.7m -with a sand layer at 74.7m (75.0m)
X	Medium to coarse SAND (SW), with silt and fine gravel, very dense, gray (79.9m)
XI	SANDSTONE (Graywacke) (RX) (81.1m)
XII	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [5:1] (82.9m)
XIII	SILTSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [3:1] (84.3m)
XIV	SANDSTONE (Graywacke) (RX) with interbedded SILTSTONE (RX) [1:1] (87.2m)
XV	SANDSTONE (Graywacke) (RX) with thinly interbedded siltstone (RX) [3:1] (89.8m)
XVI	SILTSTONE (Graywacke) (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) [5:1] (94.2m)
XVII	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [4:1] -with a siltstone bed, 95.1m to 95.5m (97.2m)
XVIII	SILTSTONE (RX) -with a sandstone bed dipping at 40 degrees, medium gray, hard, 98.8m to 99.1m -moderately hard, smooth fractures, below 99.1m (99.5m)
XIX	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2:1] (102.1m)
XX	SILTSTONE (RX)with highly interbedded SANDSTONE (Graywacke) (RX) [5:1]

TOTAL DEPTH: 104.2 m BACKFILLED WITH: Cement Grout

See Plate 98-7.6 for detailed stratigraphy below 62.0 m



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 08/06/98

FUGRO

PLATE 98-7.3

PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)

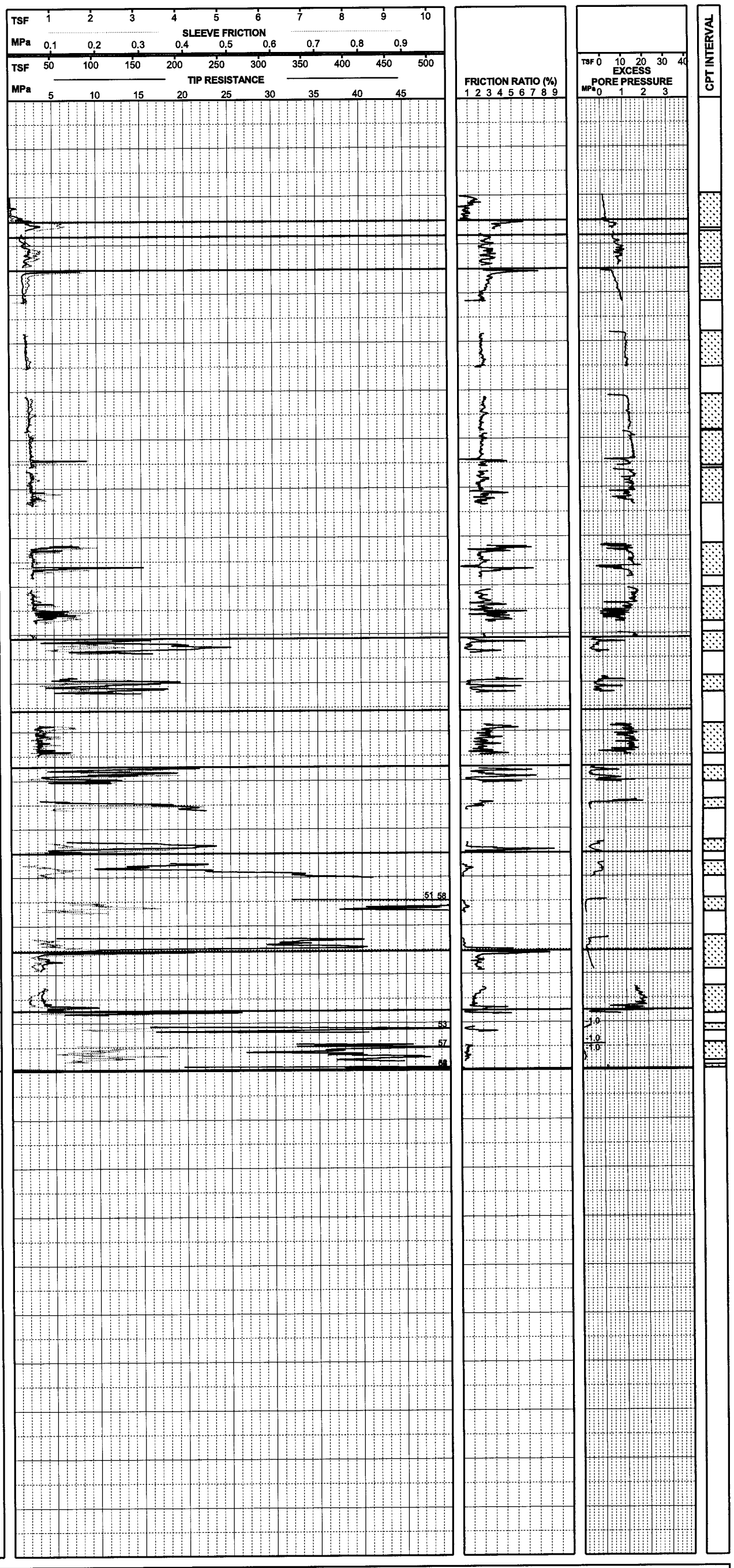
START DATE: 3/11/98
COMPLETION DATE: 3/16/98

DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		WOH, WOH, WOH, WOH, WOH, WOH, WOH, PUSH, PUSH, 4/60cm, PUSH, PUSH	Fat CLAY (CH), very soft to soft, olive gray **See Plate 98-7.7 for detailed stratigraphy to 14.0m** (10.1m)	I
-19	4			
-23	8			
-27	12	PUSH, PUSH, PUSH	Fat CLAY (CH), very stiff, greenish gray to grayish green (11.3m)	II
		PUSH, PUSH, PUSH, PUSH, SAVE	Sandy organic CLAY (OH), very stiff, mottled with brown and gray, with an organic odor (14.0m)	III
-31	16	PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, 49/45cm, 32, PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, SAVE, PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, 22, PUSH, SAVE	Fat CLAY (CH), very stiff to hard, gray -with a sand layer at 14.0m -greenish gray, expansive, desiccated and with a few silt pockets and gas blisters, to 15.5m -with shell fragments and shells, below 15.5m -with silt partings, 16.5m to 18.0m -expansive and with gas blisters, 17.4m to 22.6m -with mica flakes, 19.2m to 29.0m -with silt pockets at 19.5m -with a few silt pockets and partings, at 23.2m -with sand pockets and partings, below 23.8m -with many shells at 29.9m -with sand seams, 33.8m to 36.6m -with shell fragments at 36.0m -with sand layers, 36.6m to 37.2m -with a very dense sand layer, 38.4m to 38.7m -with a few shell fragments and mica flakes, below 39.6m -with sand seams, 41.5m to 42.7m (44.3m)	IV
-35	20			
-39	24			
-43	28			
-47	32			
-51	36			
-55	40			
-59	44			
-63	48	PUSH	Silty fine to medium SAND (SM),dense, gray -with many clay pockets, partings, and seams, many shell fragments and mica flakes (50.3m)	V
-67	52	PUSH, PUSH	Lean CLAY (CL), hard, gray -with silt and sand pockets, partings and seams -with organic pockets and mica flakes, below 54.3m (54.9m)	VI
-71	56	30/20cm, 41, 30/25cm, 77	Silty fine SAND (SM), dense, gray to dark gray -with clay pockets and seams -with a clay layer at 55.2m -with a clay layer, 55.6m to 55.9m -with organic partings at 57.0m (62.0m)	VII
-75	60			
-79	64	30/25cm, 30/5cm, 90, 65/30cm	-with a lean clay layer, 57.2m to 57.5m -clay layer with organic partings, below 61.6m Fine to medium SAND (SP), with coarse sand, silt and a trace of fine gravel, very dense, gray (70.1m)	VIII
-83	68			
-87	72	48	Lean CLAY (CL), hard, gray -with sand seams at 70.7m -with a sand layer at 74.7m (75.0m)	IX
-91	76	63/30cm	Medium to coarse SAND (SW), with silt and fine gravel, very dense, gray	X
-95	80	85/45cm		
-99	84			
-103	88			
-107	92			
-111	96			
-115	100			
-119	104			
-123	108			
-127	112			
-131	116			
-135				



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

PLATE 98-7.4

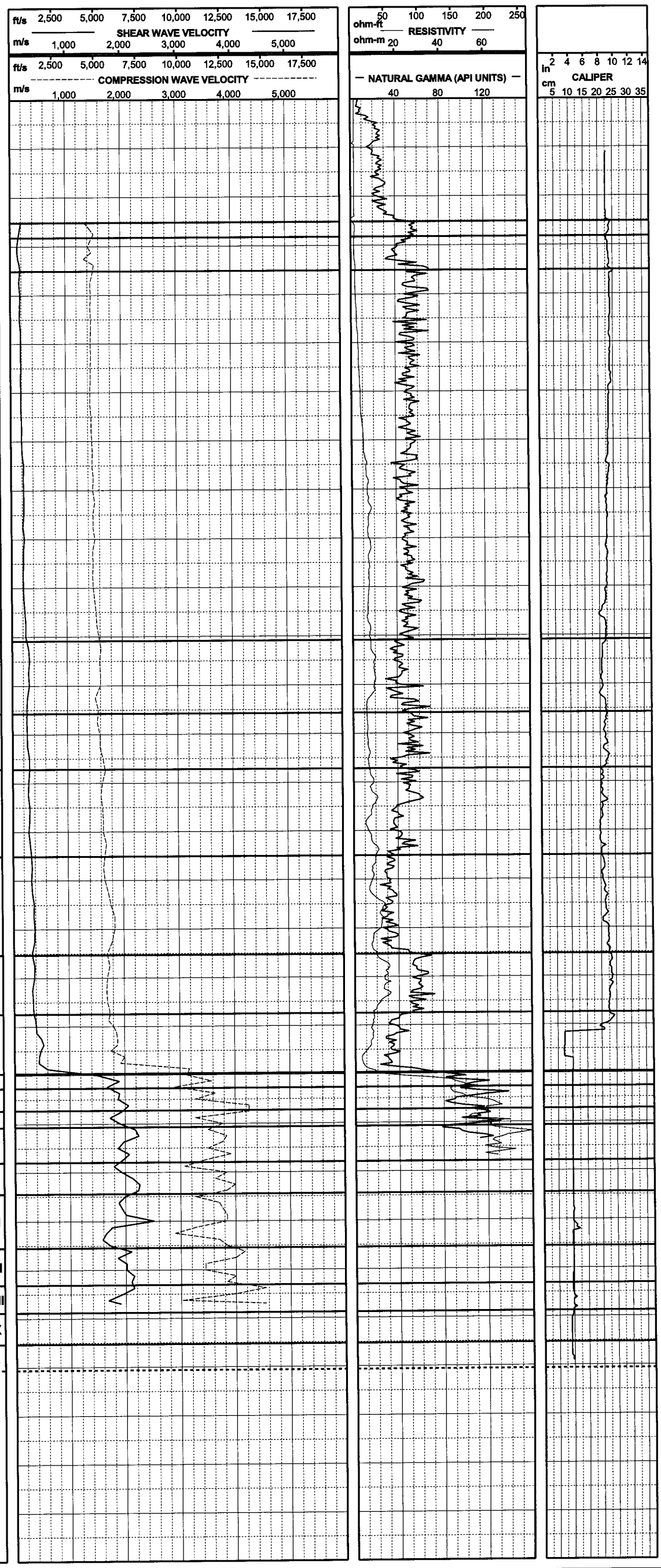
PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)
START DATE: 3/11/98
COMPLETION DATE: 3/16/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		WOH	Fat CLAY (CH), very soft to soft, olive gray	I
		WOH	-with silt pockets and partings and shell fragments	
		WOH	-with sand pocket, partings and seams, to 1.5m	
-19	4	WOH	-with organic pockets at 1.2m	
		WOH	-with light gray streaks at 2.1m	
		WOH	-with many gray sand pockets, partings, seams, layers and gas blisters, below 5.5m	
		WOH		
-23	8	PUSH	-with a silty fine sand layer at 7.5m	
		PUSH	-with a silty fine sand layer at 7.8m	
		4/60cm	-with silt pockets and partings, at 8.5m (10.1m)	
		PUSH	Fat CLAY (CH), very stiff, greenish gray to grayish green	II
		PUSH	-with a few sand pockets at 10.2m (11.3m)	
-27	12	PUSH	-olive gray with organic pockets at, 11.1m	III
		PUSH	Sandy organic CLAY (OH), very stiff, mottled with brown and gray, with an organic odor (14.0m)	
		PUSH		
-31	16	SAVE	Fat CLAY (CH), very stiff to hard, gray	IV
		PUSH	-with a sand layer at 14.0m	
		PUSH	-greenish gray, expansive, desiccated and with a few silt pockets and gas blisters, to 15.5m	
-35	20	PUSH	-with shell fragments and shells, below 15.5m	
		PUSH	-with silt partings, 16.5m to 18.0m	
		PUSH	-expansive and with gas blisters, 17.4m to 22.6m	
-39	24	49/45cm	-with mica flakes, 19.2m to 29.0m	
		32	-with silt pockets at 19.5m	
		PUSH	-with a few silt pockets and partings, at 23.2m	
		PUSH	-with sand pockets and partings, below 23.8m	
		PUSH		
-43	28	PUSH		
		PUSH		
		PUSH	-with many shells at 29.9m	
		SAVE		
-47	32	PUSH		
		PUSH		
		PUSH	-with sand seams, 33.8m to 36.6m	
		PUSH		
-51	36	PUSH	-with shell fragments at 36.0m	
		22	-with sand layers, 36.6m to 37.2m	
			-with a very dense sand layer, 38.4m to 38.7m	
-55	40	PUSH	-with a few shell fragments and mica flakes, below 39.6m	
			-with sand seams, 41.5m to 42.7m	
-59	44	SAVE	(44.3m)	
			Silty fine to medium SAND (SM),dense, gray	V
-63	48	PUSH	-with many clay pockets, partings, and seams, many shell fragments and mica flakes	
			(50.3m)	
-67	52	PUSH	Lean CLAY (CL), hard, gray	VI
			-with silt and sand pockets, partings and seams	
		PUSH	-with organic pockets and mica flakes, below 54.3m (54.9m)	
-71	56	30/20cm	Silty fine SAND (SM), dense, gray to dark gray	VII
		41	-with clay pockets and seams	
			-with a clay layer at 55.2m	
		30/25cm	-with a clay layer, 55.6m to 55.9m	
-75	60	77	-with organic partings at 57.0m	
			-with a lean clay layer, 57.2m to 57.5m	
			-clay layer with organic partings, below 61.6m (62.0m)	
		30/25cm	Fine to medium SAND (SP), with coarse sand, silt and a trace of fine gravel, very dense, gray	VIII
-79	64	30/5cm		
		90		
-83	68	65/30cm	(70.1m)	
-87	72	48	Lean CLAY (CL), hard, gray	IX
			-with sand seams at 70.7m	
			-with a sand layer at 74.7m (75.0m)	
-91	76	63/30cm	Medium to coarse SAND (SW), with silt and fine gravel, very dense, gray	X
			(79.9m)	
-95	80	85/45cm		
		82/5cm	SANDSTONE (Graywacke) (RX) (81.1m)	XI
		100-25		
		75-20	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [5:1] (82.9m)	XII
		100-75		
-99	84	100-75		XIII
		100-85	SILTSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [3:1] (84.3m)	XIV
		100-85		
		100-50		
-103	88	100-70	SANDSTONE (Graywacke) (RX) with interbedded SILTSTONE (RX) [1:1] (87.2m)	XV
		100-60	SANDSTONE (Graywacke) (RX) with thinly interbedded siltstone (RX) [3:1] (89.8m)	
		80-20		
-107	92	100-0	SILTSTONE (Graywacke) (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) [5:1]	XVI
		90-15	(94.2m)	
		100-75	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [4:1]	XVII
-111	96	100-25	-with a siltstone bed, 95.1m to 95.5m (97.2m)	
		100-40	SILTSTONE (RX)	XVIII
		25-0	-with a sandstone bed dipping at 40 degrees, medium gray, hard, 98.8m to 99.1m (99.5m)	
-115	100	100-25	-moderately hard, smooth fractures, below 99.1m	XIX
		95-85		
		92-50	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2:1] (102.1m)	XX
-119	104	95-20		
			SILTSTONE (RX)with highly interbedded SANDSTONE (Graywacke) (RX) [5:1]	
-123	108		TOTAL DEPTH: 104.2 m	
			BACKFILLED WITH: Cement Grout	
-127	112			
-131	116			
-135				

See Plate 98-7.6 for detailed stratigraphy below 79.9m



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

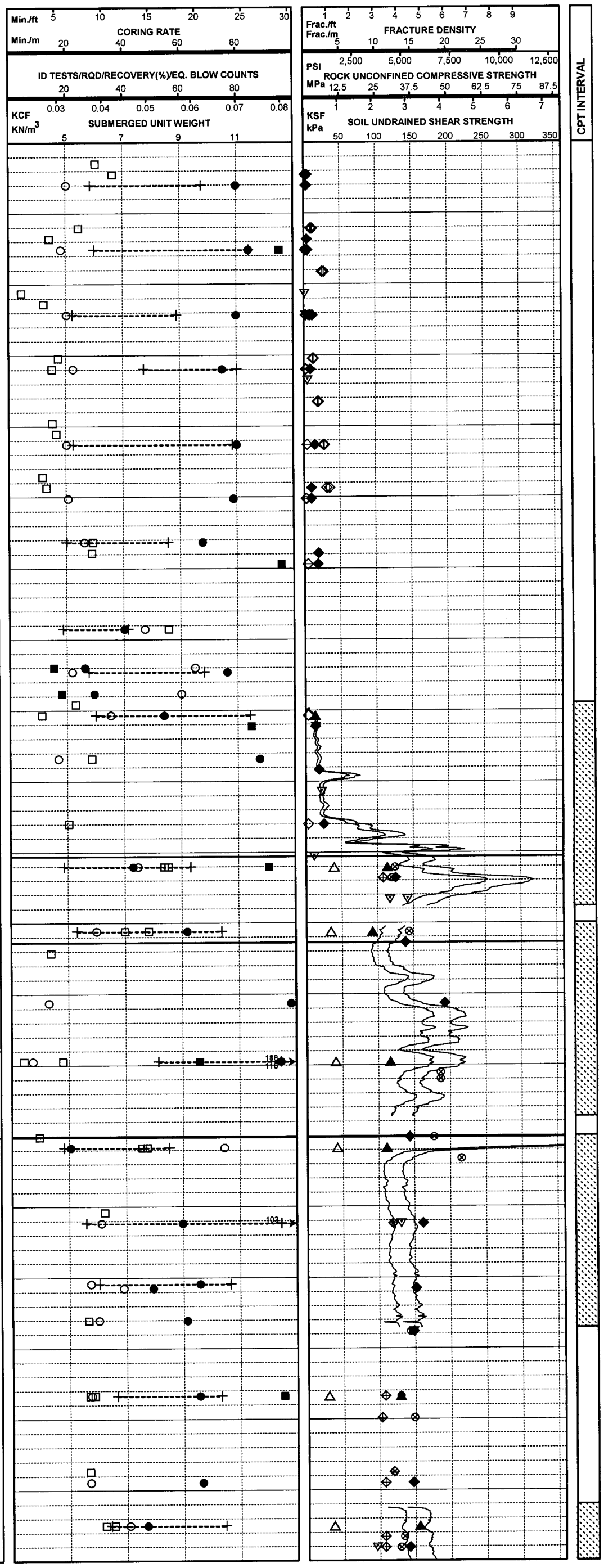
PLATE 98-7.5

PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)
START DATE: 3/11/98
COMPLETION DATE: 3/16/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
			Fat CLAY (CH), very soft to soft, olive gray	I
		WOH	-with silt pockets and partings and shell fragments	
-16			-with sand pocket, partings and seams, to 1.5m	
	1	WOH	-with organic pockets at 1.2m	
-17				
	2	WOH	-with light gray streaks at 2.1m	
-18				
	3	WOH		
-19				
	4	WOH		
-20				
	5	WOH		
-21		WOH	-with many gray sand pockets, partings, seams, layers and gas blisters, below 5.5m	
	6			
-22		WOH		
	7			
-23		PUSH	-with a silty fine sand layer at 7.5m	
			-with a silty fine sand layer at 7.8m	
	8	PUSH		
-24		4/60cm	-with silt pockets and partings, at 8.5m	
	9			
-25		PUSH		
	10		(10.1m)	
		PUSH	Fat CLAY (CH), very stiff, greenish gray to grayish green	II
-26			-with a few sand pockets at 10.2m	
	11		-olive gray with organic pockets at, 11.1m	
		PUSH	(11.3m)	
-27			Sandy organic CLAY (OH), very stiff, mottled with brown and gray, with an organic odor	III
	12	PUSH		
-28				
	13	PUSH		
-29				
			(14.0m)	
	14	PUSH	Fat CLAY (CH), very stiff to hard, gray	IV
-30			-with a sand layer at 14.0m	
			-greenish gray, expansive, desiccated and with a few silt pockets and gas blisters, to 15.5m	
	15	PUSH		
-31			-with shell fragments and shells, below 15.5m	
	16	SAVE		
-32		PUSH	-with silt partings, 16.5m to 18.0m	
	17			
-33			-expansive and with gas blisters, 17.4m to 22.6m	
		PUSH		
	18			
-34		PUSH		
	19			
			-with mica flakes, 19.2m to 29.0m	
-35		PUSH	-with silt pockets at 19.5m	



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

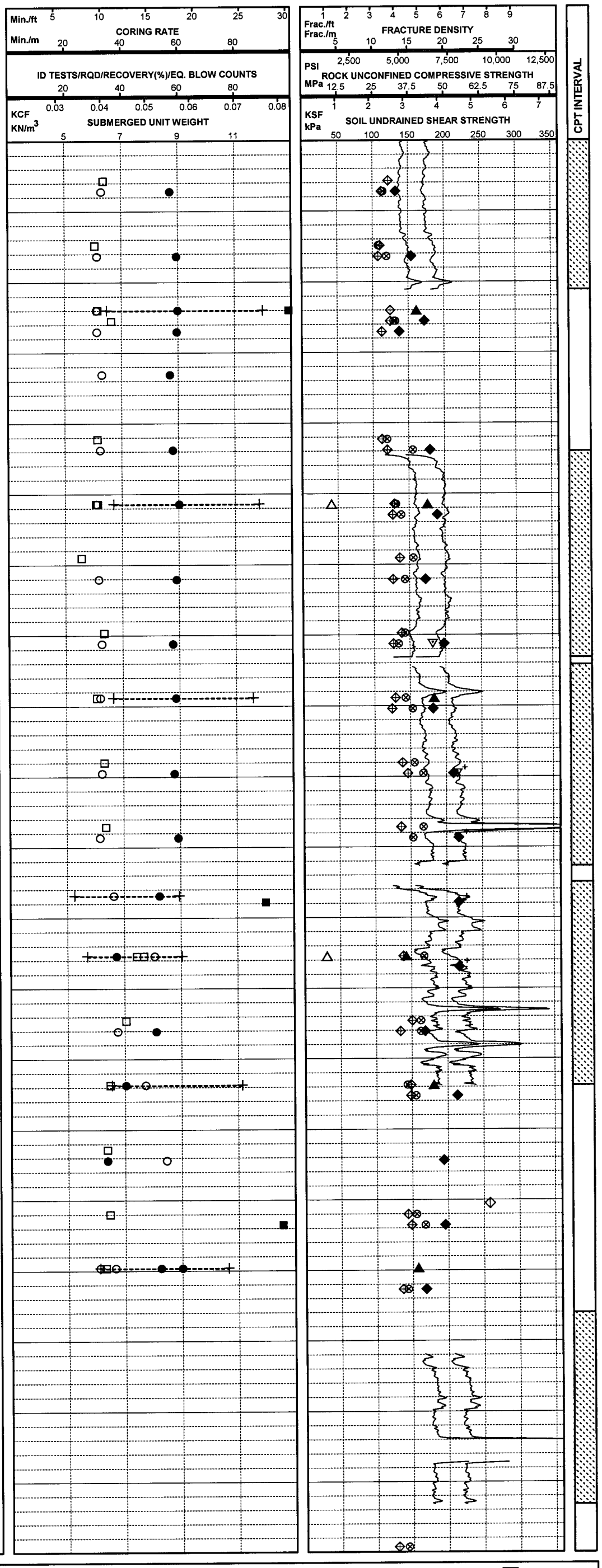
PLATE 98-7.6a

PROJECT NO:	98-42-0035	**START DATE:**	3/11/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-7 (Northwest of Pier E3)	**COMPLETION DATE:**	3/16/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
					Fat CLAY (CH), very stiff to hard, gray	
-36				PUSH		
	21					
-37				PUSH		
	22					
-38				PUSH 49/45cm		
	23			32	-with a few silt pockets and partings, at 23.2m	
-39					-with sand pockets and partings, below 23.8m	
	24			PUSH		
-40						
	25			PUSH		
-41						
	26			PUSH		
-42						
	27			PUSH		
-43						
	28			PUSH		
-44						
	29			PUSH		
-45				PUSH		
	30				-with many shells at 29.9m	IV
-46				SAVE		
	31					
-47				PUSH		
	32					
-48				PUSH		
	33					
-49				PUSH		
	34				-with sand seams, 33.8m to 36.6m	
-50				PUSH		
	35					
-51				PUSH		
	36			PUSH 22	-with shell fragments at 36.0m	
-52					-with sand layers, 36.6m to 37.2m	
	37					
-53						
	38					
-54					-with a very dense sand layer, 38.4m to 38.7m	
	39					
-55				PUSH	-with a few shell fragments and mica flakes, below 39.6m	



CPT INTERVAL

LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

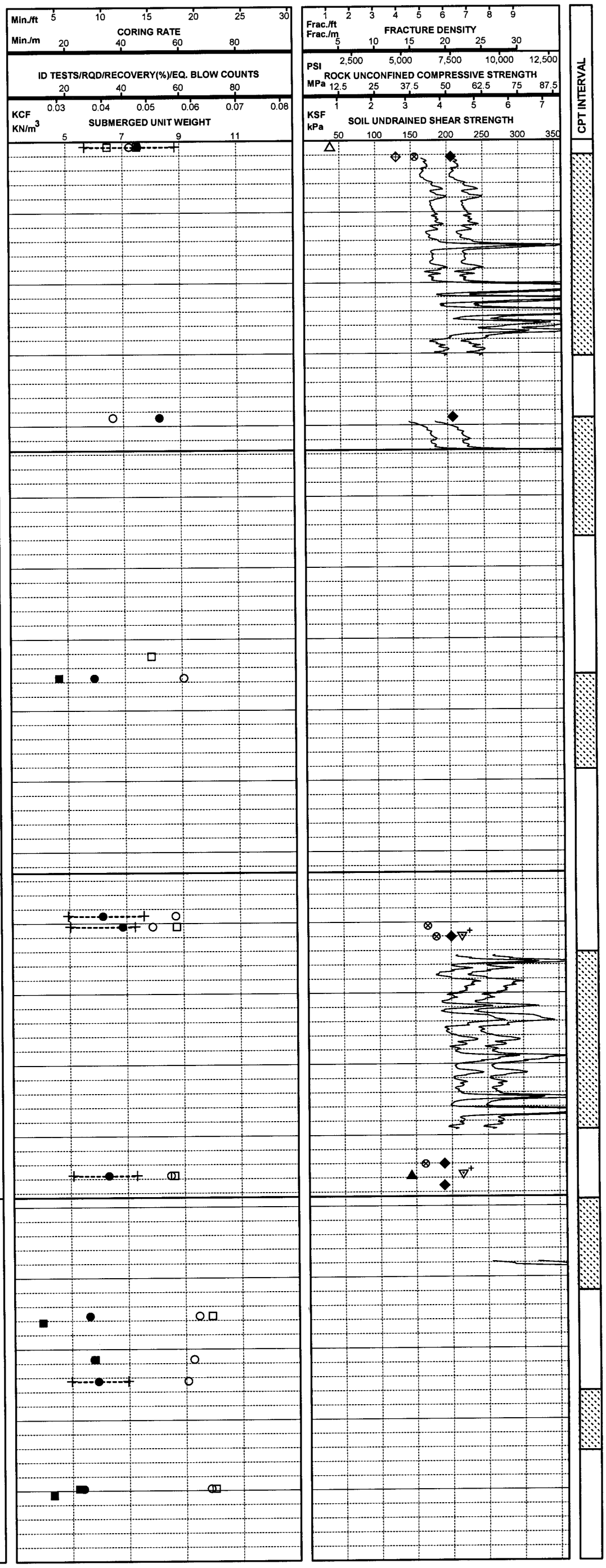
PLATE 98-7.6b

PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)
START DATE: 3/11/98
COMPLETION DATE: 3/16/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
				PUSH	Fat CLAY (CH), very stiff to hard, gray	IV
-56						
	41					
-57					-with sand seams, 41.5m to 42.7m	
	42					
-58						
	43					
-59				SAVE		
	44				(44.3m)	
-60					Silty fine to medium SAND (SM),dense, gray -with many clay pockets, partings, and seams, many shell fragments and mica flakes	V
	45					
-61						
	46					
-62						
	47			PUSH		
-63						
	48					
-64						
	49					
-65						
	50				(50.3m)	
-66					Lean CLAY (CL), hard, gray -with silt and sand pockets, partings and seams	VI
	51			PUSH		
-67						
	52					
-68						
	53					
-69						
	54					
-70				PUSH	-with organic pockets and mica flakes, below 54.3m	
					(54.9m)	
	55				Silty fine SAND (SM), dense, gray to dark gray -with clay pockets and seams -with a clay layer at 55.2m	VII
-71					-with a clay layer, 55.6m to 55.9m	
	56					
-72				30/20cm		
	57				-with organic partings at 57.0m -with a lean clay layer, 57.2m to 57.5m	
-73				41		
	58					
-74						
	59			30/25cm		
-75						



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

PLATE 98-7.6c

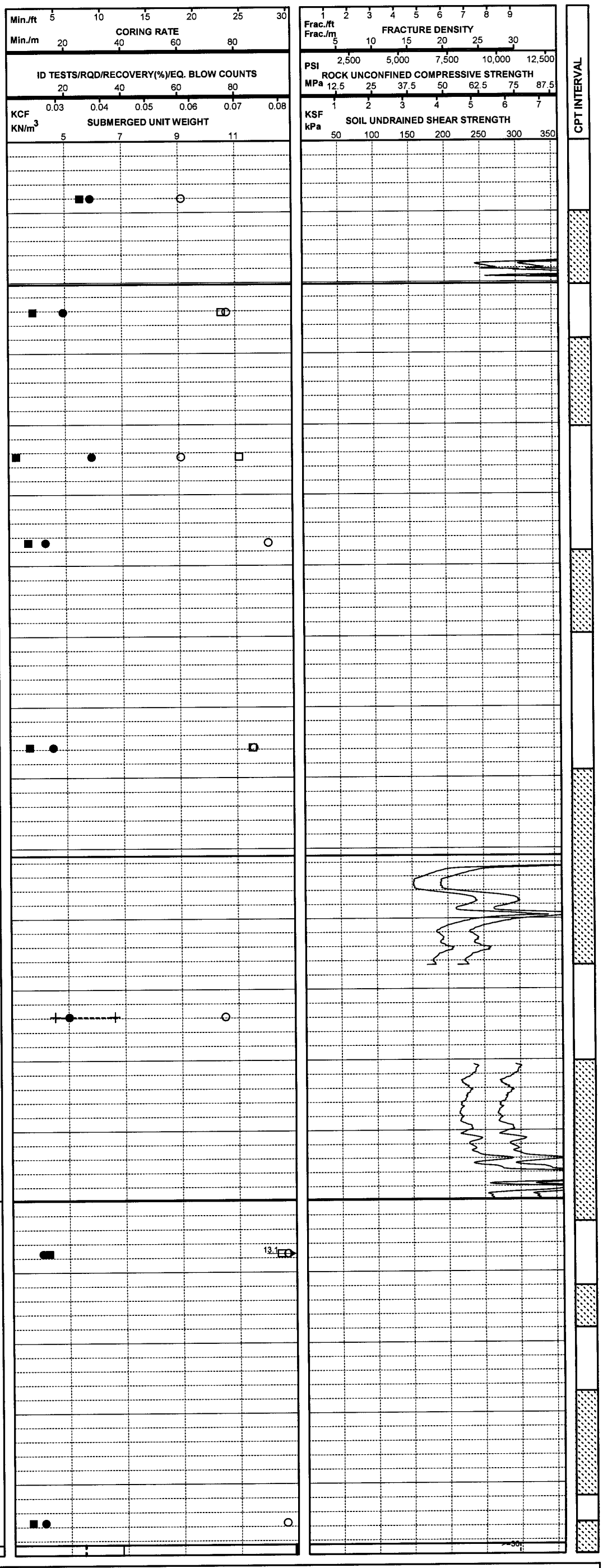
PROJECT NO:	98-42-0035	**START DATE:**	3/11/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-7 (Northwest of Pier E3)	**COMPLETION DATE:**	3/16/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

MATERIAL DESCRIPTION	STRATUM NO.
Silty fine SAND (SM), dense, gray to dark gray	VII
-clay layer with organic partings, below 61.6m (62.0m)	
Fine to medium SAND (SP), with coarse sand, silt and a trace of fine gravel, very dense, gray	VIII
(70.1m)	
Lean CLAY (CL), hard, gray -with sand seams at 70.7m -with a sand layer at 74.7m	IX
(75.0m)	
Medium to coarse SAND (SW), with silt and fine gravel, very dense, gray	X
(79.9m)	XI

Blow count: 77; 30/25cm; 30/5cm; 90; 65/30cm; 48; 63/30cm; 85/45cm; 82/5cm; 100-25



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

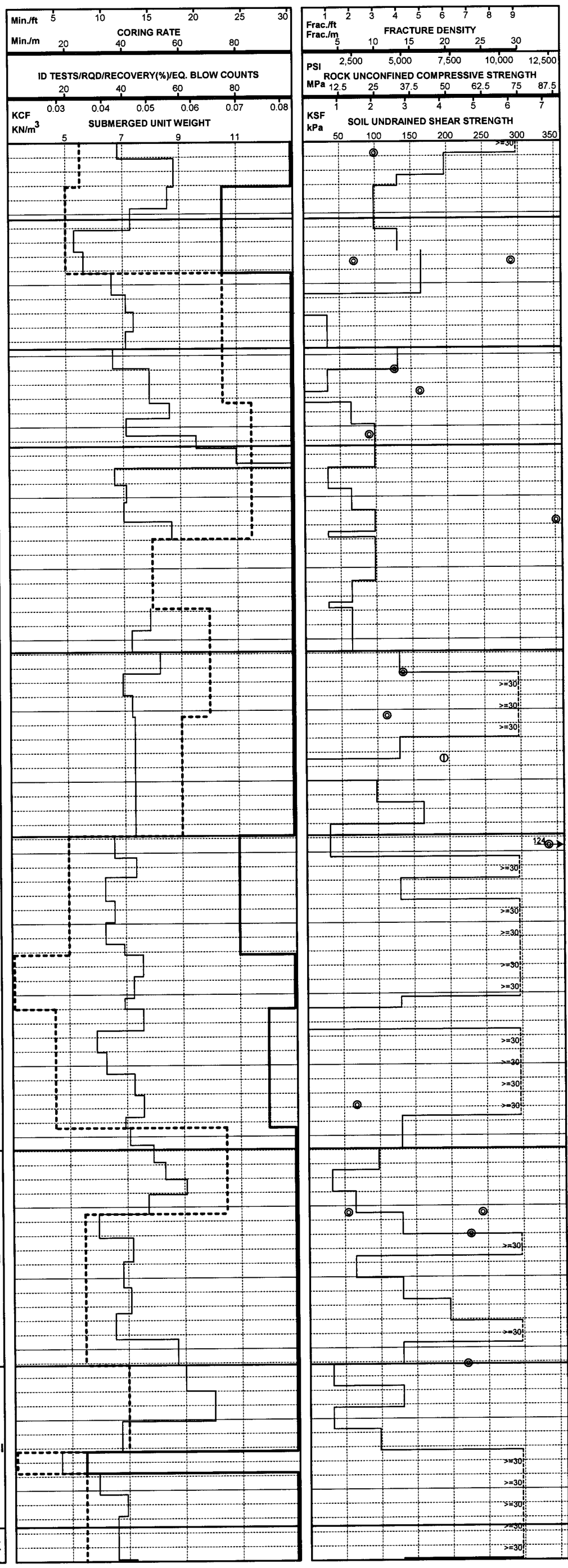
PLATE 98-7.6d

PROJECT NO:	98-42-0035	**START DATE:**	3/11/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-7 (Northwest of Pier E3)	**COMPLETION DATE:**	3/16/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-96	81	100-25	SANDSTONE (Graywacke) (RX), medium gray, slightly weathered to fresh, hard, thinly to moderately bedded, intensely to moderately fractured -with very thin, slightly to moderately rough fractures with discontinuous calcite filling, and very thin healed calcite joints -beds dip at 30 degrees, fractures inclined at approximately 30, 60, and 80 degrees, below 79.9m (81.1m)	XI
-97	82	75-20	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [5:1], dark gray, fresh, moderately hard to hard, moderately fractured -with very thin, smooth to moderately rough fractures with discontinuous calcite filling, and very thin healed calcite joints -with very thin to thin sandstone beds -laminated siltstone and sandstone, intensely fractured at 82.0m	XII
-98		100-75	(82.9m)	
-99	83	100-75	SILTSTONE (RX) interbedded with SANDSTONE (Graywacke) (RX) [3:1], fresh, bedding at 20 degrees, intensely to slightly fractured -with very thin fractures, partly filled with calcite, slightly rough to smooth -siltstone: moderately hard, thinly to moderately bedded -sandstone: hard, very thinly to thinly bedded (84.3m)	XIII
	84	100-85		
-100	85	100-85	SANDSTONE (Graywacke) (RX) with interbedded SILTSTONE (RX) [1:1], medium gray, slightly weathered to fresh, hard, moderately to thickly bedded at 25 degrees, with very thin fracture fillings and smooth fractures -with fractures inclined at 20 to 30 and 60 degrees, smooth to slightly rough	XIV
-101				
-102	86	100-50	-intensely fractured at 86.0m	
	87		(87.2m)	
-103		100-70	SANDSTONE (Graywacke) (RX) with thinly interbedded siltstone (RX) [3:1], medium gray, slightly weathered to fresh, hard, thickly bedded, dipping at 20 to 30 degrees, moderately fractured -with clean to very thin fractures inclined at 20 and 40 to 60 degrees, moderately rough to slightly rough -with discontinuous calcite filling, and very thin healed calcite joints	XV
-104	88			
	89	100-60		
-105			(89.8m)	
-106	90	80-20	SILTSTONE (Graywacke) (RX) with thinly interbedded SANDSTONE (Graywacke) (RX) [5:1], dark gray, slightly weathered, moderately hard, thinly to moderately bedded, intensely to moderately fractured -fractures inclined at 30 and 60 degrees, smooth to slightly rough mwith discontinuous calcite filling, and very thin to thin healed calcite joints -very intensely fractured at 90.2m	XVI
-107	91		-intensely to very intensely fractured below 91.4m	
	92	100-0		
-108				
-109	93	90-15		
	94		(94.2m)	
-110		100-75	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [4:1], medium gray, fresh, hard, moderately bedded, moderately fractured -with very thin fractures inclined at 45, 60, and 80 to 90 degrees, smooth to slightly rough with discontinuous calcite filling, and very thin to thin healed calcite joints -with a siltstone bed, 95.1m to 95.5m -very intensely fractured, 95.3m to 95.5m	XVII
	95			
-111				
	96	100-25	-with a thin siltstone bed, very intensely fractured, at 96.0m -very intensely fractured at 96.3m	
-112			-with a thin siltstone bed, very intensely fractured, at 96.6m	
	97		(97.2m)	
-113		100-40	SILTSTONE (RX), dark gray, fresh, hard, very thickly bedded at 20 degrees, slightly to moderately fractured -with very thin fractures inclined at 65 and 60 degrees, smooth to slightly rough with discontinuous calcite filling, and very thin healed calcite joints	XVIII
	98			
-114		25-0	-intensely to very intensely fractured below 98.5m -with a sandstone bed dipping at 40 degrees, medium gray, hard, 98.8m to 99.1m	
	99		-moderately hard, smooth fractures, below 99.1m	
-115		100-25	(99.5m)	
			SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2:1], medium gray to dark gray, fresh, hard, fine grained, thickly bedded, moderately to intensely fractured	XIX



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

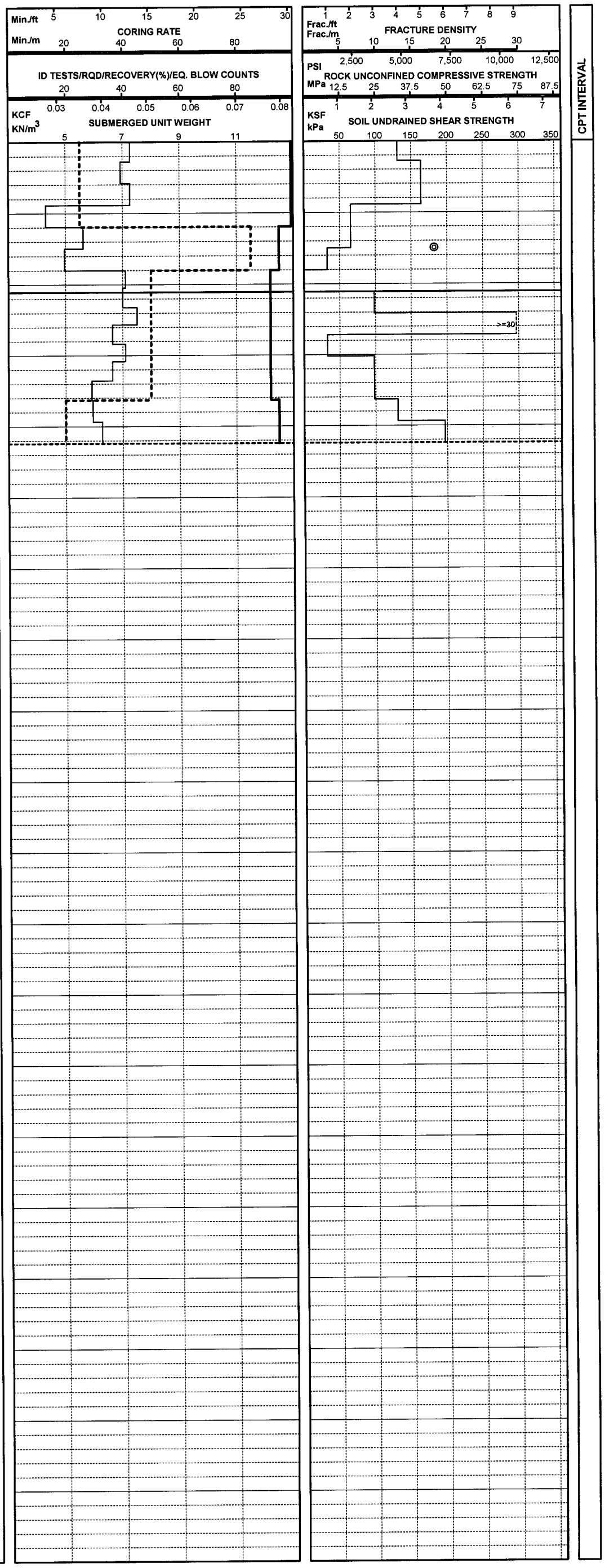
PLATE 98-7.6e

PROJECT NO:	98-42-0035	**START DATE:**	3/11/98	**DRILLER:**	Fugro-McClelland Marine Geosciences
BORING:	98-7 (Northwest of Pier E3)	**COMPLETION DATE:**	3/16/98	**DRILLING METHOD:**	Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-116				100-25	SANDSTONE (Graywacke) (RX) with thinly interbedded SILTSTONE (RX) [2:1], medium gray to dark gray, fresh, hard, fine grained, thickly bedded, moderately to intensely fractured -with fractures dipping 45 degrees and 70 degrees, smooth to slightly rough with discontinuous calcite filling, and very thin healed calcite joints	XIX
	101					
-117				95-85		
	102				(102.1m)	
-118				92-50	SILTSTONE (RX)with highly interbedded SANDSTONE (Graywacke) (RX) [5:1], dark gray, fresh, moderately hard, thinly to thickly bedded, moderately to intensely fractured -fractures inclined at 45 degrees and near vertical, smooth to slightly rough with discontinuous calcite filled fractures, and very thin healed calcite joints -very intensely fractured at 102.4m -very intensely fractured at 102.9m -with very thin sandstone beds and partly laminated siltstone and sandstone, below 103.8m	XX
	103					
-119						
	104			95-20		
-120					TOTAL DEPTH: 104.2 m BACKFILLED WITH: Cement Grout	
	105					
-121						
	106					
-122						
	107					
-123						
	108					
-124						
	109					
-125						
	110					
-126						
	111					
-127						
	112					
-128						
	113					
-129						
	114					
-130						
	115					
-131						
	116					
-132						
	117					
-133						
	118					
-134						
	119					
-135						



CPT INTERVAL

LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-7.6f

PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)

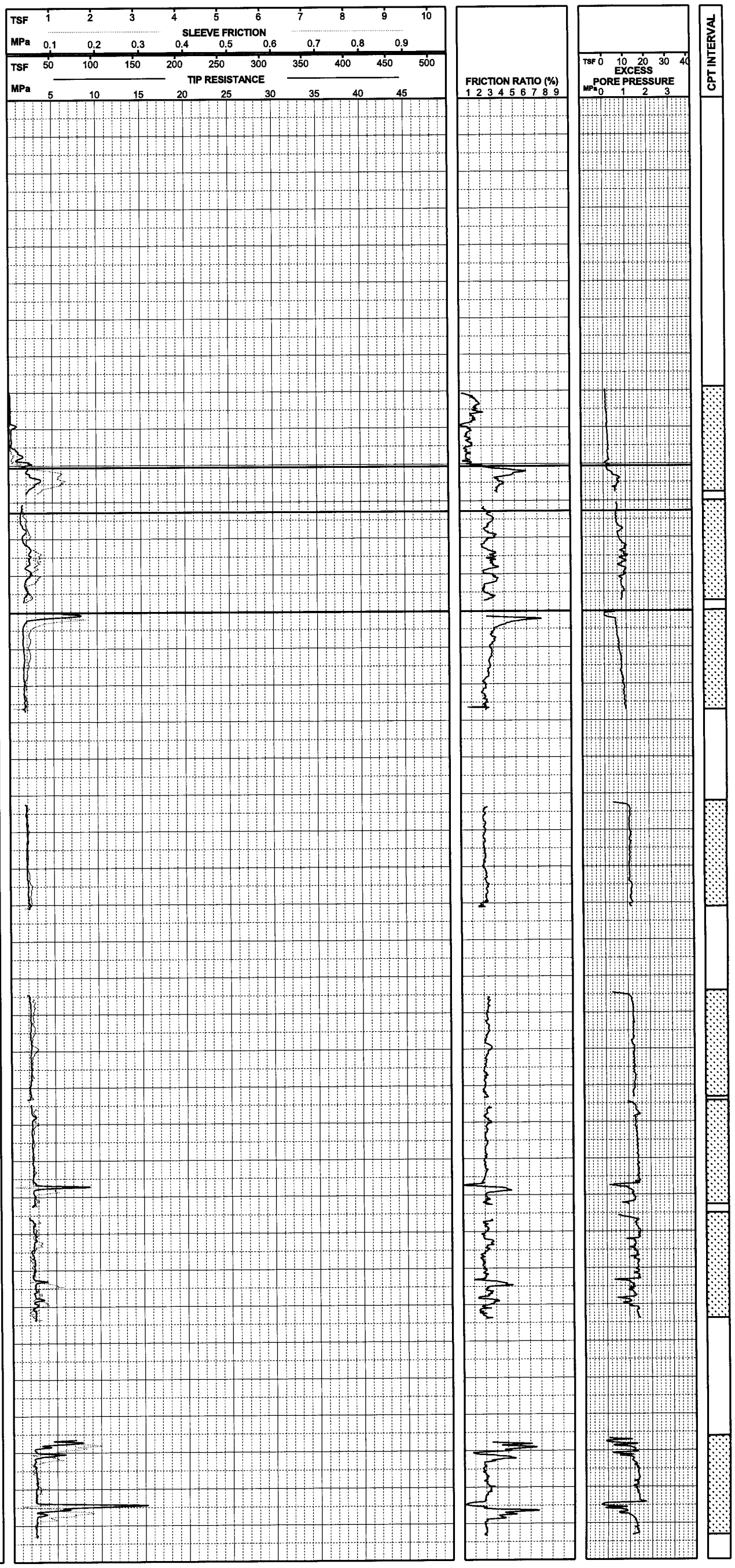
START DATE: 3/11/98
COMPLETION DATE: 3/16/98

DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-16		WOH	Fat CLAY (CH), very soft to soft, olive gray	
	1	WOH	-with silt pockets and partings and shell fragments	
-17			-with sand pocket, partings and seams, to 1.5m	
	2	WOH	-with organic pockets at 1.2m	
-18			-with light gray streaks at 2.1m	
	3	WOH		
-19				
	4	WOH		
-20				
	5	WOH	-with many gray sand pockets, partings, seams, layers and gas blisters, below 5.5m	I
-21		WOH		
	6			
-22		WOH		
	7			
-23		PUSH	-with a silty fine sand layer at 7.5m	
	8	PUSH	-with a silty fine sand layer at 7.8m	
-24		4/60cm	-with silt pockets and partings, at 8.5m	
	9			
-25		PUSH		
	10	PUSH	(10.1m) Fat CLAY (CH), very stiff, greenish gray to grayish green	II
-26			-with a few sand pockets at 10.2m	
	11	PUSH	(11.3m) -olive gray with organic pockets at, 11.1m	
-27			Sandy organic CLAY (OH), very stiff, mottled with brown and gray, with an organic odor	III
	12	PUSH		
-28				
	13	PUSH		
-29				
	14	PUSH	(14.0m) Fat CLAY (CH), very stiff to hard, gray -with a sand layer at 14.0m	
-30				
	15	PUSH	-greenish gray, expansive, desiccated and with a few silt pockets and gas blisters, to 15.5m	
-31				
	16	SAVE	-with shell fragments and shells, below 15.5m	
-32		PUSH	-with silt partings, 16.5m to 18.0m	
	17		-expansive and with gas blisters, 17.4m to 22.6m	
-33		PUSH		
	18			
-34		PUSH		
	19		-with mica flakes, 19.2m to 29.0m	
-35		PUSH	-with silt pockets at 19.5m	
	20			
-36		PUSH		
	21			
-37		PUSH		
	22			
-38		PUSH 49/45cm		
	23	32	-with a few silt pockets and partings, at 23.2m	
-39			-with sand pockets and partings, below 23.8m	
	24	PUSH		
-40				
	25	PUSH		
-41				
	26	PUSH		
-42				
	27	PUSH		IV
-43				
	28	PUSH		
-44				
	29	PUSH		
-45		PUSH		
	30		-with many shells at 29.9m	
-46		SAVE		
	31			
-47		PUSH		
	32			
-48		PUSH		
	33			
-49		PUSH		
	34		-with sand seams, 33.8m to 36.6m	
-50		PUSH		
	35			
-51		PUSH		
	36	PUSH 22	-with shell fragments at 36.0m	
-52			-with sand layers, 36.6m to 37.2m	
	37			
-53				
	38		-with a very dense sand layer, 38.4m to 38.7m	
-54				
	39			
-55		PUSH	-with a few shell fragments and mica flakes, below 39.6m	



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/16/98

FUGRO

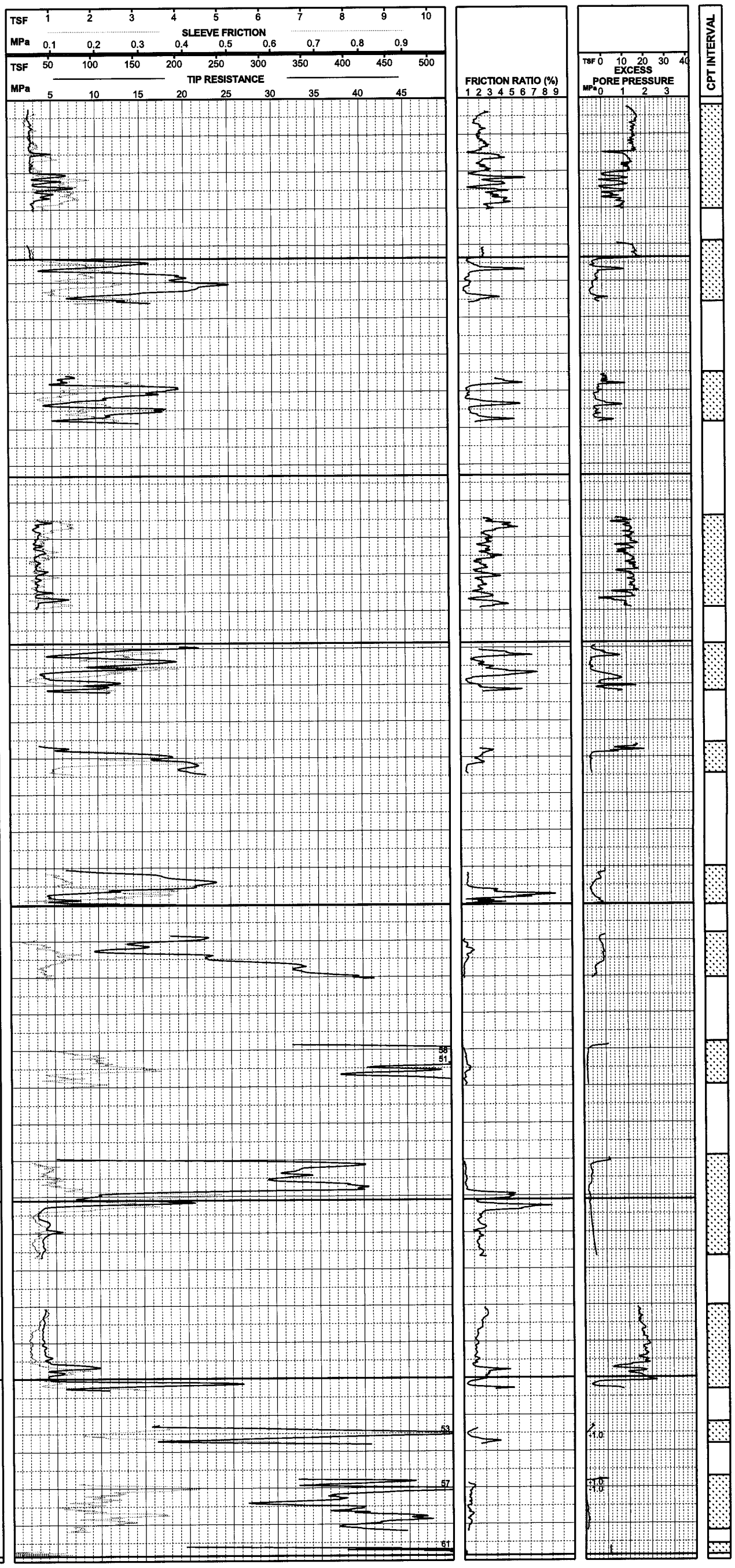
PLATE 98-7.7a

PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)
START DATE: 3/11/98
COMPLETION DATE: 3/16/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-56	41			PUSH	Fat CLAY (CH), very stiff to hard, gray	IV
-57	42				-with sand seams, 41.5m to 42.7m	
-58	43					
-59	44			SAVE	(44.3m)	
-60	45				Silty fine to medium SAND (SM),dense, gray -with many clay pockets, partings, and seams, many shell fragments and mica flakes	V
-61	46					
-62	47			PUSH		
-63	48					
-64	49					
-65	50				(50.3m)	
-66	51			PUSH	Lean CLAY (CL), hard, gray -with silt and sand pockets, partings and seams	VI
-67	52					
-68	53					
-69	54				-with organic pockets and mica flakes, below 54.3m	
-70	55			PUSH	(54.9m)	
-71	56				Silty fine SAND (SM), dense, gray to dark gray -with clay pockets and seams -with a clay layer at 55.2m -with a clay layer, 55.6m to 55.9m	VII
-72	57			30/20cm		
-73	58			41	-with organic partings at 57.0m -with a lean clay layer, 57.2m to 57.5m	
-74	59					
-75	60			30/25cm		
-76	61			77		
-77	62				-clay layer with organic partings, below 61.6m	
-78	63			30/25cm	(62.0m) Fine to medium SAND (SP), with coarse sand, silt and a trace of fine gravel, very dense, gray	VIII
-79	64					
-80	65			30/5cm		
-81	66			90		
-82	67					
-83	68					
-84	69			65/30cm		
-85	70				(70.1m)	
-86	71				Lean CLAY (CL), hard, gray -with sand seams at 70.7m	IX
-87	72			48		
-88	73					
-89	74					
-90	75				-with a sand layer at 74.7m (75.0m)	
-91	76			63/30cm	Medium to coarse SAND (SW), with silt and fine gravel, very dense, gray	X
-92	77					
-93	78					
-94	79					
-95				85/45cm		



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/16/98

FUGRO

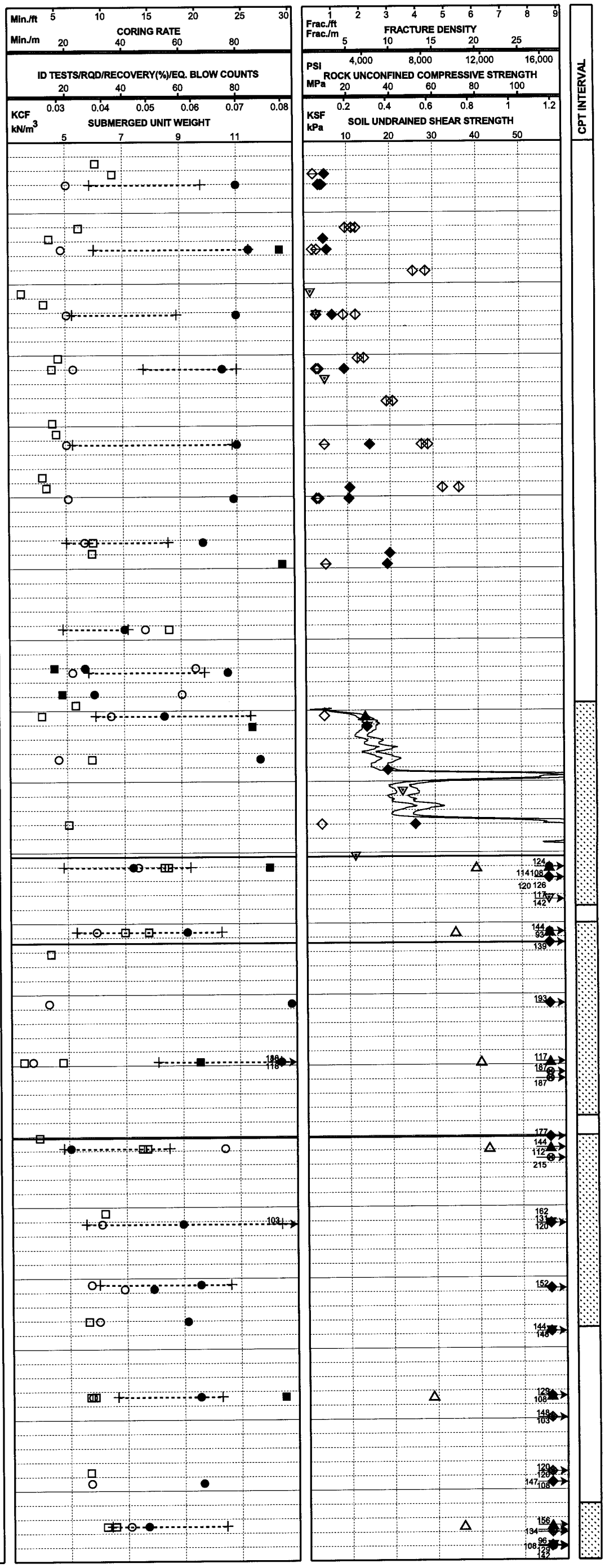
PLATE 98-7.7b

PROJECT NO: 98-42-0035
BORING: 98-7 (Northwest of Pier E3)
START DATE: 3/11/98
COMPLETION DATE: 3/16/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836618 N647712
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -15.5 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
			Fat CLAY (CH), very soft to soft, olive gray -with silt pockets and partings and shell fragments -with sand pocket, partings and seams, to 1.5m	
-16	1	WOH	-with organic pockets at 1.2m	
-17	2	WOH	-with light gray streaks at 2.1m	
-18	3	WOH		
-19	4	WOH		
-20	5	WOH		I
-21		WOH	-with many gray sand pockets, partings, seams, layers and gas blisters, below 5.5m	
-22	6	WOH		
-23	7	PUSH	-with a silty fine sand layer at 7.5m	
-24	8	PUSH	-with a silty fine sand layer at 7.8m -with silt pockets and partings, at 8.5m	
-25	9	4/60cm		
	10	PUSH	(10.1m) Fat CLAY (CH), very stiff, greenish gray to grayish green -with a few sand pockets at 10.2m	II
-26	11	PUSH	-olive gray with organic pockets at, 11.1m (11.3m) Sandy organic CLAY (OH), very stiff, mottled with brown and gray, with an organic odor	
-27	12	PUSH		III
-28	13	PUSH		
-29	14	PUSH	(14.0m) Fat CLAY (CH), very stiff to hard, gray -with a sand layer at 14.0m -greenish gray, expansive, desiccated and with a few silt pockets and gas blisters, to 15.5m	
-30	15	PUSH		
-31	16	SAVE	-with shell fragments and shells, below 15.5m	
-32	17	PUSH	-with silt partings, 16.5m to 18.0m	IV
-33	18	PUSH	-expansive and with gas blisters, 17.4m to 22.6m	
-34	19	PUSH		
-35		PUSH	-with mica flakes, 19.2m to 29.0m	



LOG OF BORING AND TEST RESULTS

BORING 98-7

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

PLATE 98-7.8

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
0.3	1					6.0																					
0.5	2					6.6							4.8		2.2												
0.6	3	80	68	29	1.32								4.2														
0.6	400															3.8											
0.6	401															3.4											
1.2	4					5.5																					
1.2	402															11.0											
1.2	403															12.0											
1.2	404															12.0											
1.2	405															9.6											
1.4	5					4.4							4.5														
1.5	6	84	84	30	1.00		95		2.70				5.3		2.9												H
1.5	6													1.9													
1.8	406															25.4											
1.8	407															28.2											

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

000355/MB(8/12/98/08:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
2.1	7					3.5						1.4															
2.3	8					4.2																					
2.4	9	80	59	22	1.57							2.9	6.6		2.8												
2.4	408															12.0											
2.4	409															9.1											
3.0	11					4.7																					
3.0	410															12.4											
3.0	411															13.9											
3.2	12	75	80	47	0.84	4.5						4.8	9.3		3.3												
3.2	12													2.8													
3.7	412															20.6											
3.7	413															19.2											
4.0	13					4.5																					
4.1	14					4.7																					
4.3	15	80	79	23	1.03								15.2		4.6												

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

8003SSM8(8/12/98/10:37:49 AM)

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
4.3	414															27.3											
4.3	415															28.7											
4.7	16					4.2																					
4.9	17					4.3							10.6														
4.9	416															32.1											
4.9	417															35.9											
5.0	18	79											10.3		2.8												
5.0	18													3.3													
5.6	19	68	56	20	1.34	5.9																					
5.8	20					5.9							19.8														
5.9	21						96						19.1		4.8												H
6.9	22	40	42	19	0.94	8.6																					
7.4	23	26					16																				H
7.5	24	76	68	28	1.20																						
7.8	25	30					18																				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

Earth Mechanics

FUGRO

80035SIMB(8/12/98/09:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
7.9	26					5.3																					
8.1	27	54	84	30	0.44																						
8.1	27													4.2													
8.1	27	54				4.1						14.4					13.8										
8.2	28						85						14.2														H
8.7	30	88				5.9																					
8.8	31											22.5	19.0														
9.6	33					5.0						11.5	25.4														
9.6	32													3.6													
10.2	34	43	63	19	0.54		91				124.5																H
10.2	34	43				8.5											113.9										
10.2	34					8.4						141.7						39.4									
10.4	35									107.7	119.7	117.3	125.5														
11.1	36	62	74	23	0.76						143.6																
11.1	36	62				7.0											92.8										

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

80035SMB(8/12/98/08:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
11.1	36					7.8												34.6									
11.3	37							3					138.8														
11.4	38					4.4																					
12.1	39	98											193.1														
13.0	40	118	180	52	0.52		66	7	2.41																		H
13.0	40	118				3.4											116.9										
13.0	40					4.8												40.4									
13.1	41										186.7																
13.2	42										186.7																
14.0	43					4.0					177.2		143.6														
14.2	44	21	55	18	0.06																						
14.2	44	21				7.7											111.6										
14.2	44					7.6												42.2									
14.3	45										215.5																
15.1	47					6.2																					

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

8/12/98 9:43 AM

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
15.2	48	60	103	26	0.44					119.7	119.7	131.2	161.7														
16.1	49	66	77	31	0.77				2.73																		C,RC,CS
16.2	50	49											152.1														
16.6	51	61				5.7						148.0															
16.8	52										143.6		148.4														
17.7	54	66	73	37	0.79		95			107.7	129.3																H
17.7	54	66				5.7											129.4										
17.7	54					5.9												28.9									
18.0	55									102.9	148.4																
18.7	57					5.7				119.7	119.7																
18.9	58	67								107.7			147.2														
19.5	59	47	75	34	0.31																						
19.5	59	47				6.2											156.0										
19.5	59					6.6												36.0									
19.7	60									107.7	134.1																

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

8003SSM(8/12/98/09:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
19.8	61									107.7	129.3	95.8	142.4														
20.6	63					6.4				122.1																	
20.7	64	57								112.5	114.9		132.8														
21.5	66					6.1				110.1	107.7																
21.6	67	59								107.7	119.7		154.5														
22.4	69	60	90	35	0.45		99			124.5																	H
22.4	69	60				6.2											161.4										
22.6	70									124.5	129.3		172.6														
22.6	111					6.6					131.7																
22.7	112	60								112.5			137.6														
23.3	71	57																									
24.2	73					6.1				112.5	119.7																CS
24.4	74	58								119.7	155.6		179.8														
25.1	76	60	89	37	0.45					129.3	131.7																
25.1	76	60				6.1											175.7										

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H = Hydrometer
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

B0035SMB(8/12/98)(6:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
25.1	76					6.1												41.0									
25.3	77									126.9	138.9		189.5														
25.9	78					5.6				136.5	155.6																
26.2	79	59								126.9	143.6		172.6														
27.0	81					6.3				138.9	143.6																
27.1	82	58								126.9	134.1	181.9	197.9														
27.9	84	59	86	37	0.45					129.3	143.6																
27.9	84	59				6.1											183.4										
28.0	85									124.5	153.2		182.2														
28.8	87					6.3				138.9	155.6																
29.0	88	58								146.0	167.6	215.5	210.0														
29.7	90					6.4				136.5	167.6																
29.9	91	59									153.2		217.2														
30.7	92	53	60	23	0.81				2.74																		C,K
30.8	93						90						217.2														H

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

8003SSMB(8/12/98/09:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
31.5	95	37	60	27	0.31					138.9	167.6																
31.5	95	37				7.4											142.9										
31.5	95					7.7												31.2									
31.7	96												217.2														
32.5	97					7.0				150.8	162.8																
32.6	98	51								134.1	162.8		169.0														
33.4	100	40	81	35	0.11					148.4	143.6																
33.4	100	40				6.5											180.6										
33.5	101									148.4	155.6		213.6														
34.3	102					6.4																					
34.4	103	34											194.3														
35.1	500															258.6											
35.2	105					6.4				143.6	155.6																
35.4	106						96			148.4	167.6		195.5														
36.0	107	60	76	31	0.64																						H

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

80035SMB(01/29/98/08:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
36.0	107	52				6.3											157.8										
36.3	109									136.5	143.6		169.0														
39.9	114									129.3	143.6																
40.1	115	45	58	27	0.59	7.5																					
40.1	115					6.5												37.3									
40.2	116									129.3	155.6		206.4														
43.8	117	56	77	34					2.74																		K,C
43.9	118	53											207.6														
47.2	119					7.9																					
47.5	120	29					17																				
50.9	121	32	46	20	0.46				2.48																		C
51.1	122	39	43	20	0.81	8.8					167.6																
51.2	123										179.6	215.5	200.3														
54.4	124										162.8	215.5	189.5														
54.6	125	33	43	21	0.56																						

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.9j

8003SSMB(8/12/98/09:49 AM)

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
54.6	125	33				8.6											143.6										
54.7	126												189.5														
56.5	127	26				9.9																					
56.6	128						10																				
57.2	129	28					28																				
57.5	130	29	40	20	0.47																						
59.0	131	24				10.0	22																				
59.0	131																		57.5	37							
59.1	132						13		2.70																		
60.8	133	29					25																				
62.4	134	19				10.5	9																				
64.5	135	29				11.1	3																				
65.7	136	13					7																				
68.6	137	15				11.5	7																				
72.4	138	20	36	15	0.23																						

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

Earth Mechanics

FUGRO

80035SMB(8/12/98/08:49 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
75.7	139	11				13.1	13		2.73																		
79.6	140	11					6																				
80.2	142																									24.9	
81.5	143b																									72.6	
81.5	143a																									17.6	
83.1	145a																									31.7	
83.4	145b																									40.5	
84.1	146																									22.7	
85.3	147																									87.9	
87.5	149a																									34.0	
88.1	149b																									28.3	
88.7	150																									48.2	
89.9	151																									124.0	
93.6	153																									17.0	
95.1	154b																									60.8	

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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

8003SSNB(8/12/98/08:43 AM)

Earth Mechanics

FUGRO

98-7		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
95.1	154a																									13.8	
95.4	155a																									56.6	
97.2	155b																									55.3	
101.5	159																									45.6	

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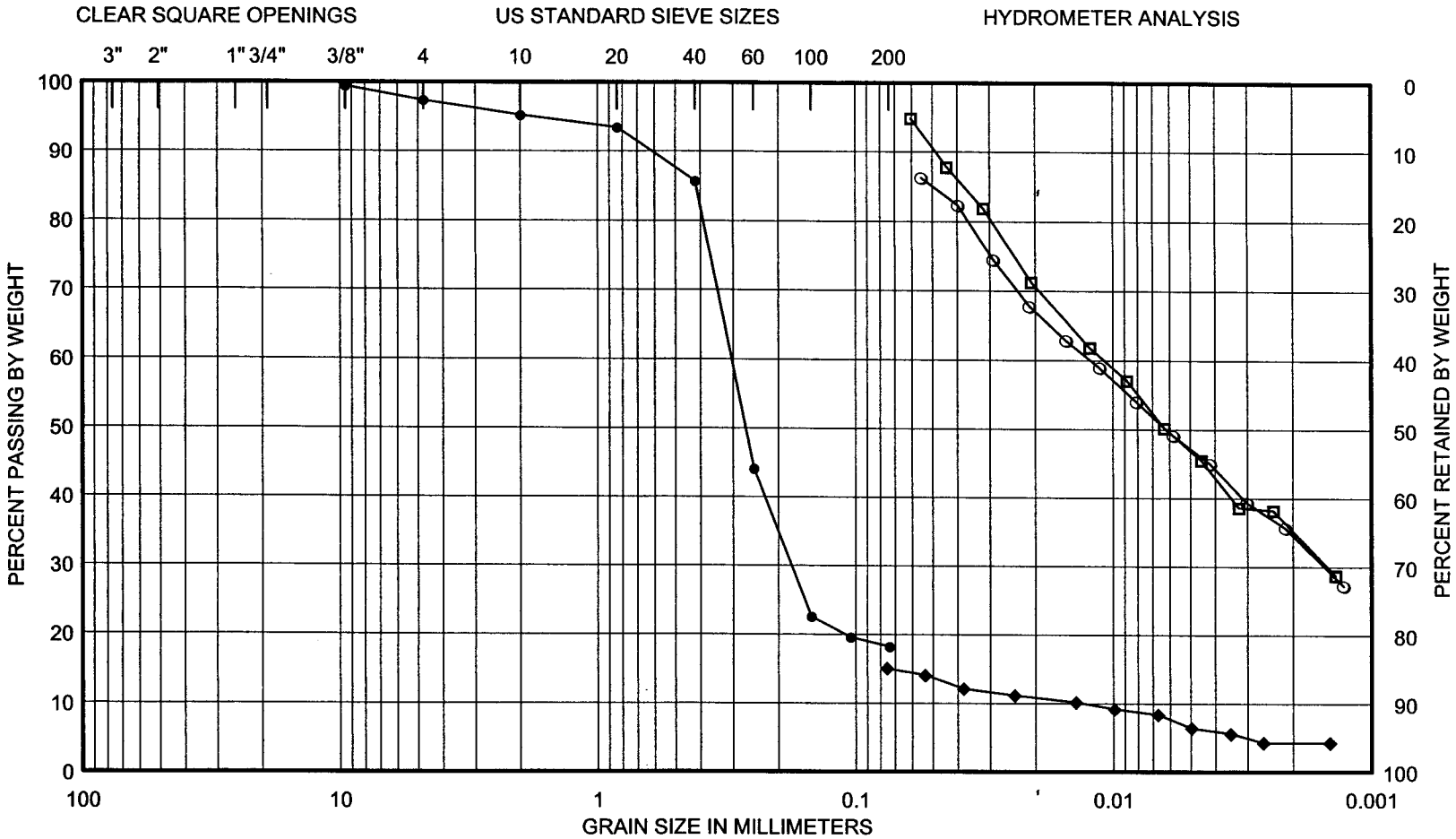
SUMMARY OF LABORATORY TEST RESULTS
BORING 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.9m

80035SMB(8/12/98/09:49 AM)



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
6	1.5	○—○	FAT CLAY (CH)
21	5.9	□—□	FAT CLAY (CH)
23	7.4	◆—◆	SILTY FINE SAND (SM)
25	7.8	●—●	SILTY FINE SAND (SM)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-7

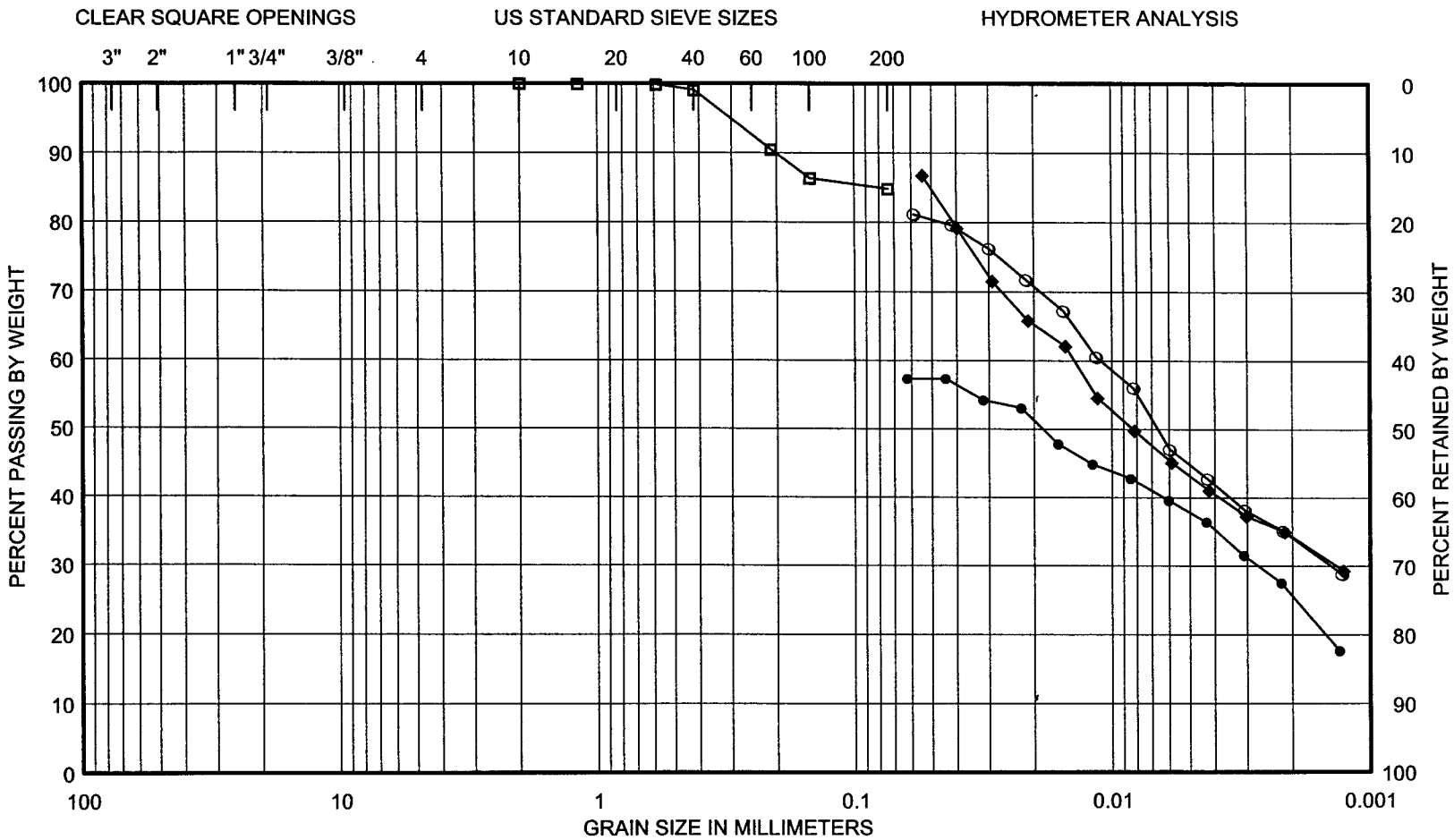
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-7.10a



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
28	8.2	○—○	FAT CLAY (CH) with sand
28	8.2	□—□	FAT CLAY (CH) with sand
34	10.2	◆—◆	FAT CLAY (CH)
40	13.0	●—●	SANDY ORGANIC CLAY (OH)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-7

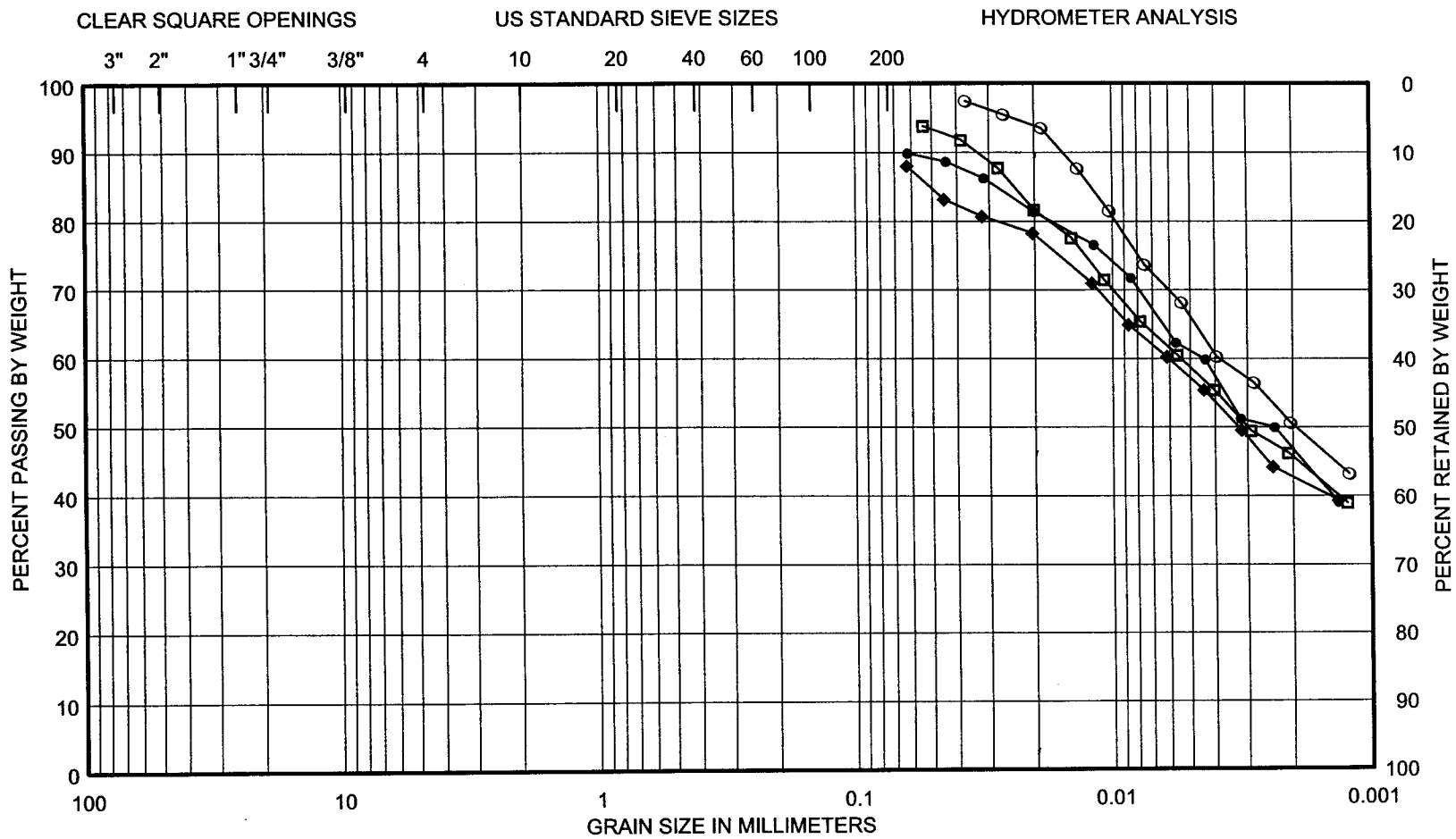
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-7.10b



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
54	17.7	○—○	ELASTIC SILT (MH)
69	22.4	□—□	FAT CLAY (CH)
93	30.8	◆—◆	FAT CLAY (CH)
106	35.4	●—●	FAT CLAY (CH)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-7

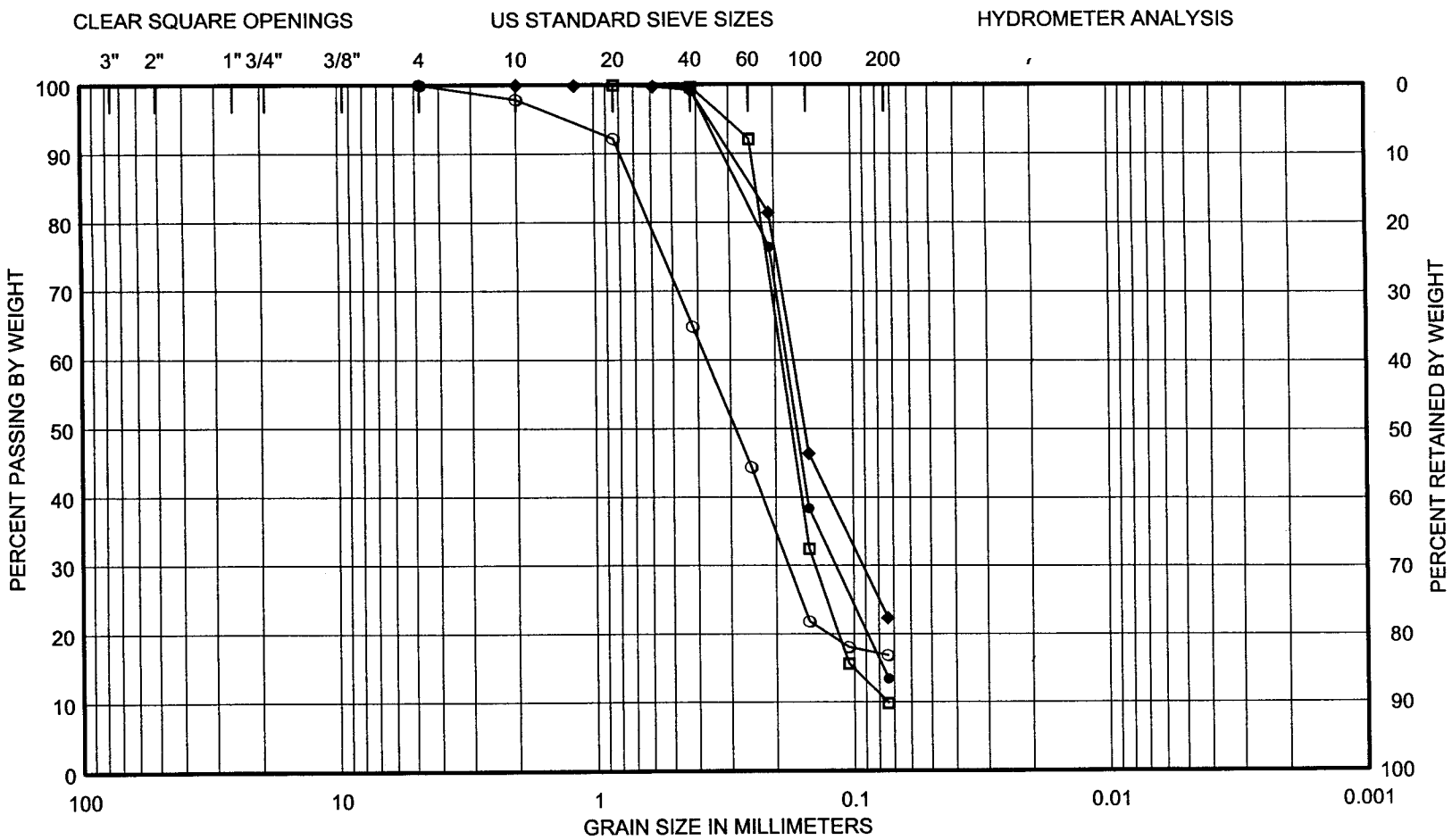
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-7.10c



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
120	47.5		SILTY FINE TO MEDIUM SAND (SM)
128	56.6		FINE SAND (SP-SM) with silt
131	59.0		SILTY FINE SAND (SM)
132	59.1		SILTY FINE SAND (SM)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-7

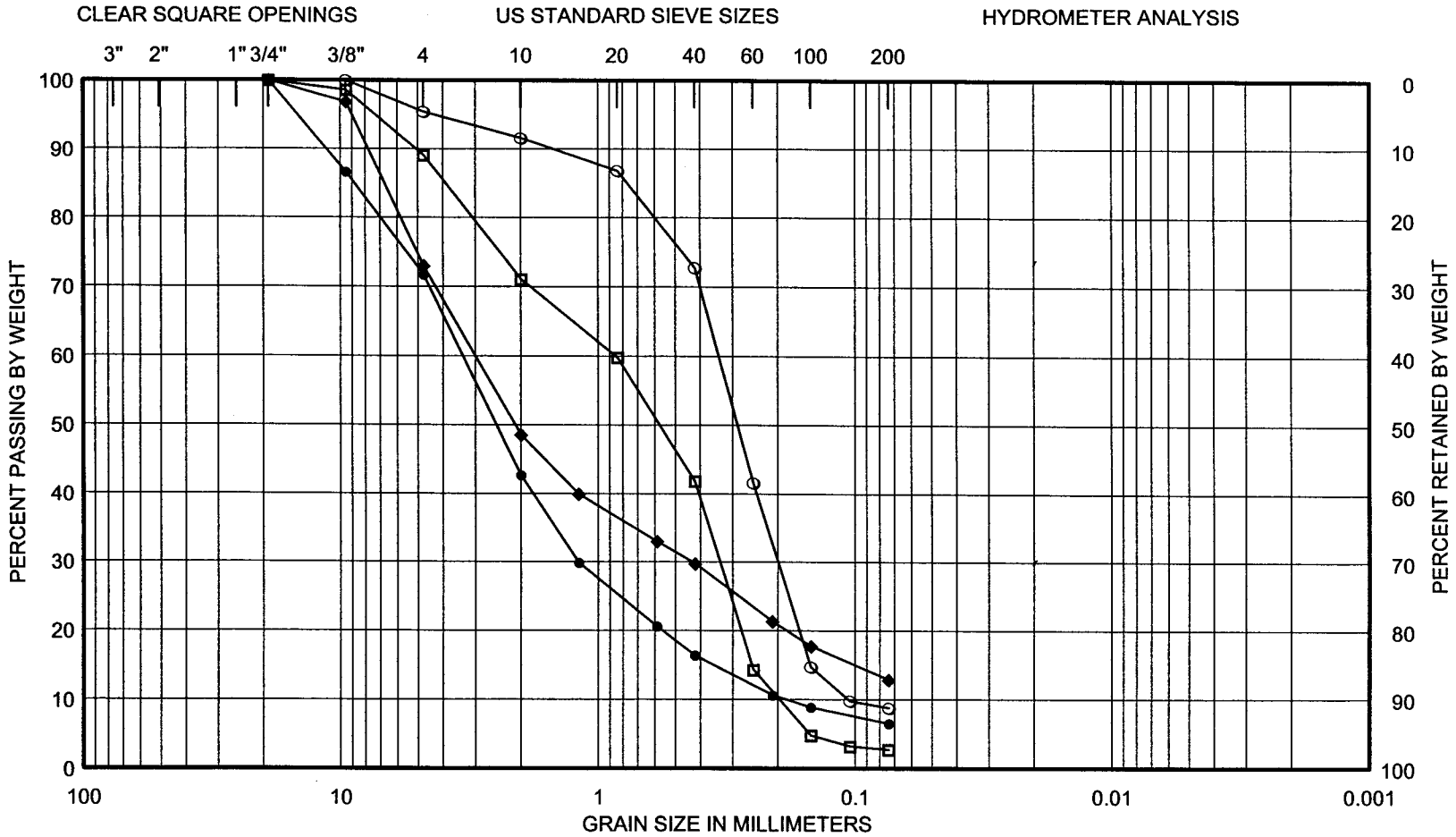
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-7.10d



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
134	62.4	○—○	FINE SAND (SP-SM) with medium sand, silt and a trace of coarse sand
135	64.5	□—□	FINE TO MEDIUM SAND (SP) with coarse sand and a trace of fine gravel
139	75.7	◆—◆	SILTY FINE TO COARSE SAND (SM) with fine gravel
140	79.6	●—●	MEDIUM TO COARSE SAND (SW-SM) with silt and fine gravel

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-7

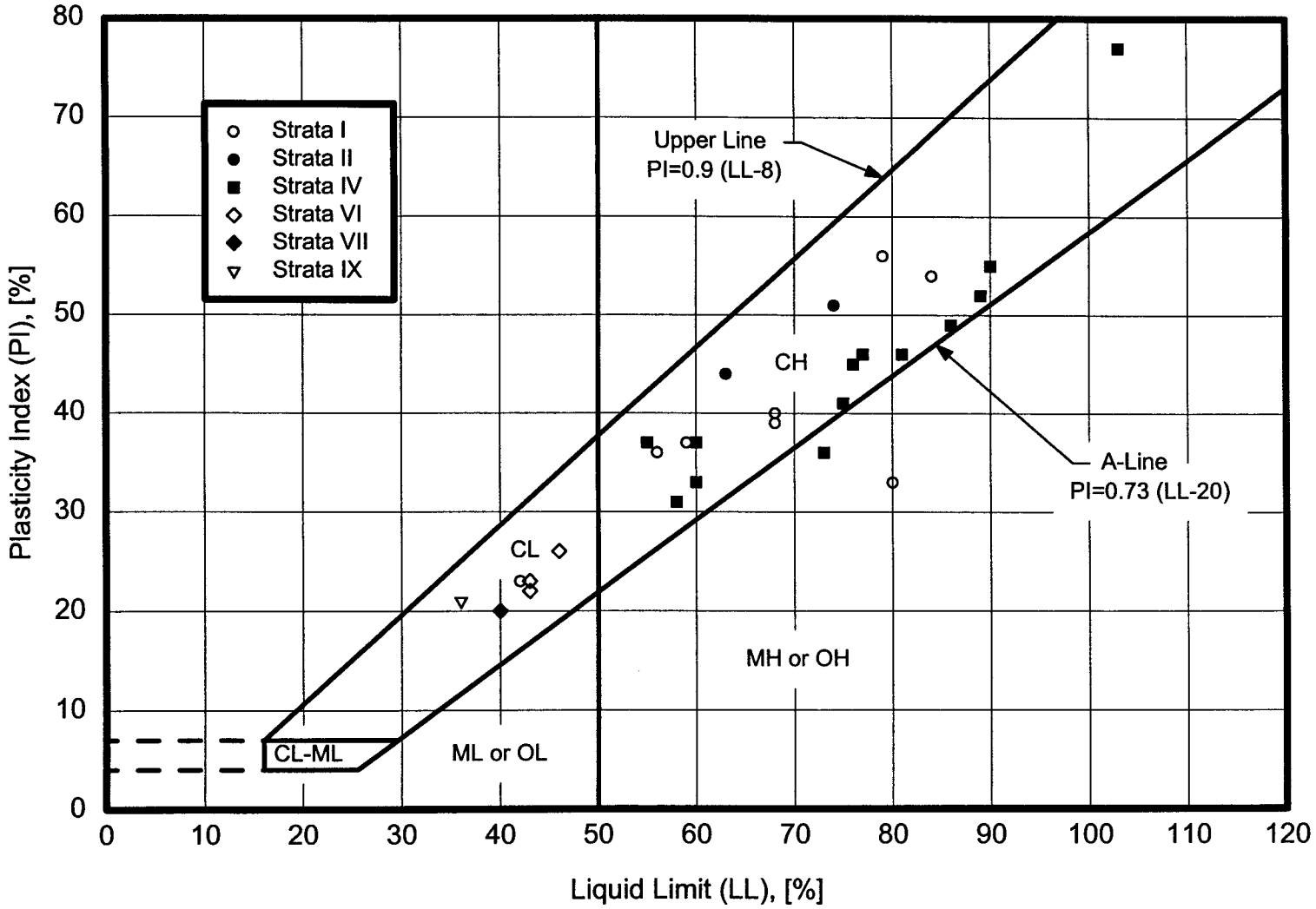
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

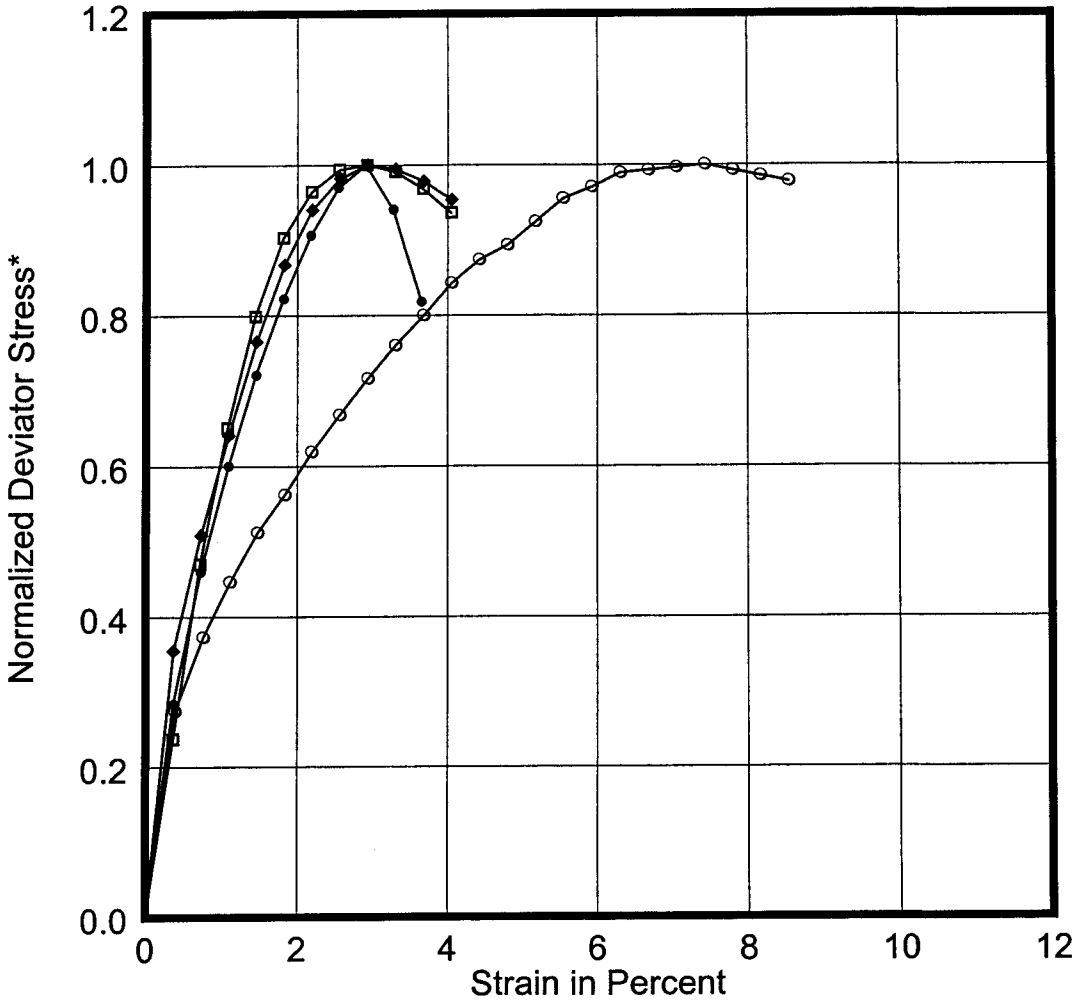
PLATE 98-7.10e



PLASTICITY CHART
Boring 98-7
SFOBB East Span Seismic Safety Project

Earth Mechanics

FUGRO



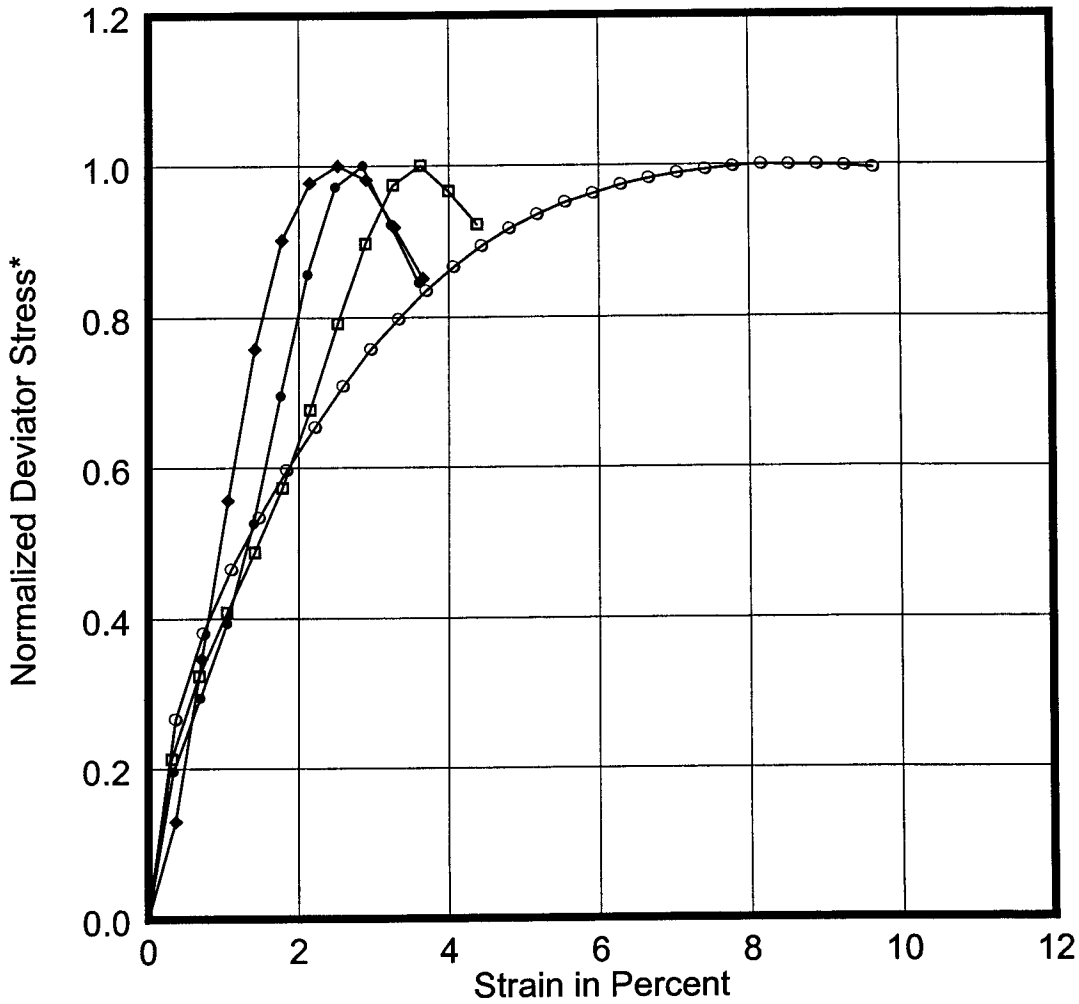
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	27	8.1	UU	172	28	1.4
□——□	34	10.2	UU	827	228	0.8
◆——◆	36	11.1	UU	827	186	0.7
●——●	40	13.0	UU	827	234	0.8

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-7
SFOBB - East Span Seismic Safety Project

PLATE 98-7.12a



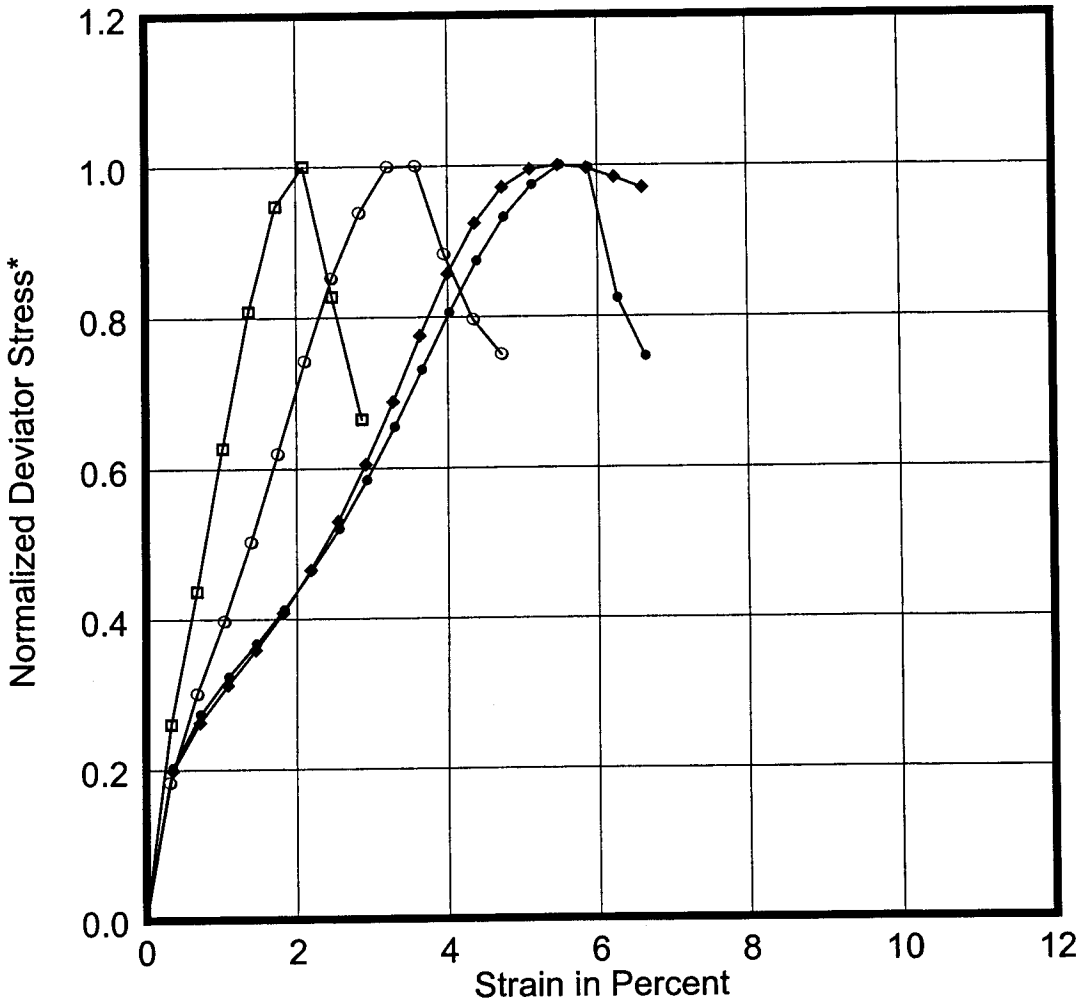
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	44	14.2	UU	827	223	1.3
□——□	54	17.7	UU	827	259	1.5
◆——◆	59	19.5	UU	827	312	1.0
●——●	69	22.4	UU	827	323	1.3

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-7
SFOBB - East Span Seismic Safety Project

PLATE 98-7.12b

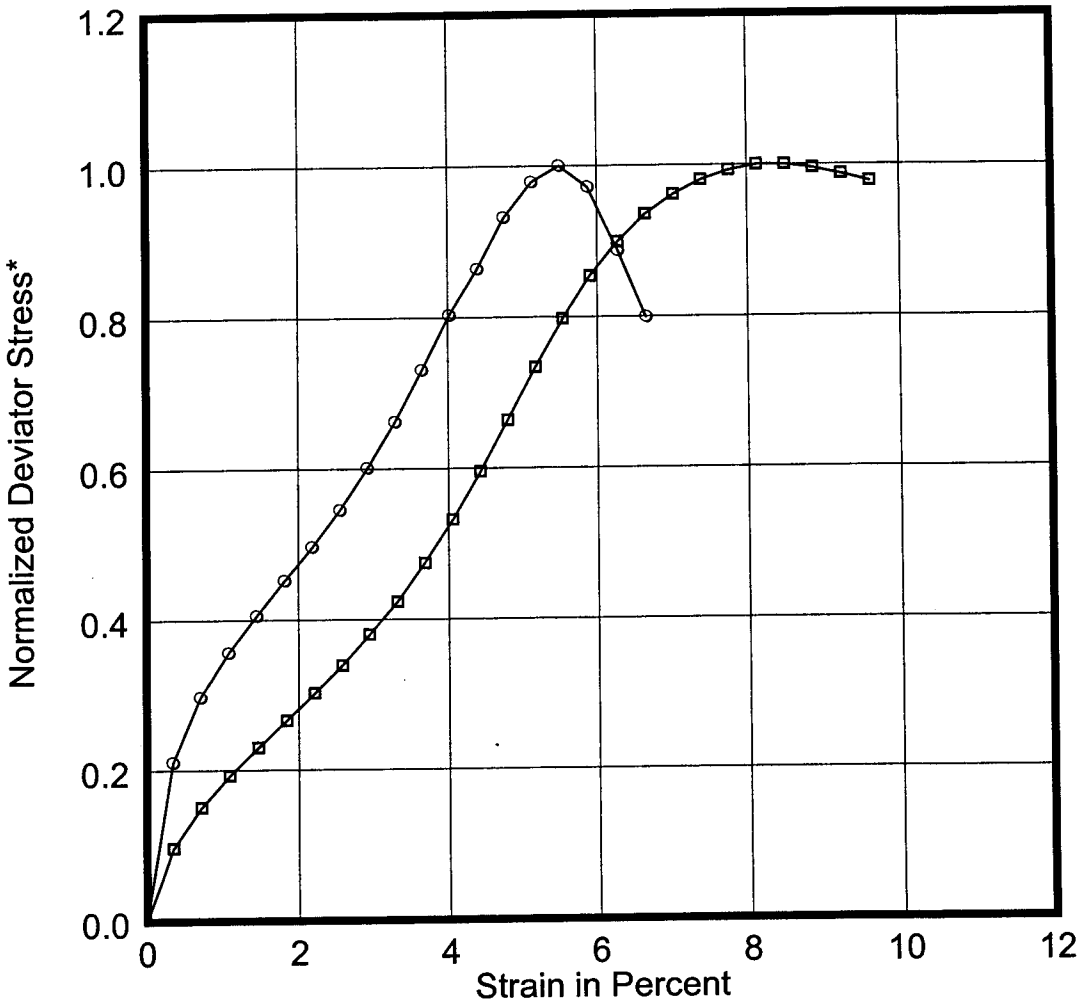


Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
	76	25.1	UU	827	351	1.4
	84	27.9	UU	827	367	0.8
	95	31.5	UU	827	286	2.4
	100	33.4	UU	827	361	2.4

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-7
SFOBB - East Span Seismic Safety Project

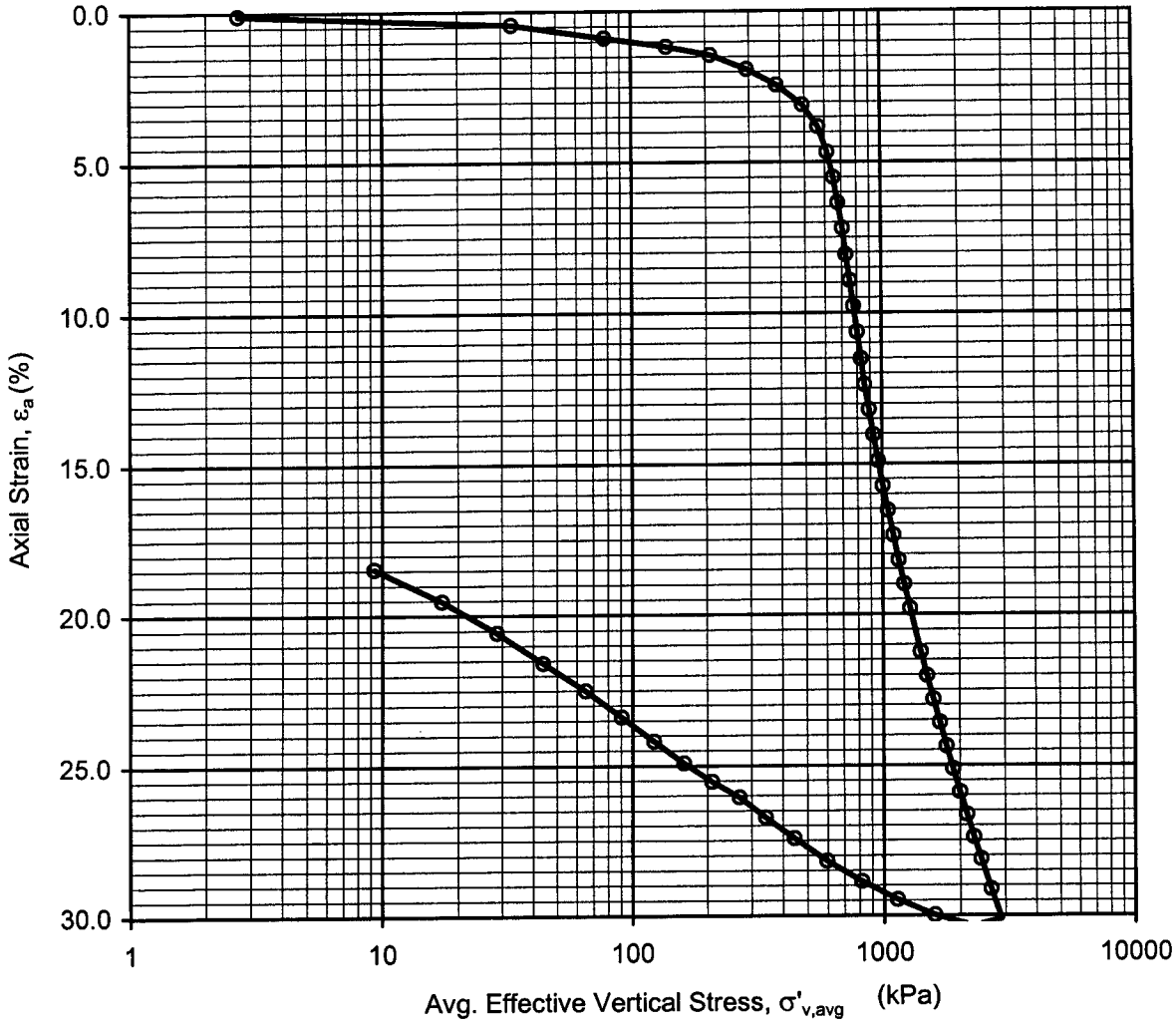


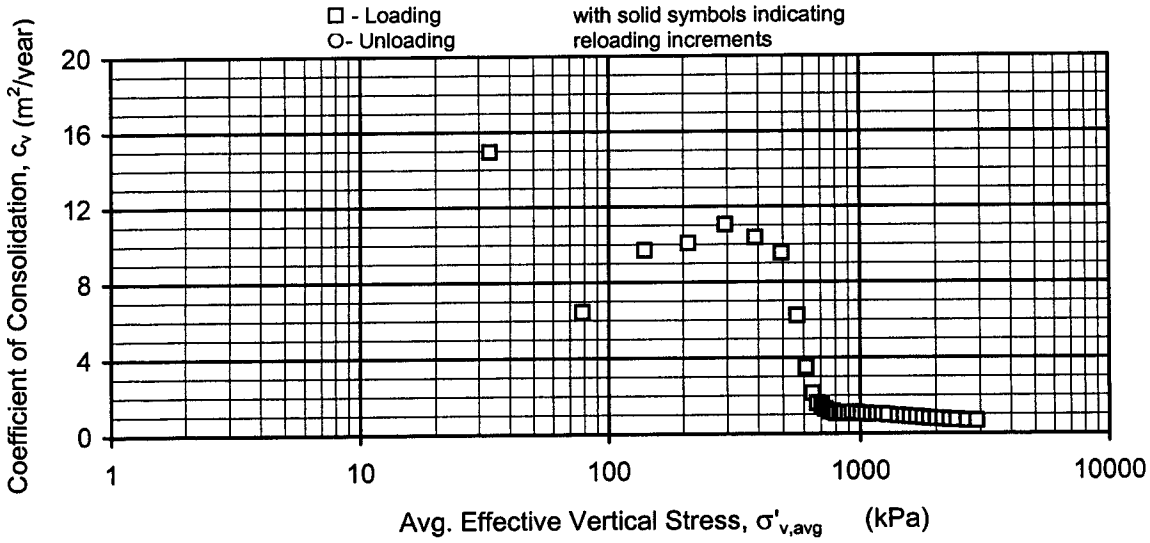
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	107	36.0	UU	827	316	2.2
□——□	125	54.6	UU	1241	287	3.9

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-7
SFOBB - East Span Seismic Safety Project

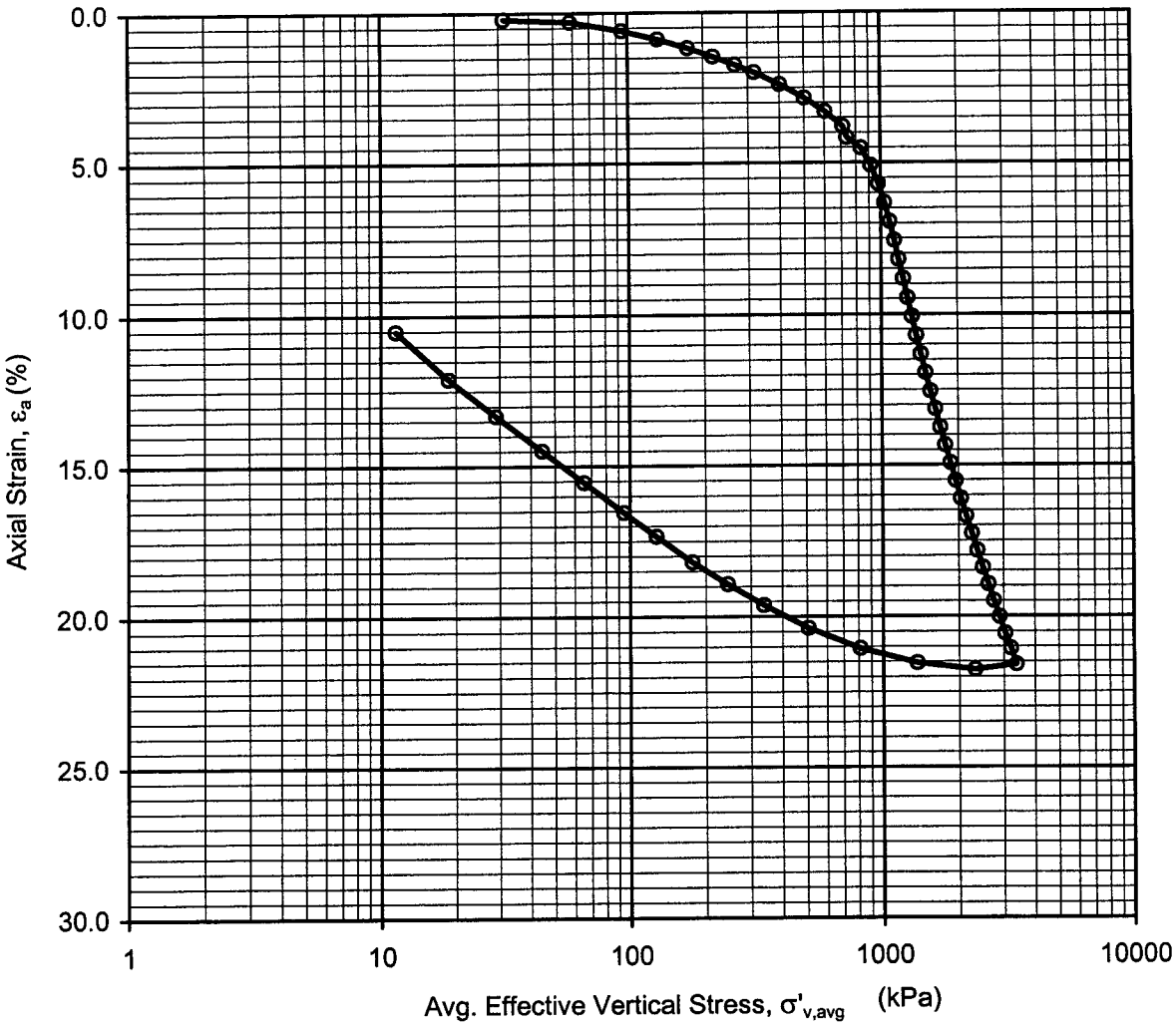


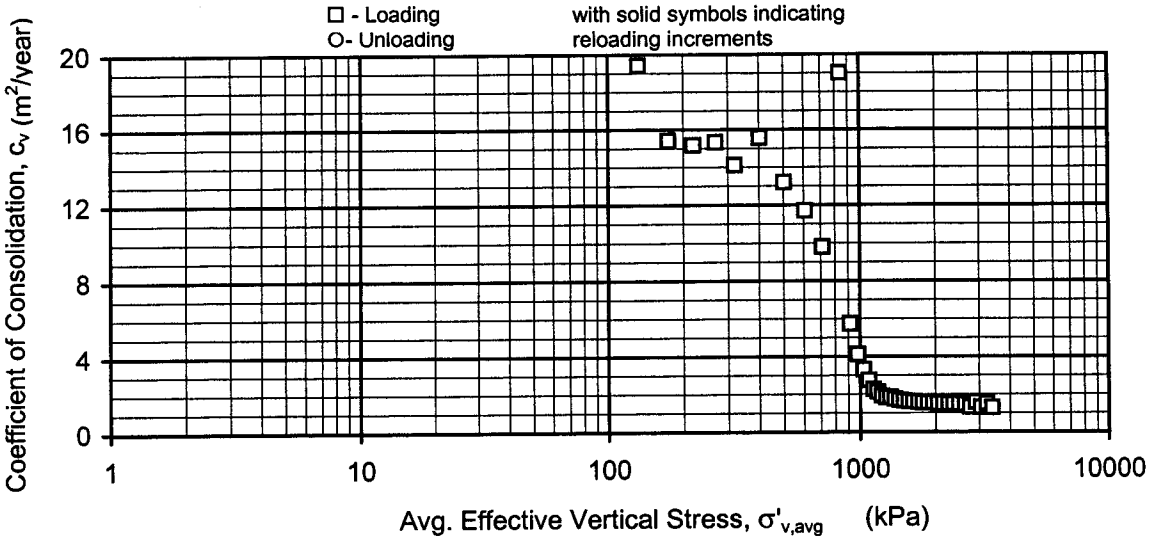


CRS CONSOLIDATION TEST RESULTS

Sample No. 49 - Penetration: 16.0 m
Boring 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.13a

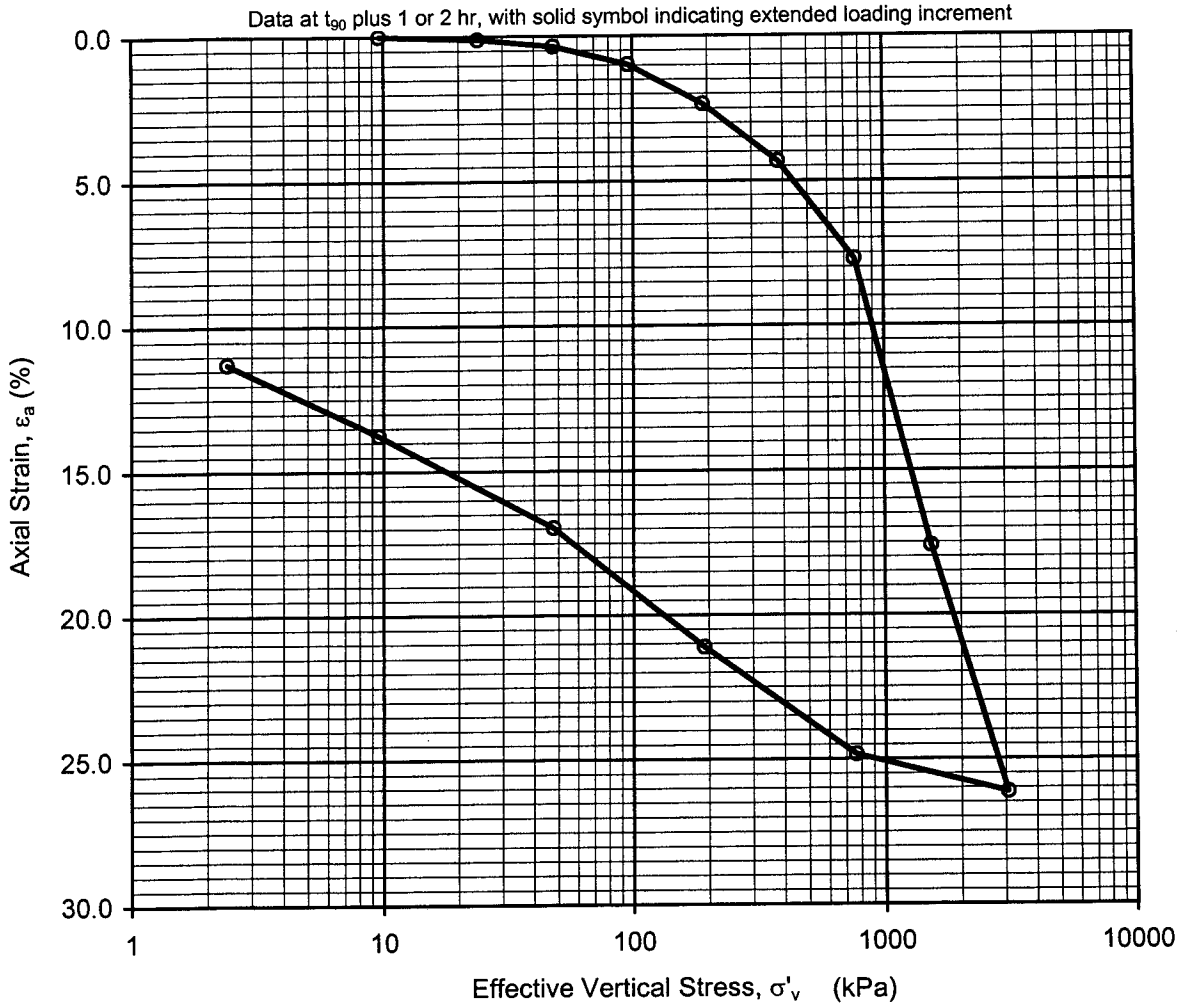


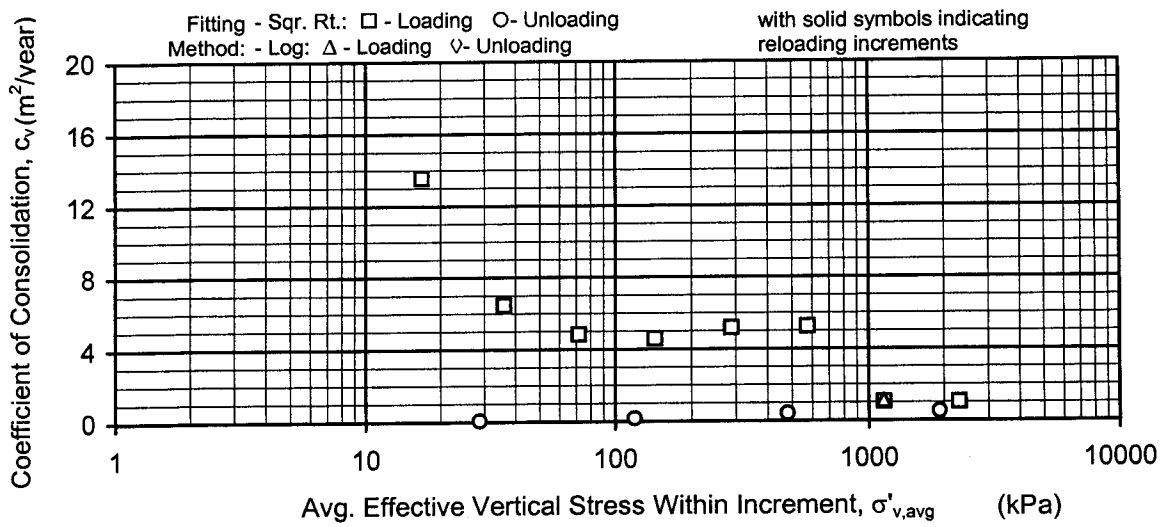


CRS CONSOLIDATION TEST RESULTS

Sample No. 92 - Penetration: 30.6 m
Boring 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.13b

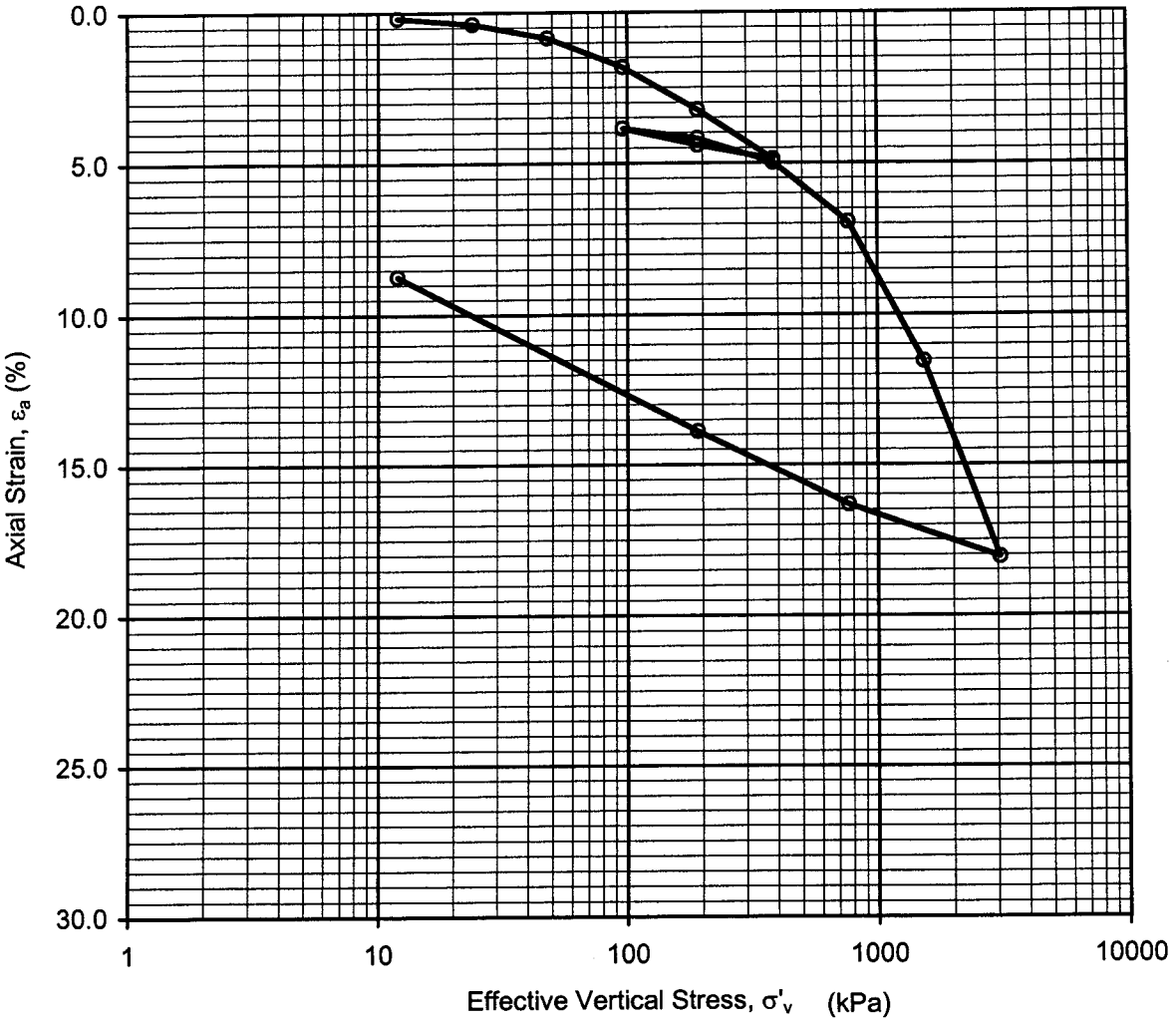


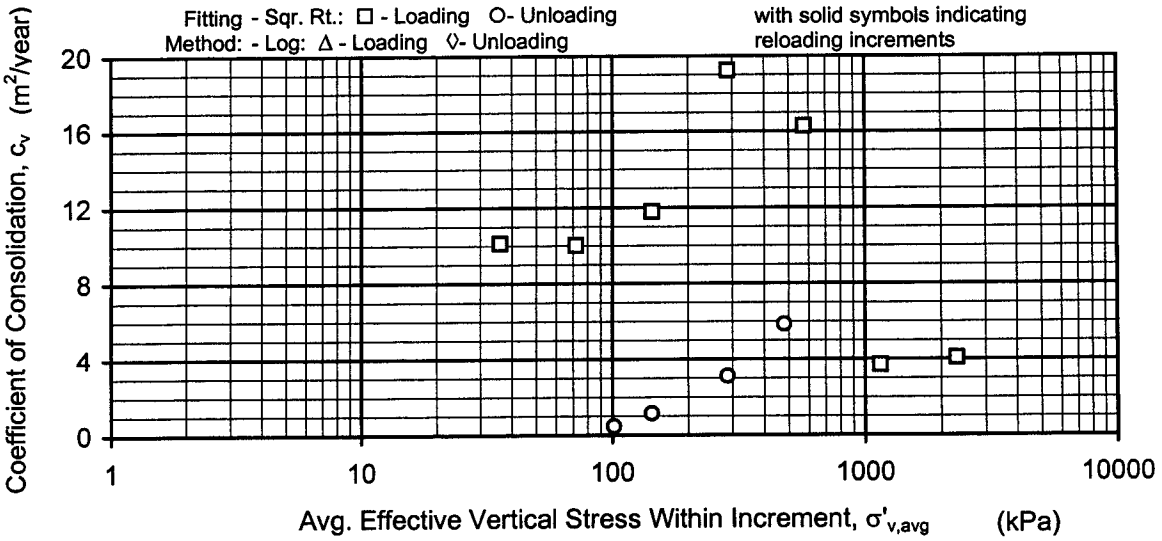


INCREMENTAL CONSOLIDATION TEST RESULTS

Sample No. 117 - Penetration: 43.8 m
Boring 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.13c

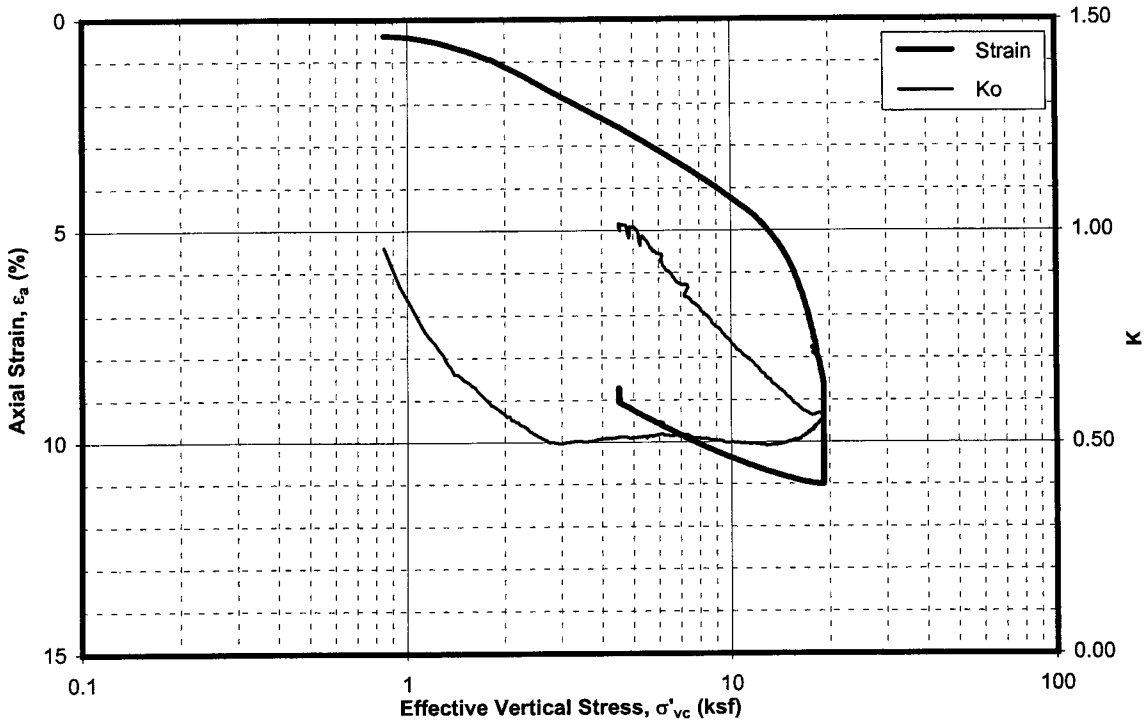


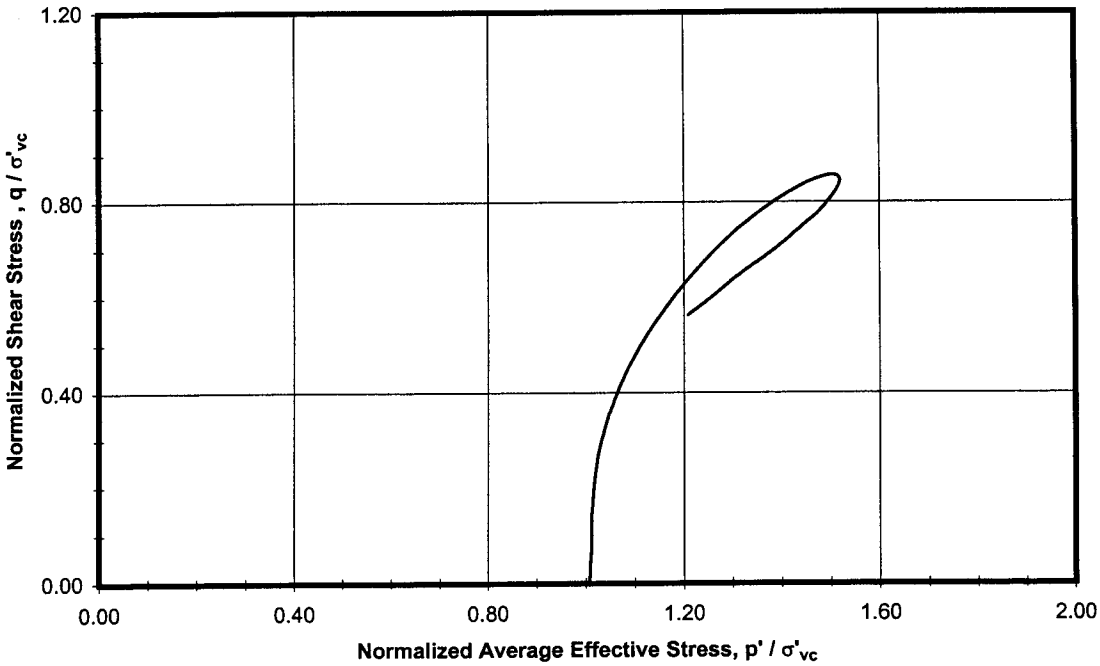


INCREMENTAL CONSOLIDATION TEST RESULTS

Sample No. 121 - Penetration: 50.9 m
Boring 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.13d





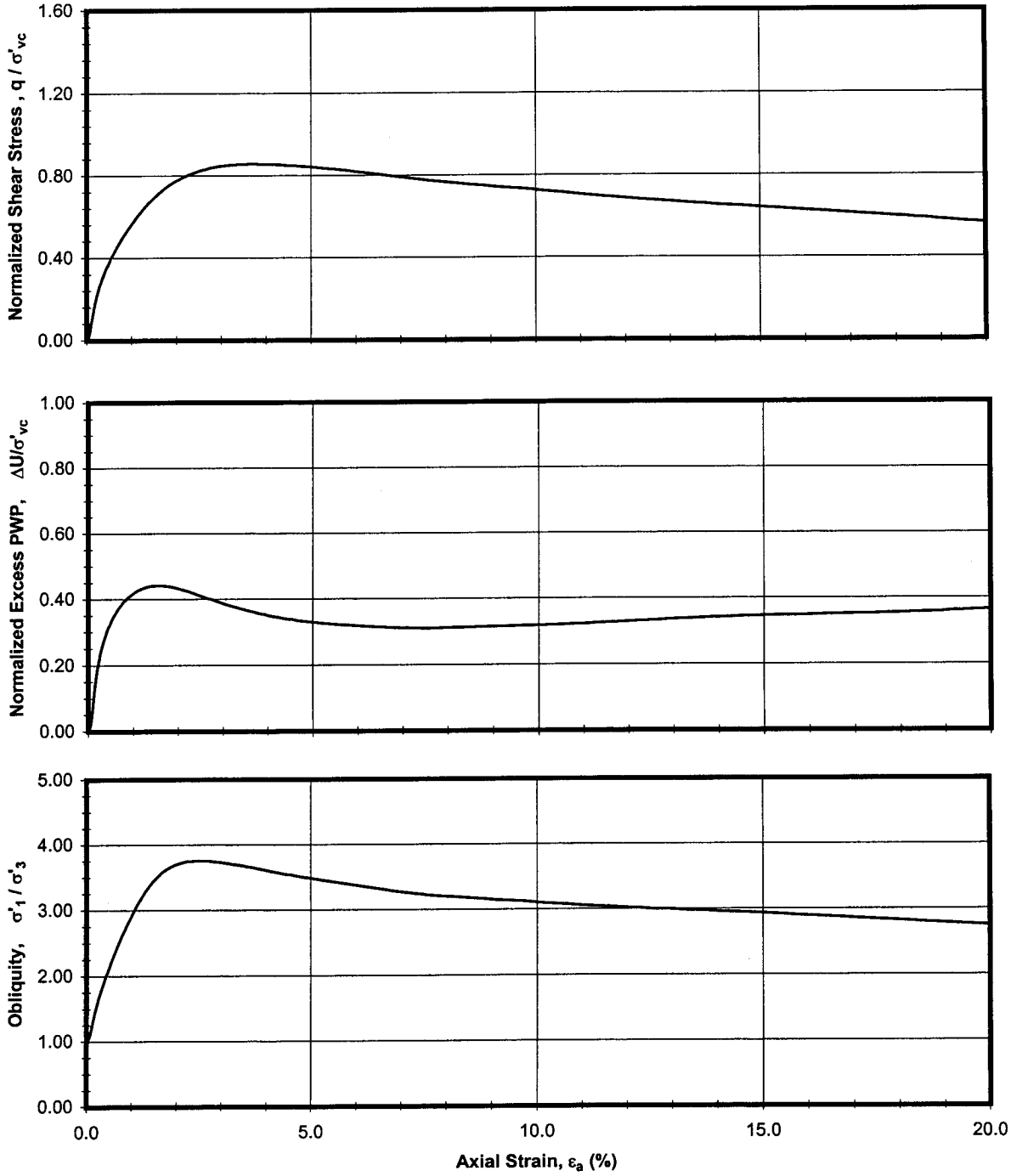
Ko-CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

Sample No. 92 - Penetration: 30.6 m

Boring 98-7

SFOBB East Span Seismic Safety Project

PLATE 98-7.14a.1



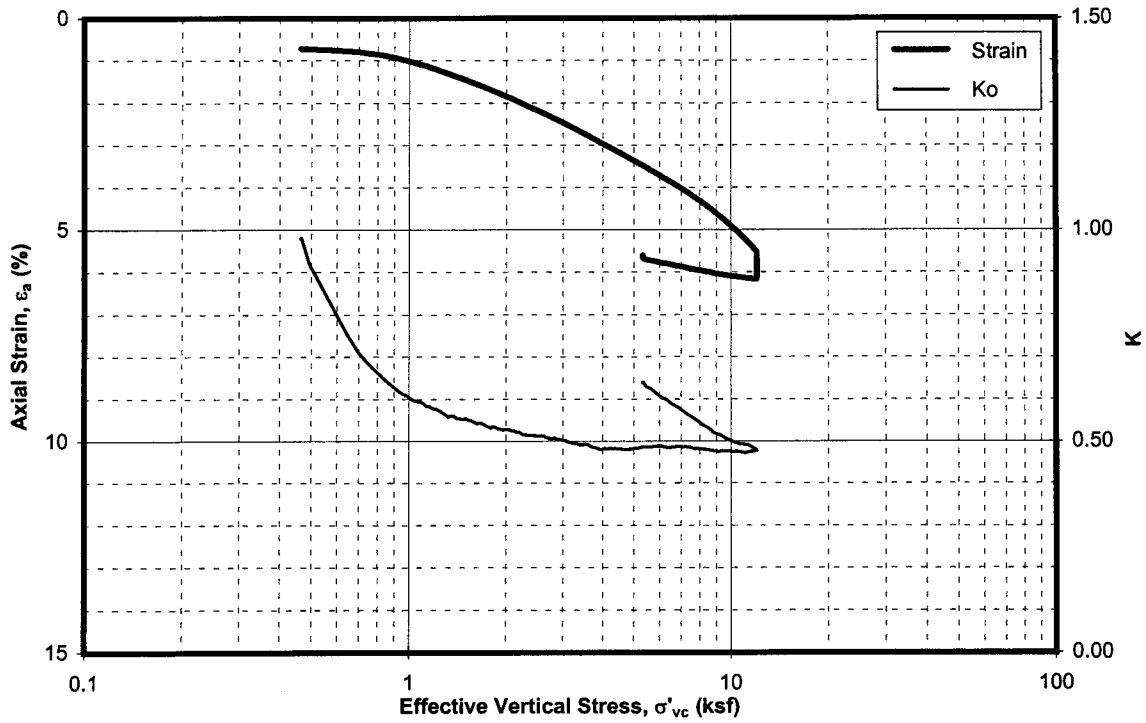
Ko-CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

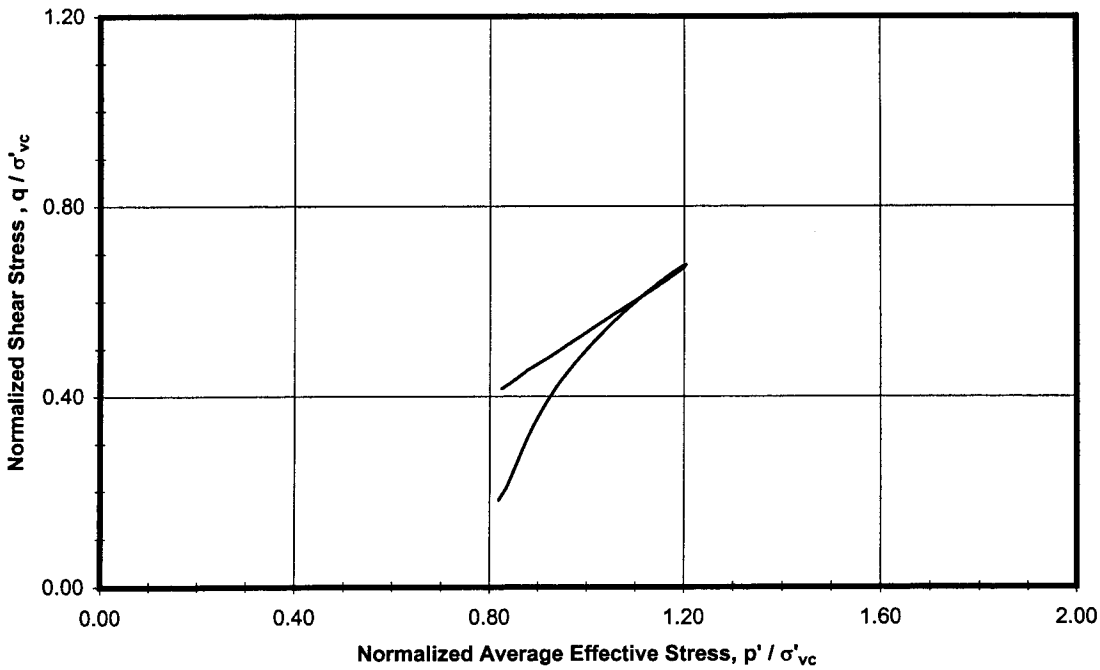
Sample No. 92 - Penetration: 30.6 m

Boring 98-7

SFOBB East Span Seismic Safety Project

PLATE 98-7.14a.2





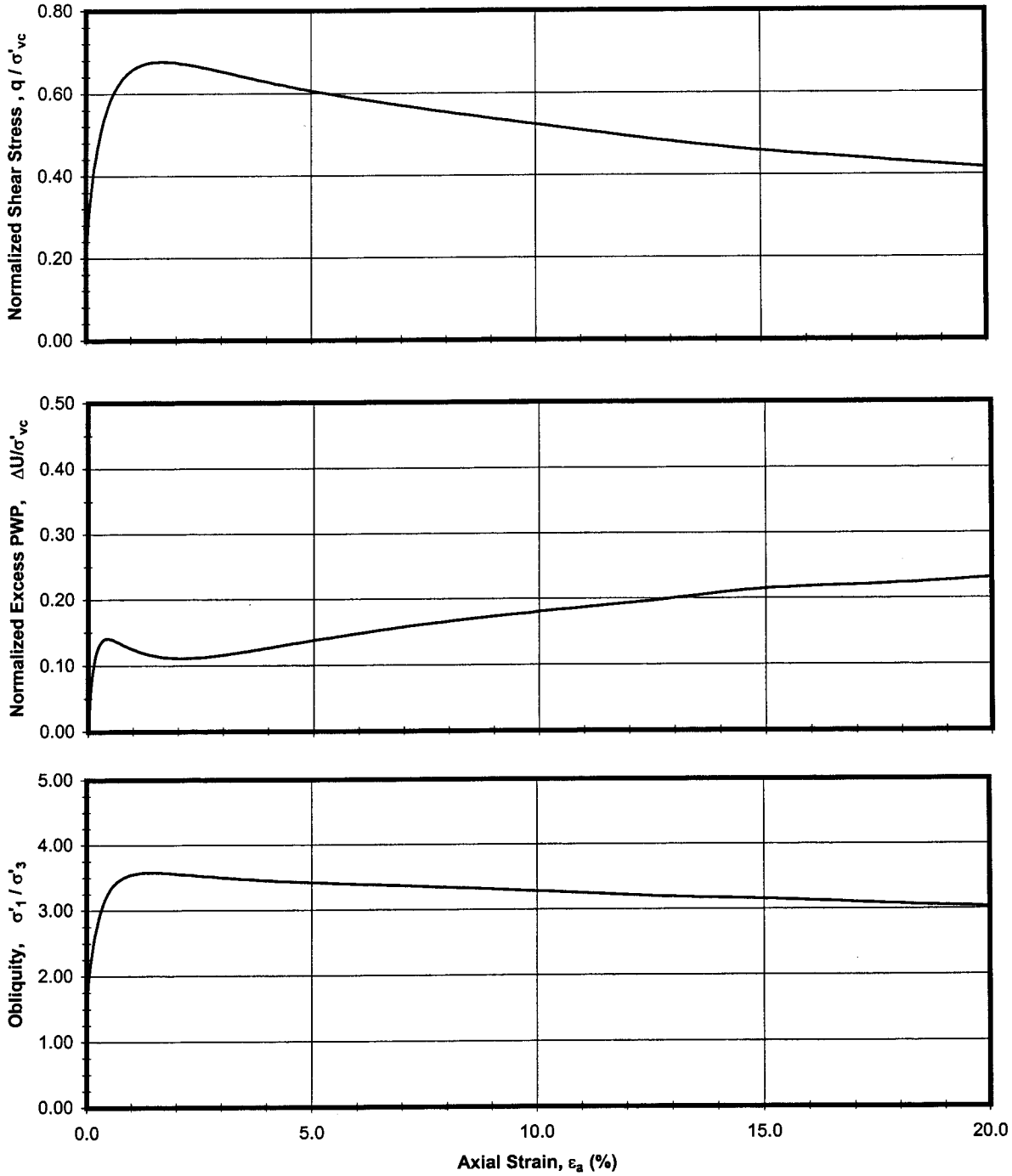
Ko-CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

Sample No. 117 - Penetration: 43.8 m

Boring 98-7

SFOBB East Span Seismic Safety Project

PLATE 98-7.14b.1



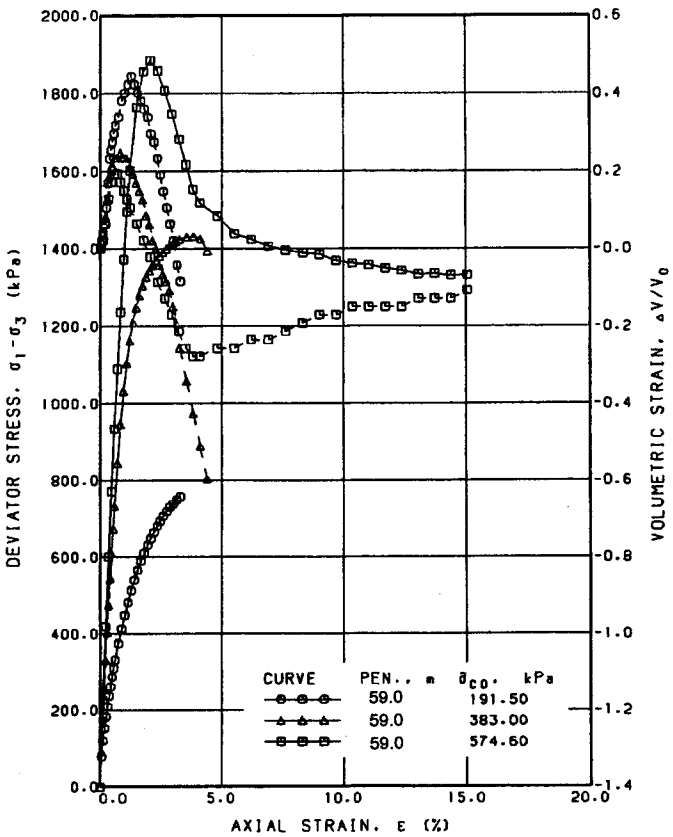
Ko-CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

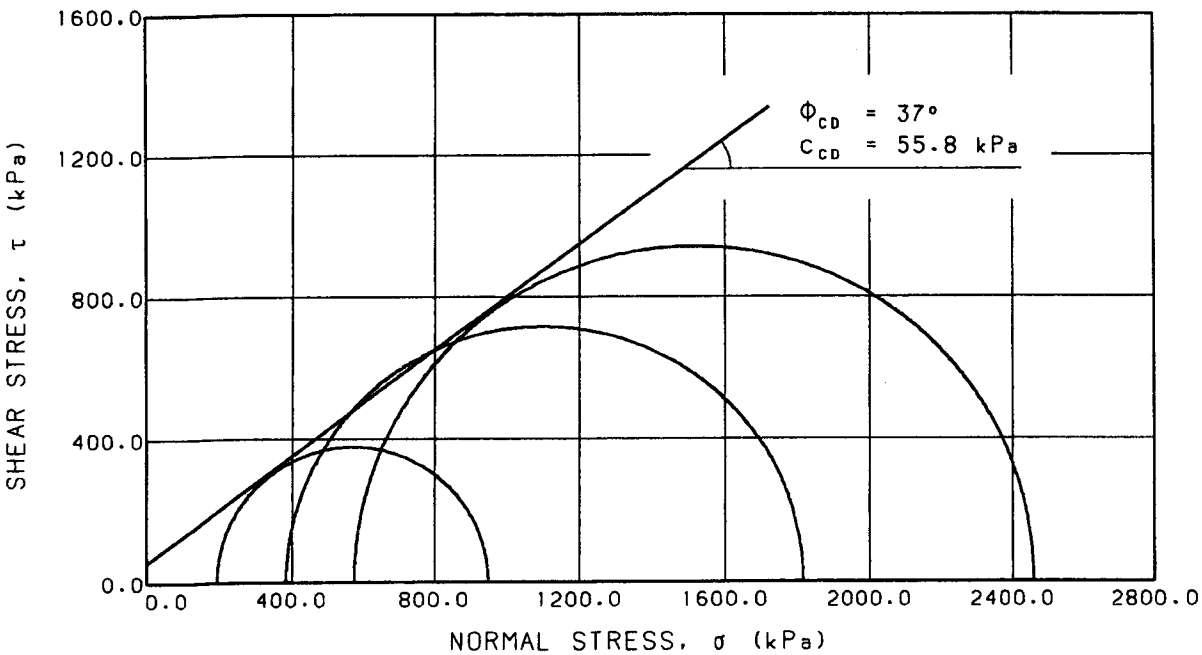
Sample No. 117 - Penetration: 43.8 m

Boring 98-7

SFOBB East Span Seismic Safety Project

PLATE 98-7.14b.2



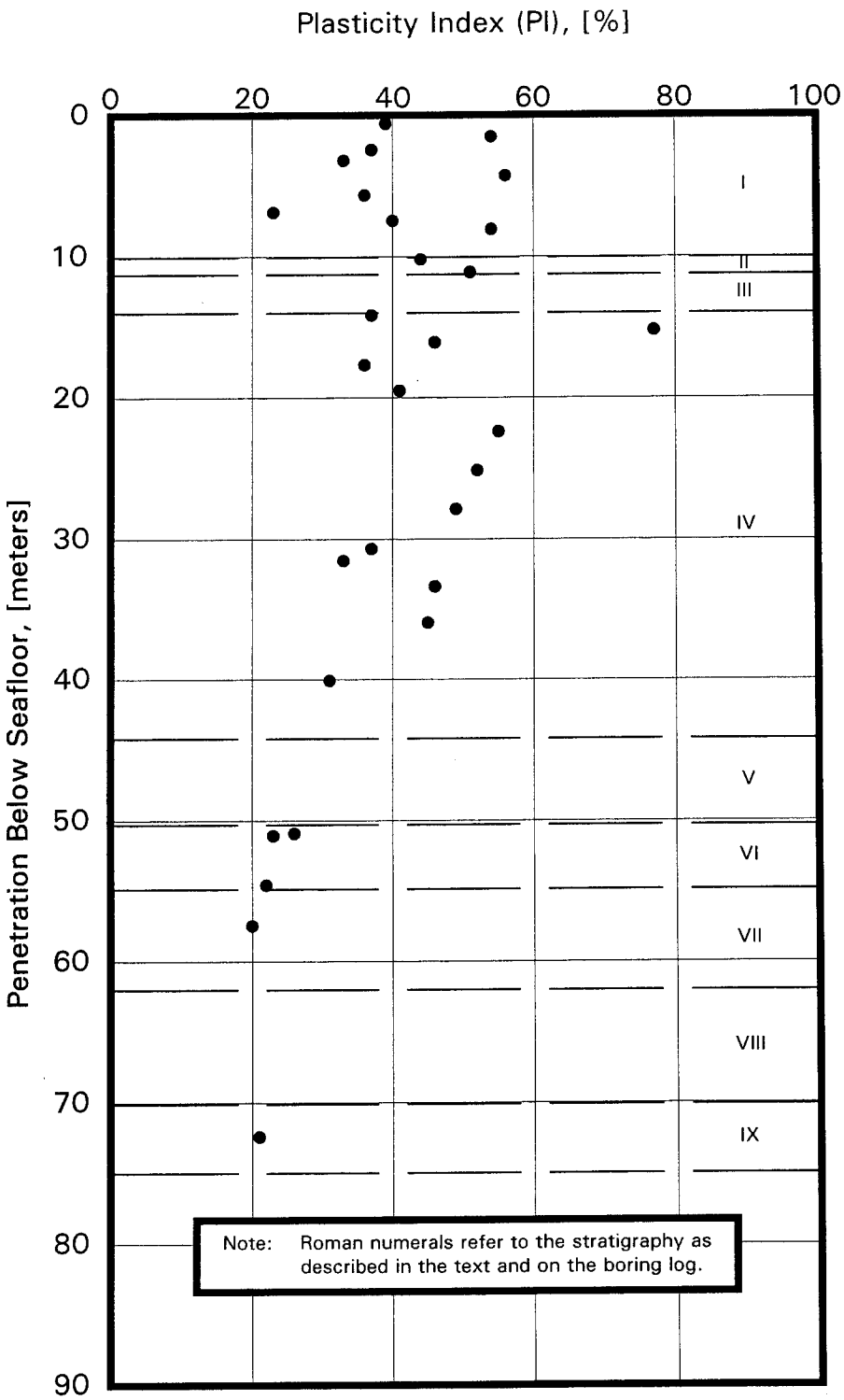


CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST RESULTS

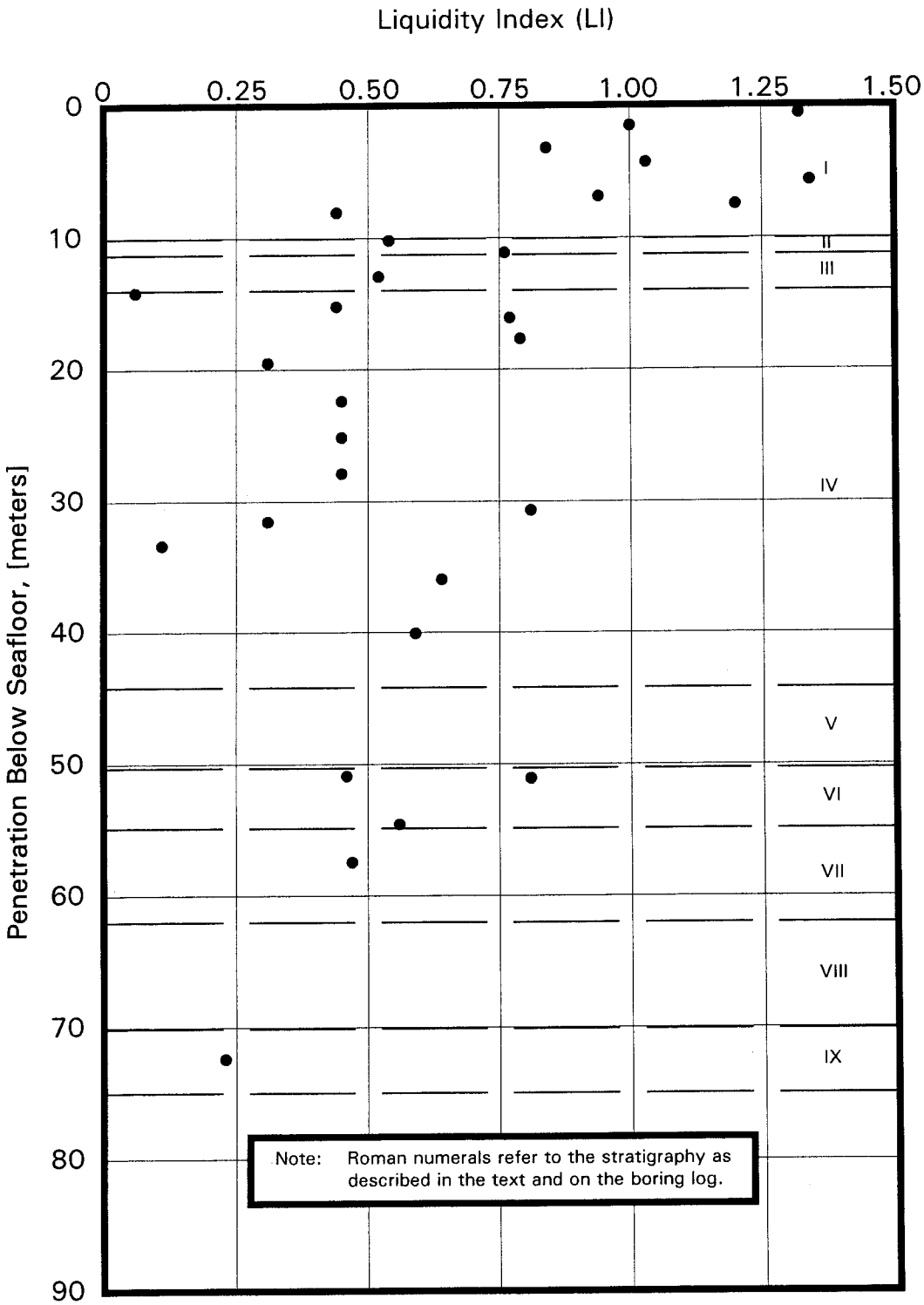
Sample No. 131 – Penetration: 59.0 m

Boring 98-7

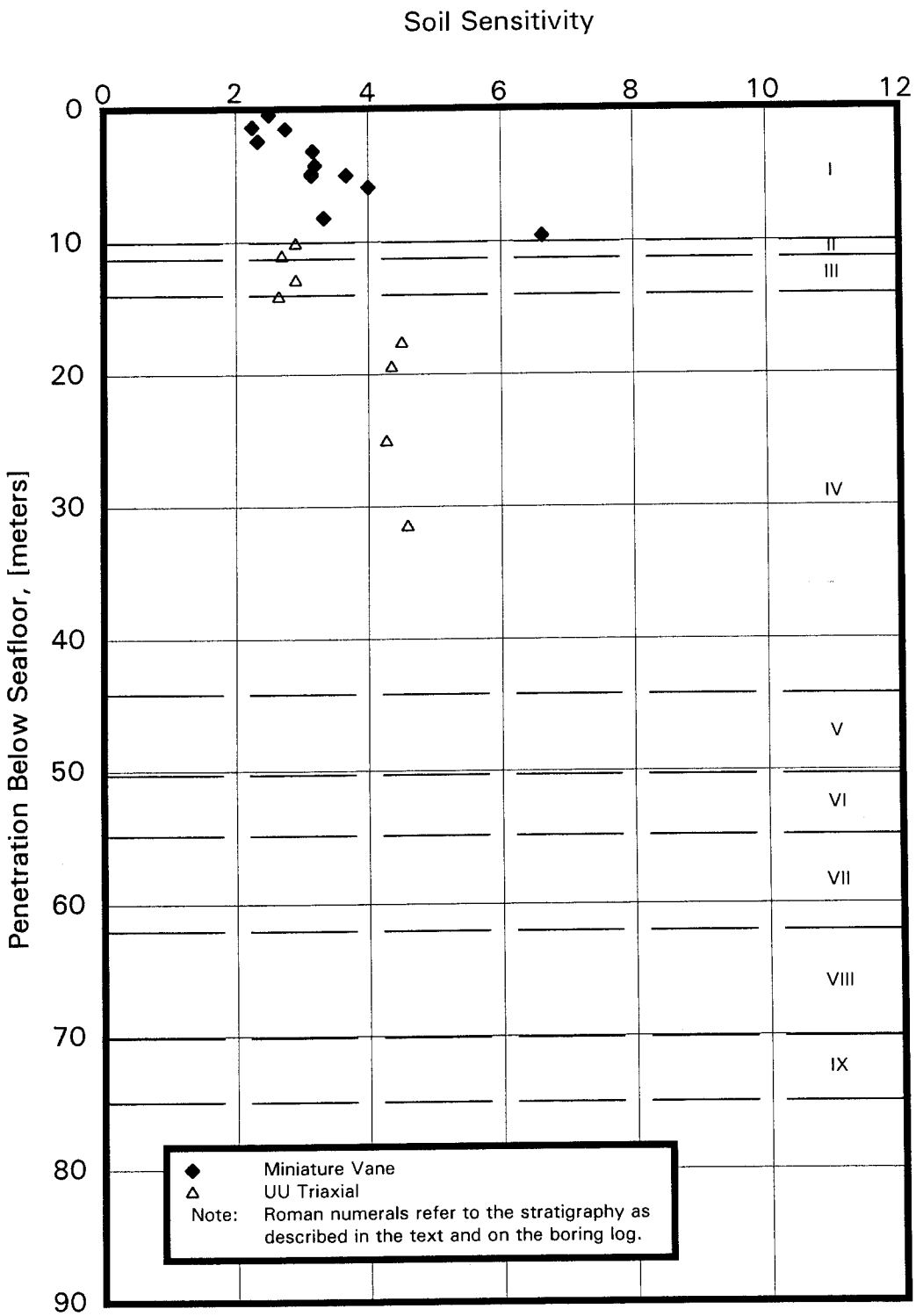
SFOBB East Span Seismic Safety Project



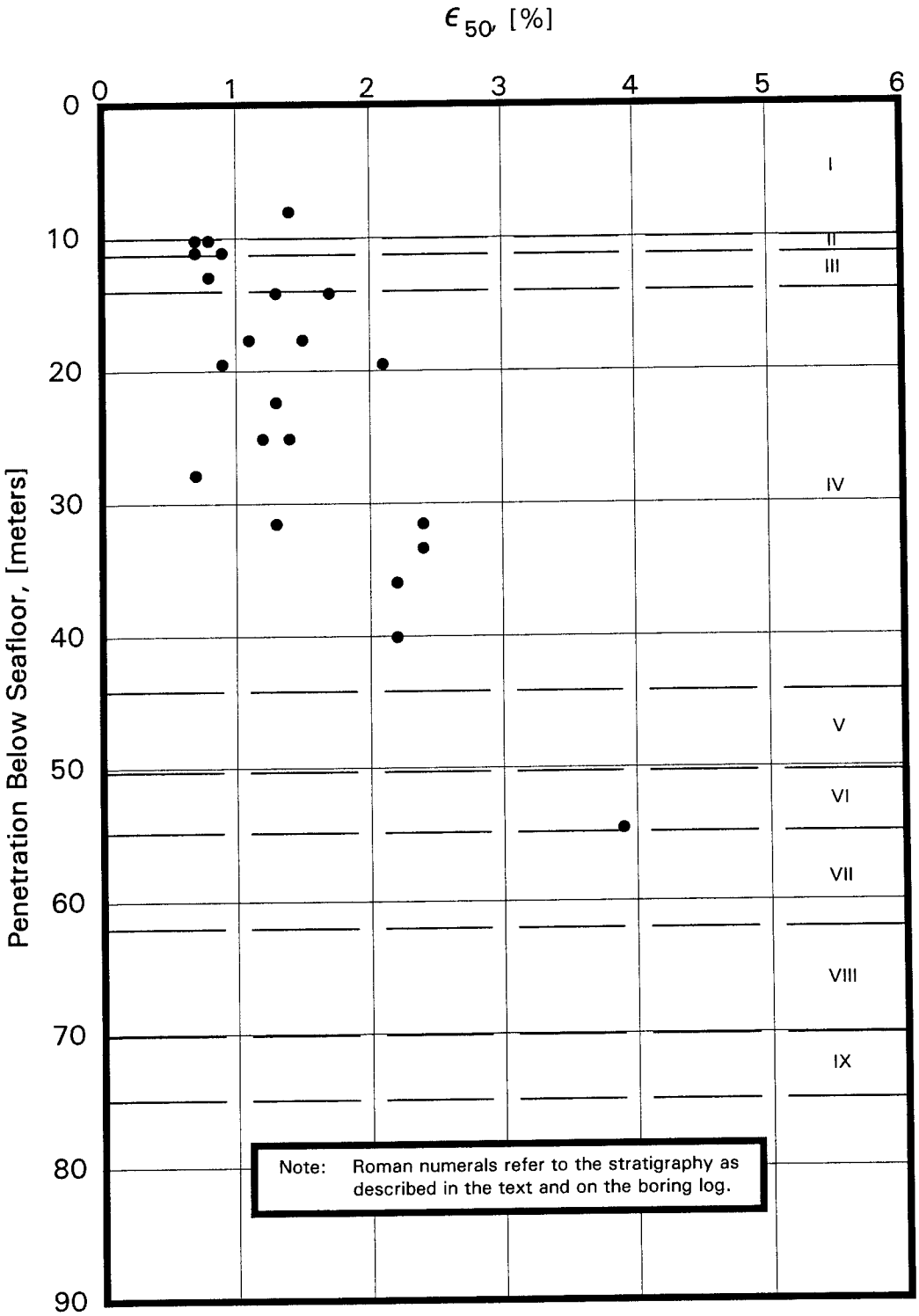
PLASTICITY INDEX PROFILE
Boring 98-7
SFOBB East Span Seismic Safety Project



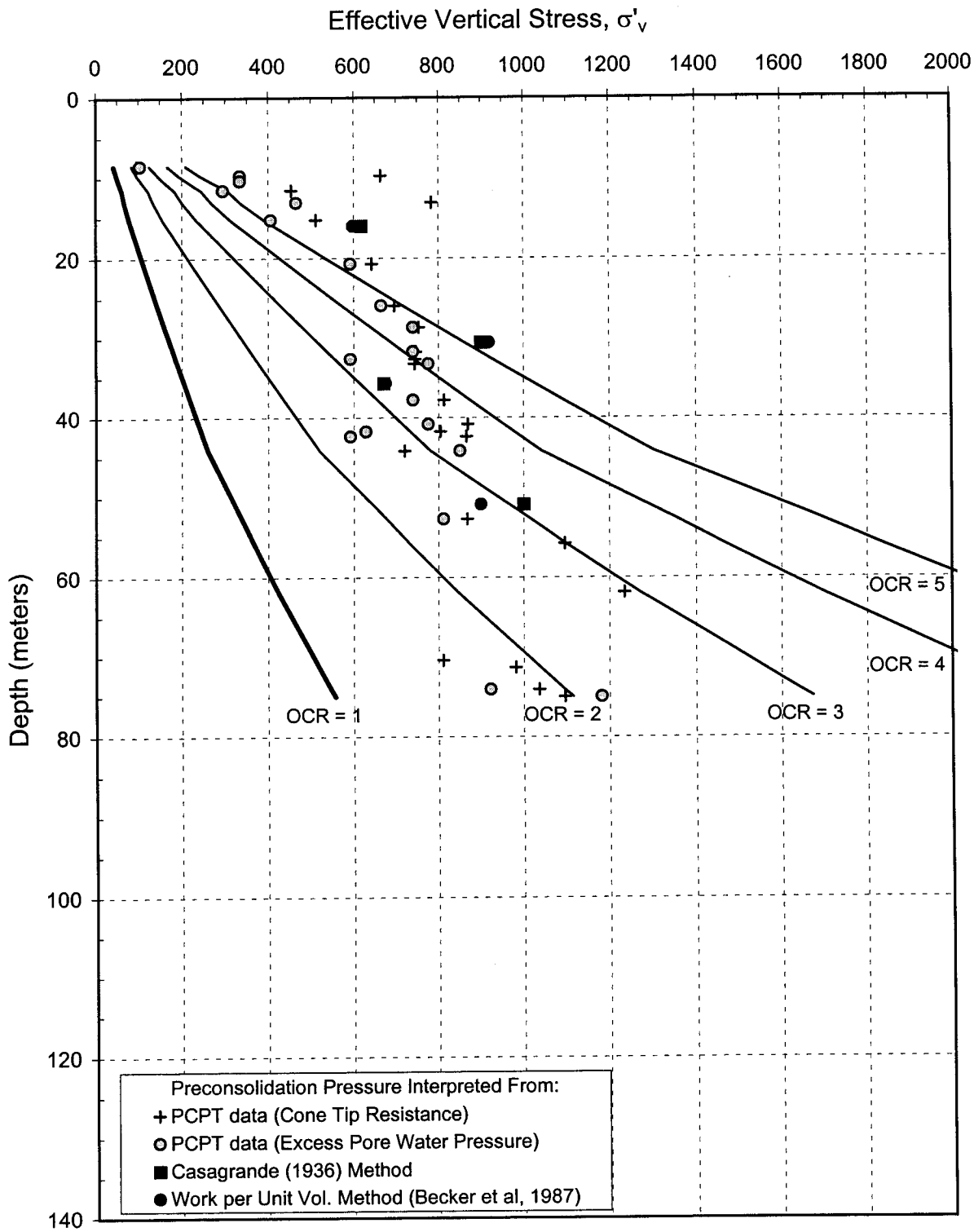
LIQUIDITY INDEX PROFILE
Boring 98-7
SFOBB East Span Seismic Safety Project



SOIL SENSITIVITY PROFILE
Boring 98-7
SFOBB East Span Seismic Safety Project



ϵ_{50} PROFILE
Boring 98-7
SFOBB East Span Seismic Safety Project



PRECONSOLIDATION STRESS PROFILE
Boring 98-7
SFOBB East Span Seismic Safety Project

PLATE 98-7.20

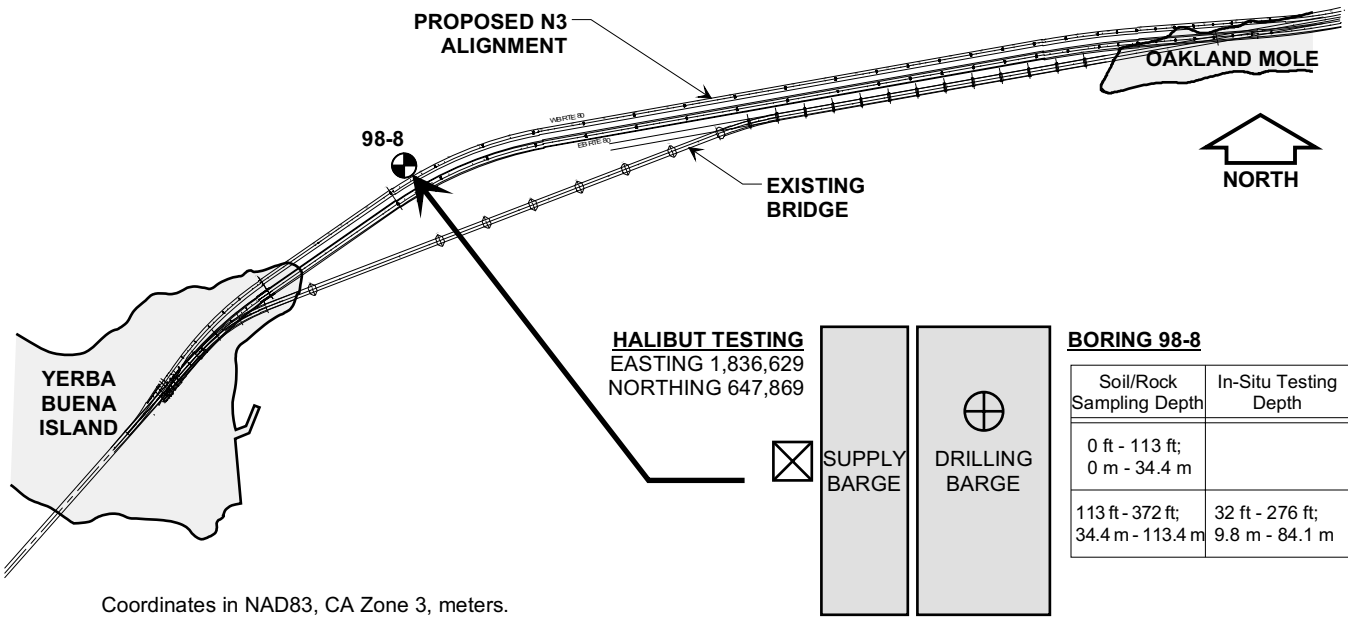
BORING 98-8

Date	Time From	Time To	Description of Activity
March 4, 1998	1530	1830	Lift two spuds at boring location 98-9. Reposition four-point anchor spread at boring location 98-8. Set two spuds.
	1830	2100	Rig up to drill and sample.
	****	2100	Estimate water depth of 12.8m (42 ft) using echo sounder.
	2100	2135	Lower drill pipe to mudline.
	****	2135	Measure water depth of 13.1m (43 ft) using bottom sensor. Current tide level is approximately -0.3m (-1 ft) MSL. Calculate mudline elevation of -12.8m (-42 ft) MSL.
	2135	2400	Drill and sample, 0m (0 ft) to 8.8m (29 ft).
March 5, 1998	0000	1000	Drill and sample, 8.8m (29 ft) to 34.4m (113 ft).
	1000	1140	Pull drill pipe to mudline. Grout hole.
	1140	1200	Reposition barge.
	1200	1900	Set casing.
	1900	2030	Repair equipment.
	2030	2400	Run drill pipe to mudline. Perform pipe test. Pipe test unsuccessful. Check CPT equipment.
March 6, 1998	0000	0200	Perform pipe test for CPT.
	0200	0600	Drill to 9.8m (32 ft). Perform in-situ testing from 9.8m (32 ft) to 19.5m (64 ft).
	0600	1130	Repair equipment.
	1130	2000	Perform in-situ testing from 16.5m (54 ft) to 33.5m (110 ft).
	2000	2400	Drill, sample, and perform in-situ testing from 33.5m (110 ft) to 39.9m (131 ft).
March 7, 1998	0000	0430	Drill, sample, and perform in-situ testing from 39.9m (131 ft) to 53.9m (177 ft).
	0430	0545	Equipment repairs.
	0545	2400	Drill, sample, and perform in-situ testing from 55.9m (177 ft) to 79.2m (260 ft).
March 8, 1998	0000	0300	Drill, sample, and perform in-situ testing from 79.2m (260 ft) to 84.1m (276 ft).
	0300	0545	Mix drilling mud and pull drill pipe to deck.
	0545	1200	Lower drill pipe and rock core pipe to top of rock.
	1200	2400	Perform rock coring and sampling from 84.1m (276 ft) to 93m (305 ft).
	*	* * * * * * *	
	0500	0800	Rig up Halibut vane equipment.

SUMMARY OF FIELD OPERATIONS
Boring 98-8
SFOBB East Span Seismic Safety Project

Date	Time From	Time To	Description of Activity
March 8, 1998	0800	1100	Perform Halibut vane testing at 0.6m (2 ft) and 1.2m (4 ft) penetration. Suspend testing due to strong currents.
	1430	2000	Resume Halibut vane testing. Perform testing at 1.8m (6 ft), 2.4m (8 ft), 3.0m (10 ft), 3.6m (12 ft), 4.3m (14 ft), 4.9m (16 ft), 5.5m (18 ft), 6.1m (20 ft), 6.7m (22 ft), and 7.3m (24 ft).
	2000	2130	Rig down Halibut vane equipment.
	*	*	* * * * * *
March 9, 1998	0000	0820	Perform rock coring and sampling from 93m (305 ft) to 99.7m (327 ft).
	0820	0940	Perform drilling rig maintenance.
	0940	1500	Perform rock coring and sampling from 99.7m (327 ft) to 104.9m (344 ft).
	1500	1700	Sampler stuck. Pull drill pipe to deck and retrieve sampler.
	1700	1800	Lower rock core pipe to 104.9m (344 ft).
	1800	2400	Perform rock coring and sampling from 104.9m (344 ft) to 109.7m (360 ft).
March 10, 1998	0000	0445	Perform rock coring and sampling from 109.7m (360 ft) to 113.4m (372 ft).
	0445	0830	Prepare for E-logging and suspension logging operations. Perform E-logging and suspension logging below 100.6m (330 ft).
	0830	0920	Raise core pipe to 86.9m (285 ft).
	0920	1100	Perform E-logging and suspension logging from 100.6m (330 ft) to 86.9m (285 ft).
	1100	1415	Pull core pipe and drill pipe to deck.
	1415	1730	Perform E-logging and suspension logging above 81.7m (268 ft).
	1730	1830	Lower N-rod.
	1830	1945	Repair drilling equipment.
	1945	2200	Pull pipe and grout borehole.
	2200	2400	Raise casing and reaction mass to deck.
March 11, 1998	0000	0030	Raise casing and reaction mass to deck.
	*****	0300	Conclude work at Boring 98-8.

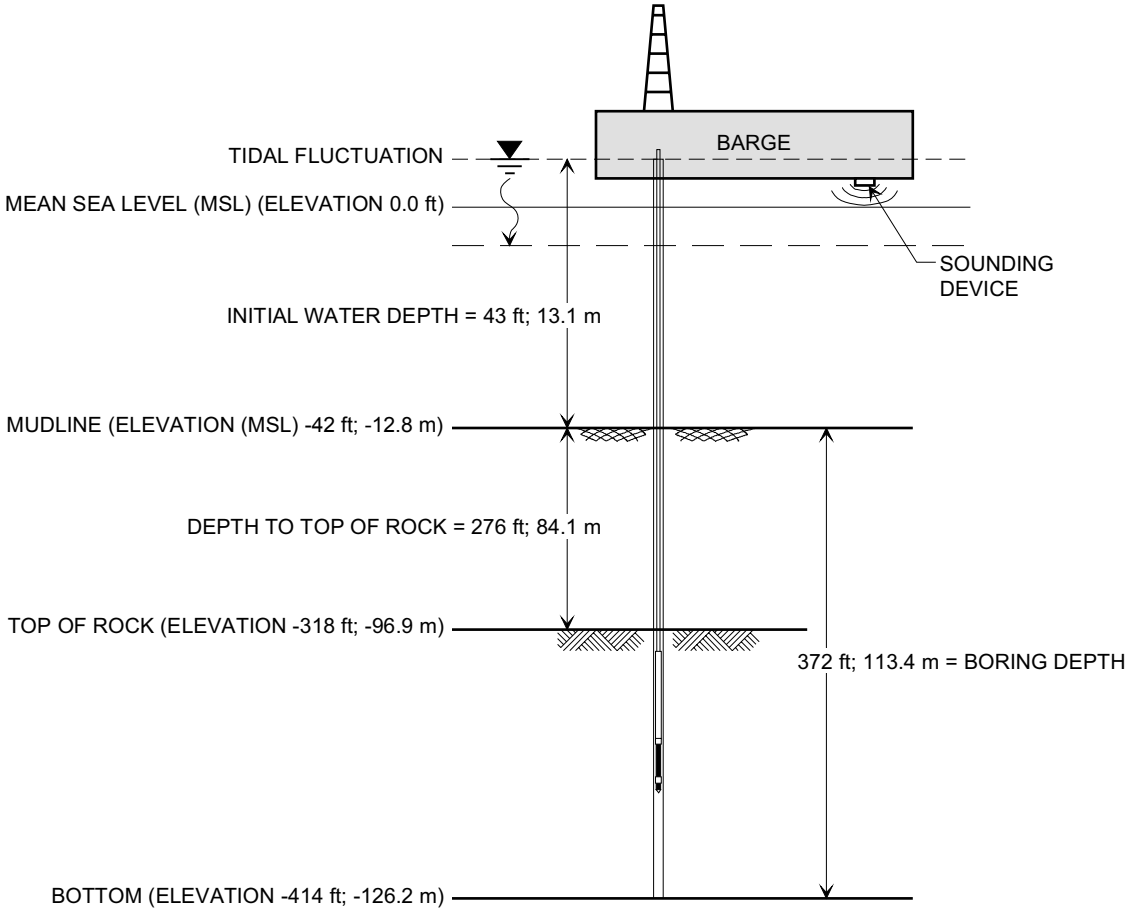
SUMMARY OF FIELD OPERATIONS
Boring 98-8
SFOBB East Span Seismic Safety Project



Coordinates in NAD83, CA Zone 3, meters.

BORING 98-8

Soil/Rock Sampling Depth	In-Situ Testing Depth	Coordinates
0 ft - 113 ft; 0 m - 34.4 m		E = 1,836,651 N = 647,876
113 ft - 372 ft; 34.4 m - 113.4 m	32 ft - 276 ft; 9.8 m - 84.1 m	E = 1,836,657 N = 647,874



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BORING 98-8 DEPTH AND LOCATION REFERENCE MAP

SFOBB East Span Seismic Safety Project

PLATE 98-8.2

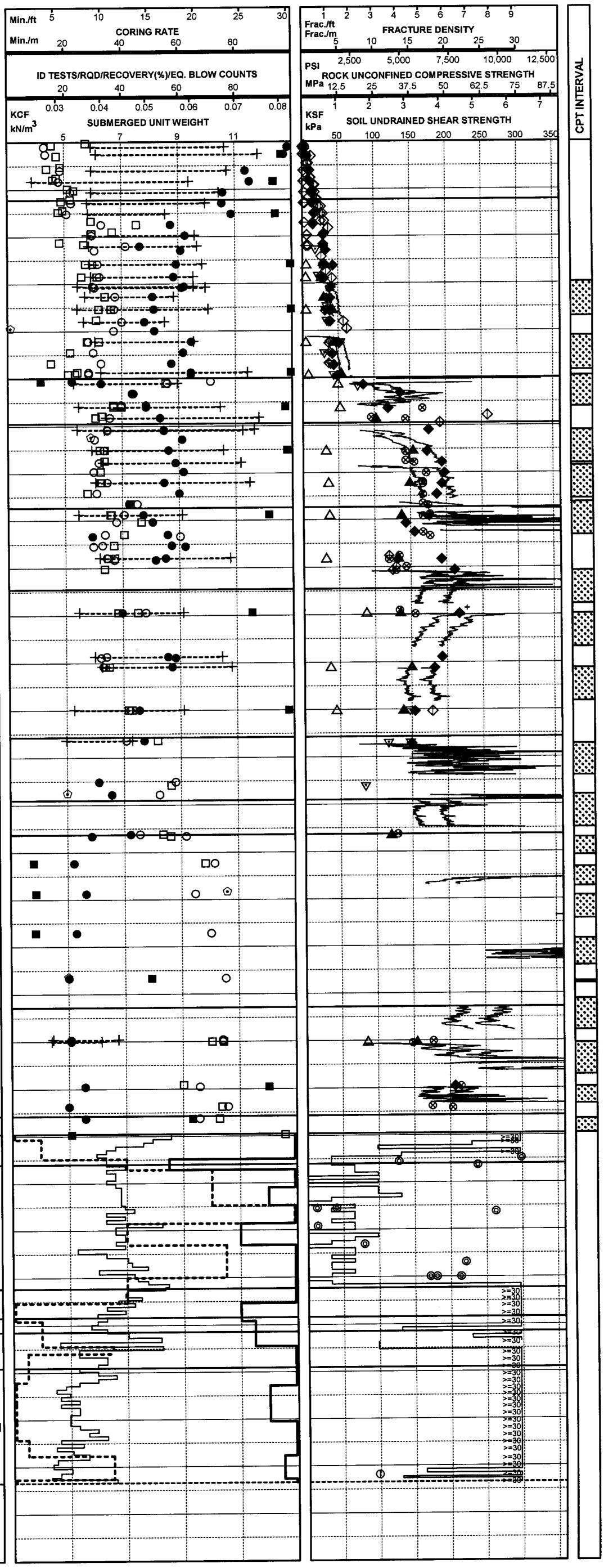
PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

Stratum	Description
I	Fat CLAY (CH), very soft to soft, olive gray -with sand pockets and partings -olive gray to dark gray to 1.8m -with a few shell fragments at 0.3m -gray at 2.1m -with a few shell fragments, 2.7m to 4.3m (4.9m)
II	Fat CLAY (CH), soft to stiff, gray -with sand seams and mica flakes, 4.9m to 6.4m -with a clayey sand layer at 7.0m -platy and expansive, 10.1m to 11.6m -with a few silt pockets and gas blisters, at 10.4m -with shell fragments, 11.3m and 13.1m -expansive and with gas blisters, below 12.8m -with silt pockets and partings, 13.7m to 15.2m -with a few shell fragments at 15.8m -with a few silt pockets at 16.8m -with organic matter pockets at 18.6m -with a few shell fragments at 19.5m (20.0m)
III	Fat CLAY (CL/CH), very stiff, greenish gray to grayish green, slickensided and desiccated -dense gray sand with silt and a clay seam, 20.0m to 20.4m (23.8m)
IV	-silty clay, 20.4m to 21.9m -with roots, 21.0m to 22.6m -with silt pockets and partings, at 22.9m Fat CLAY (CH), very stiff, olive gray to gray -with silt pockets and partings, 25.6m to 29.9m -with a few shells, shell fragments, and shell hash, below 26.5m (30.9m)
V	Fat CLAY (CH), very stiff to hard, gray -sand layer with a clay seam, 30.9m to 31.2m -with many sand pockets, partings, and seams, and with shells and shell fragments, 31.2m to 37.8m -sand layer with a clay seam, 32.6m to 32.9m -with a sand layer, 33.2m to 33.5m -with a sand layer at 34.1m (37.8m)
VI	-with a sand layer at 37.0m -with a sand layer at 37.6m Fat CLAY (CH), very stiff to hard, gray -with sand pockets, partings, and seams, and many shell fragments -with silt pockets and partings, below 43.9m -with organic partings, 43.9m to 50.3m -gray below 47.5m (50.3m)
VII	Laminated CLAY and Sandy SILT (CH/ML), dense to very stiff, gray -with silty sand seams inclined at 20 degrees, at 50.4m -with a sand layer at 51.7m (55.6m)
VIII	Fat CLAY (CH), very stiff, gray -with silt pockets, below 58.2m (58.5m)
IX	Fine SAND with silt (SP-SM), dense to very dense, gray to dark gray -with clay seams and layers -with clay partings, organic pockets, and organic seams, at 58.5m -with a clay layer, 62.2m to 62.8m -with a clay layer, 65.2m to 65.7m -clay layer with sand seams, 68.3m to 69.2m -with a clay layer at 69.5m -silty sand at 70.4m (73.2m)
X	Lean CLAY (CL), hard, gray -with a sand layer, 77.9m to 78.2m -sandy silt layer with clay pockets, partings, and seams, 78.6m to 79.9m -with silt pockets, sand pockets, and silt seams, at 81.7m (82.3m)
XI	Sandy SILT (ML), very dense, gray -interlayed with silt and clay, at 82.6m (83.8m)
XII	SANDSTONE (Graywacke) (RX), medium gray, moderately to slightly weathered, moderately hard, fine grained, intensely to moderately fractured (86.4m)
XIII	CONGLOMERATE (RX), mottled light to dark gray, slightly weathered, moderately hard to hard, slightly to moderately fractured See Plate 98-8.6 for detailed stratigraphy below 83.8m (96.9m)
XIV	SILTSTONE (RX), dark gray, fresh, moderately hard, thinly bedded, intensely fractured (99.4m)
XV	SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, fine grained, very thickly bedded, intensely fractured (100.6m)
XVI	SILTSTONE (RX), light gray, fresh, moderately hard, thinly to thickly bedded, intensely fractured (103.6m)
XVII	SANDSTONE (Graywacke) (RX), medium dark gray, fresh, hard, intensely to very intensely fractured

TOTAL DEPTH: 113.4 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/17/98

PLATE 98-8.3

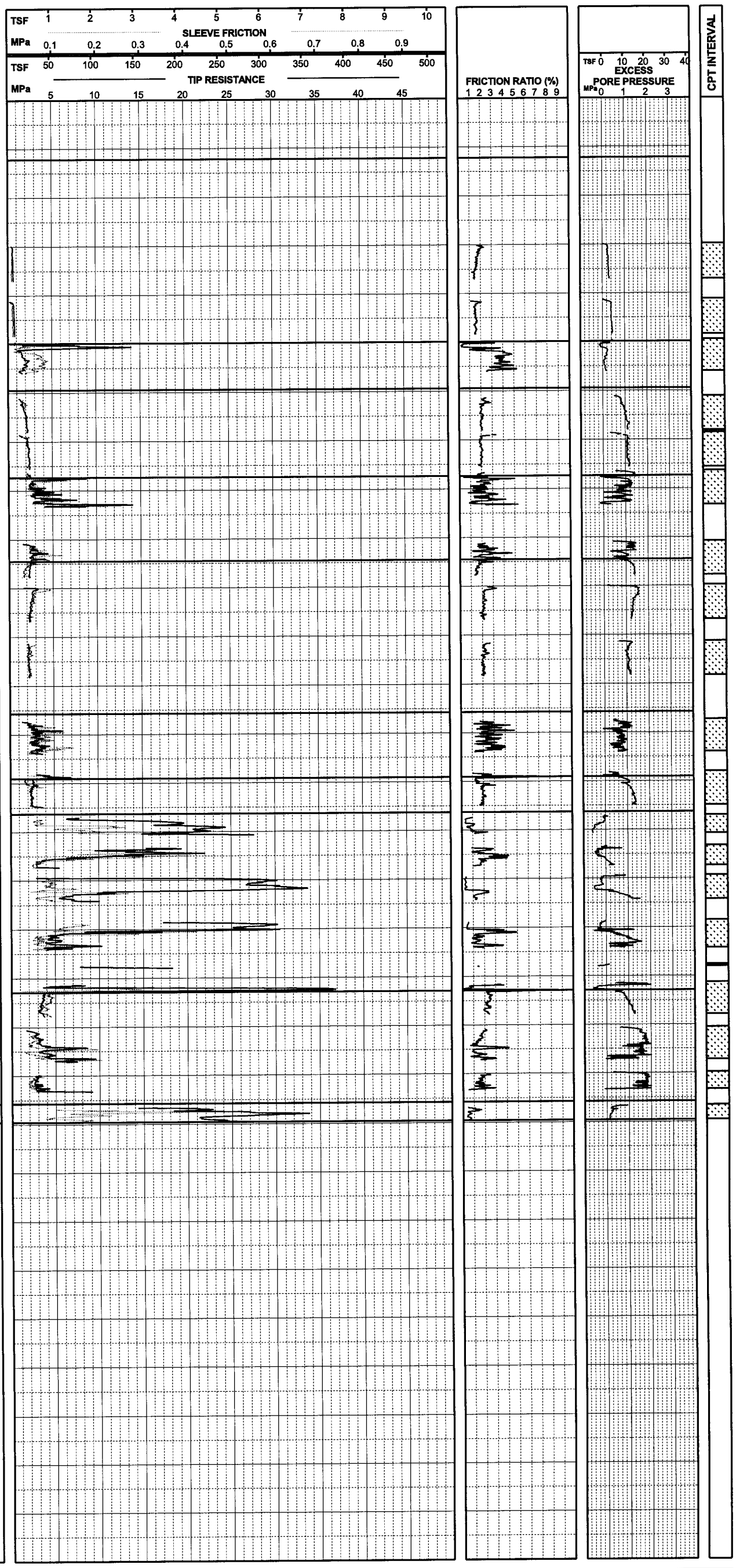
PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
		WOH, WOH, WOH, WOH	Fat CLAY (CH), very soft to soft, olive gray -with sand pockets and partings -olive gray to dark gray to 1.8m -with a few shell fragments at 0.3m -gray at 2.1m (4.9m)	I
-16	4	3/60cm, 3/60cm	-with a few shell fragments, 2.7m to 4.3m	
-20	8	3/60cm, 3/60cm, 3/60cm, 3/60cm, PUSH, PUSH, PUSH, SAVE	Fat CLAY (CH), soft to stiff, gray -with sand seams and mica flakes, 4.9m to 6.4m -with a clayey sand layer at 7.0m -platy and expansive, 10.1m to 11.6m -with a few silt pockets and gas blisters, at 10.4m	II
-24	12	PUSH, PUSH, PUSH, 1	-with shell fragments, 11.3m and 13.1m -expansive and with gas blisters, below 12.8m -with silt pockets and partings, 13.7m to 15.2m	
-28	16	PUSH, PUSH, PUSH, PUSH, PUSH, PUSH	-with a few shell fragments at 15.8m -with a few silt pockets at 16.8m (20.0m) -with organic matter pockets at 18.6m -with a few shell fragments at 19.5m	
-32	20	PUSH, PUSH, PUSH, SAVE, 29	Fat CLAY (CL/CH), very stiff, greenish gray to grayish green, slickensided and desiccated (23.8m) -dense gray sand with silt and a clay seam, 20.0m to 20.4m -silty clay, 20.4m to 21.9m	III
-36	24	PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, PUSH, PUSH	Fat CLAY (CH), very stiff, olive gray to gray (30.9m)	IV
-40	28	PUSH, PUSH, PUSH, 30/40cm, PUSH, PUSH	Fat CLAY (CH), very stiff to hard, gray -with many sand pockets, partings, and seams, and with shells and shell fragments, 31.2m to 37.8m -sand layer with a clay seam, 32.6m to 32.9m -with a sand layer, 33.2m to 33.5m (37.8m)	V
-44	32			
-48	36			
-52	40	PUSH	Fat CLAY (CH), very stiff to hard, gray -with sand pockets, partings, and seams, and many shell fragments	VI
-56	44	PUSH, PUSH	-with silt pockets and partings, below 43.9m -with organic partings, 43.9m to 50.3m	
-60	48	PUSH	-gray below 47.5m (50.3m)	
-64	52	PUSH, PUSH, 50/30cm	Laminated CLAY and Sandy SILT (CH/ML), dense to very stiff, gray -with silty sand seams inclined at 20 degrees, at 50.4m -with a sand layer at 51.7m (55.6m)	VII
-68	56	PUSH	Fat CLAY (CH), very stiff, gray -with silt pockets, below 58.2m (58.5m)	VIII
-72	60	33/30cm	Fine SAND with silt (SP-SM), dense to very dense, gray to dark gray -with clay seams and layers -with clay partings, organic pockets, and organic seams, at 58.5m -with a clay layer, 62.2m to 62.8m -with a clay layer, 65.2m to 65.7m	IX
-76	64	76, 60/20cm	-clay layer with sand seams, 68.3m to 69.2m -with a clay layer at 69.5m -silty sand at 70.4m	
-80	68			
-84	72	50/30cm	(73.2m)	
-88	76	PUSH	Lean CLAY (CL), hard, gray	X
-92	80	PUSH, 31/30cm, 30/25cm	-with a sand layer, 77.9m to 78.2m -sandy silt layer with clay pockets, partings, and seams, 78.6m to 79.9m -with silt pockets, sand pockets, and silt seams, at 81.7m (82.3m)	
-96	84	30/10cm, 30/10cm, 100-0	Sandy SILT (ML), very dense, gray -interlayed with silt and clay, at 82.6m	XI
-100	88			
-104	92			
-108	96			
-112	100			
-116	104			
-120	108			
-124	112			
-128	116			
-132				

See Plate 98-8.7 for detailed stratigraphy from 20m to 37.8m



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

PLATE 98-8.4

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

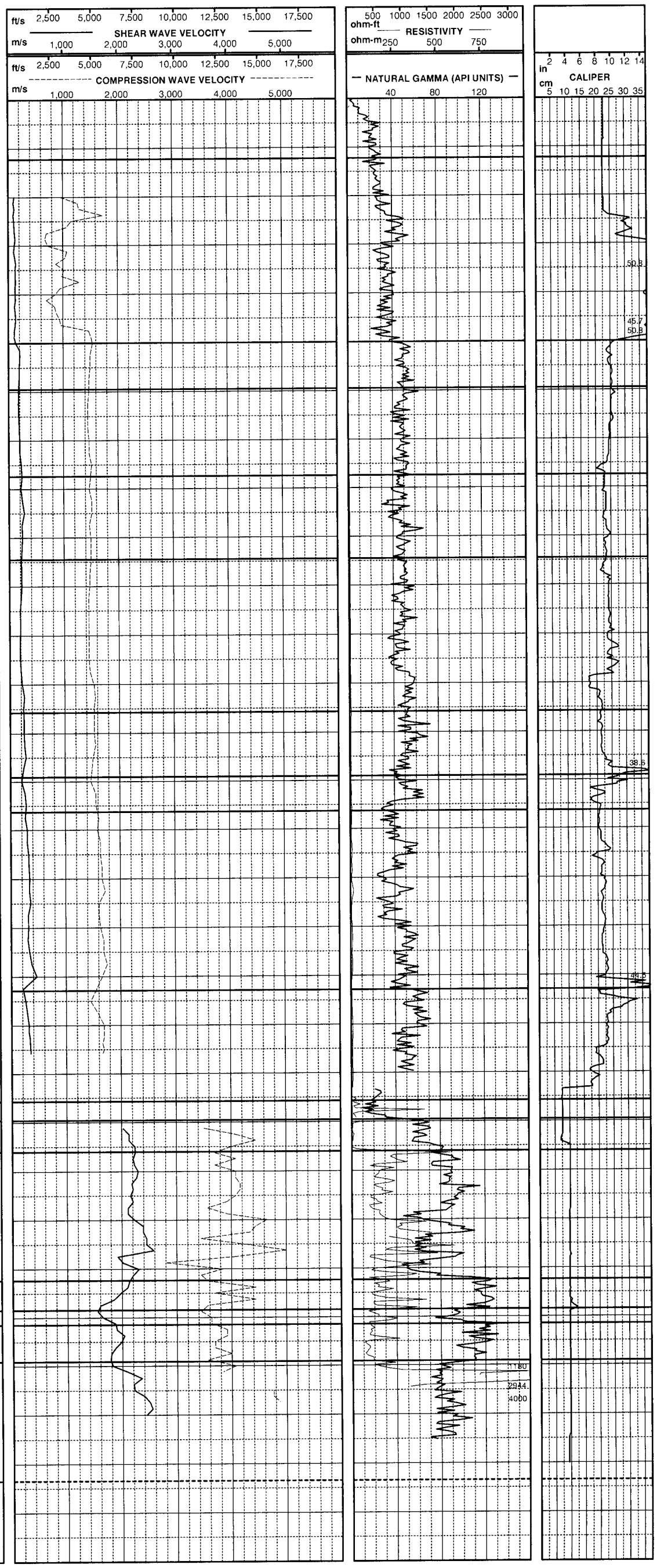
MUDLINE ELEVATION: -12.8 m (MSL)

STRATUM NO.	MATERIAL DESCRIPTION
I	Fat CLAY (CH), very soft to soft, olive gray -with sand pockets and partings -olive gray to dark gray to 1.8m -with a few shell fragments at 0.3m -gray at 2.1m (4.9m) -with a few shell fragments, 2.7m to 4.3m
II	Fat CLAY (CH), soft to stiff, gray -with sand seams and mica flakes, 4.9m to 6.4m -with a clayey sand layer at 7.0m -platy and expansive, 10.1m to 11.6m -with a few silt pockets and gas blisters, at 10.4m -with shell fragments, 11.3m and 13.1m -expansive and with gas blisters, below 12.8m -with silt pockets and partings, 13.7m to 15.2m -with a few shell fragments at 15.8m -with a few silt pockets at 16.8m -with organic matter pockets at 18.6m -with a few shell fragments at 19.5m (20.0m)
III	Fat CLAY (CL/CH), very stiff, greenish gray to grayish green, slickensided and desiccated -dense gray sand with silt and a clay seam, 20.0m to 20.4m (23.8m)
IV	-silty clay, 20.4m to 21.9m -with roots, 21.0m to 22.6m -with silt pockets and partings, at 22.9m Fat CLAY (CH), very stiff, olive gray to gray -with silt pockets and partings, 25.6m to 29.9m -with a few shells, shell fragments, and shell hash, below 26.5m (30.9m)
V	Fat CLAY (CH), very stiff to hard, gray -sand layer with a clay seam, 30.9m to 31.2m -with many sand pockets, partings, and seams, and with shells and shell fragments, 31.2m to 37.8m -sand layer with a clay seam, 32.6m to 32.9m -with a sand layer, 33.2m to 33.5m (37.8m)
VI	-with a sand layer at 34.1m -with a sand layer at 37.0m -with a sand layer at 37.6m Fat CLAY (CH), very stiff to hard, gray -with sand pockets, partings, and seams, and many shell fragments -with silt pockets and partings, below 43.9m -with organic partings, 43.9m to 50.3m -gray below 47.5m (50.3m)
VII	Laminated CLAY and Sandy SILT (CH/ML), dense to very stiff, gray -with silty sand seams inclined at 20 degrees, at 50.4m -with a sand layer at 51.7m (55.6m)
VIII	Fat CLAY (CH), very stiff, gray -with silt pockets, below 58.2m (58.5m)
IX	Fine SAND with silt (SP-SM), dense to very dense, gray to dark gray -with clay seams and layers -with clay partings, organic pockets, and organic seams, at 58.5m -with a clay layer, 62.2m to 62.8m -with a clay layer, 65.2m to 65.7m -clay layer with sand seams, 68.3m to 69.2m -with a clay layer at 69.5m -silty sand at 70.4m (73.2m)
X	Lean CLAY (CL), hard, gray -with a sand layer, 77.9m to 78.2m -sandy silt layer with clay pockets, partings, and seams, 78.6m to 79.9m (82.3m) -with silt pockets, sand pockets, and silt seams, at 81.7m
XI	Sandy SILT (ML), very dense, gray (83.8m)
XII	SANDSTONE (Graywacke) (RX), medium gray, moderately to slightly weathered, moderately hard, fine grained, intensely to moderately fractured (86.4m)
XIII	CONGLOMERATE (RX), mottled light to dark gray, slightly weathered, moderately hard to hard, slightly to moderately fractured -with interbedded siltstone, dark gray, moderately hard, intensely fractured, 92.4m to 93.0m -fractures inclined at 40 and 70 degrees, moderately rough, with thin discontinuous calcite/ quartz filling, 93.0m to 94.5m -with interbedded siltstone, dark gray moderately hard, moderately fractured, 94.6m to 94.9m (96.9m)
XIV	-very intensely fractured at 94.9m (99.4m)
XV	SILTSTONE (RX), dark gray, fresh, moderately hard, thinly bedded, intensely fractured (100.6m)
XVI	-with a 0.3m-thick sandstone bed, 97.2m to 97.5m -with a 0.3m-thick very intensely fractured zone, 97.5m to 97.8m (103.6m)
XVII	SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, fine grained, very thickly bedded, intensely fractured SILTSTONE (RX), light gray, fresh, moderately hard, thinly to thickly bedded, intensely fractured -with thinly interbedded sandstone, 101.8m to 102.1m SANDSTONE (Graywacke) (RX), medium dark gray, fresh, hard, intensely to very intensely fractured

TOTAL DEPTH: 113.4 m

BACKFILLED WITH: Cement Grout

See Plate 98-8.6 for detailed stratigraphy below 82.3m



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

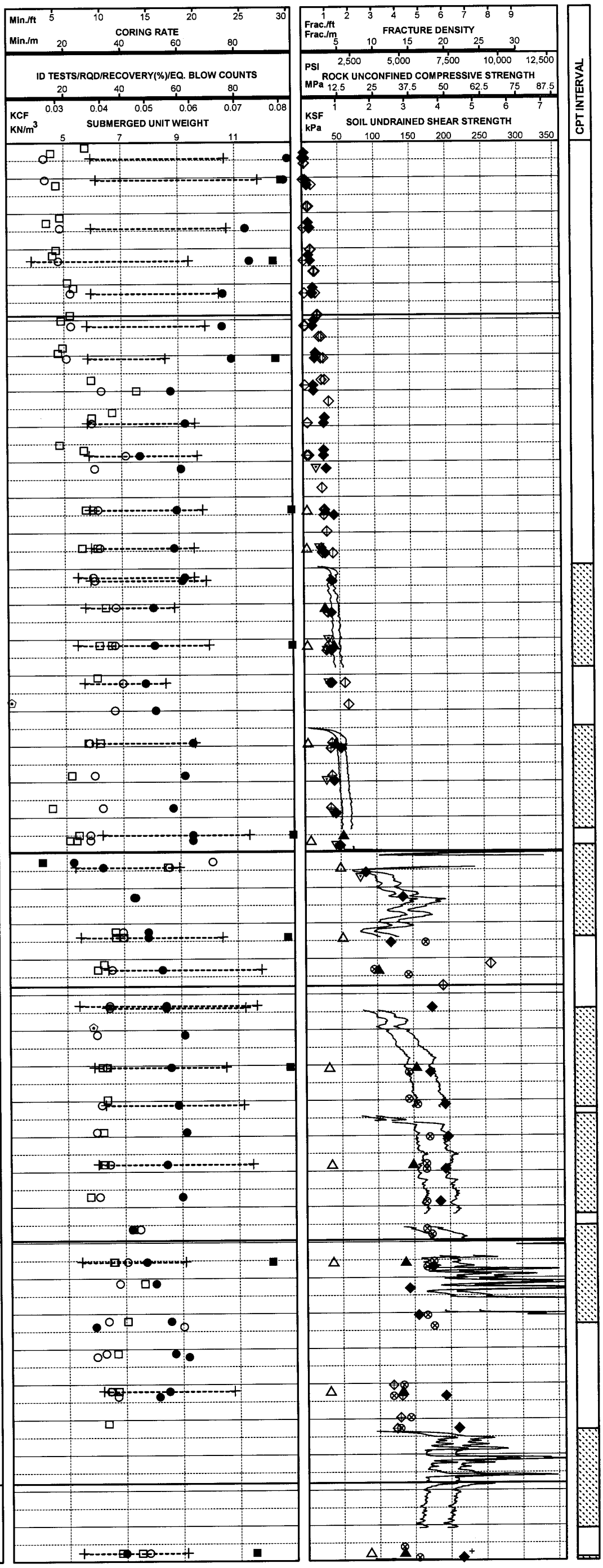
PLATE 98-8.5

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-13		WOH	Fat CLAY (CH), very soft to soft, olive gray	I
			-with sand pockets and partings	
			-olive gray to dark gray to 1.8m	
-14	1	WOH	-with a few shell fragments at 0.3m	
-15	2	WOH	-gray at 2.1m	
			-with a few shell fragments, 2.7m to 4.3m	
-16	3	WOH		
-17	4	WOH	(4.9m)	
-18	5	3/60cm	Fat CLAY (CH), soft to stiff, gray	II
			-with sand seams and mica flakes, 4.9m to 6.4m	
-19	6	3/60cm		
-20	7	3/60cm	-with a clayey sand layer at 7.0m	
-21	8	3/60cm		
		3/60cm		
-22	9	PUSH		
-23	10	PUSH	-platy and expansive, 10.1m to 11.6m	
			-with a few silt pockets and gas blisters, at 10.4m	
-24	11	PUSH	-with shell fragments, 11.3m and 13.1m	
-25	12	SAVE		
-26	13	PUSH	-expansive and with gas blisters, below 12.8m	
-27	14	PUSH	-with silt pockets and partings, 13.7m to 15.2m	
-28	15	PUSH		
-29	16	1	-with a few shell fragments at 15.8m	
-30	17	PUSH	-with a few silt pockets at 16.8m	
-31	18	PUSH		
-32	19	PUSH	-with organic matter pockets at 18.6m	
		PUSH	-with a few shell fragments at 19.5m	
			(20.0m)	
-33	20	PUSH	Fat CLAY (CL/CH), very stiff, greenish gray to grayish green, slickensided and desiccated	III
-34	21	PUSH	-dense gray sand with silt and a clay seam, 20.0m to 20.4m	
			-silty clay, 20.4m to 21.9m	
			-with roots, 21.0m to 22.6m	
-35	22	PUSH		
-36	23	PUSH	-with silt pockets and partings, at 22.9m	
			(23.8m)	
-37	24	SAVE	Fat CLAY (CH), very stiff, olive gray to gray	IV
-38	25	29		
			-with silt pockets and partings, 25.6m to 29.9m	
-39	26	PUSH		
			-with a few shells, shell fragments, and shell hash, below 26.5m	
-40	27	PUSH		
-41	28	PUSH		
-42	29	PUSH		
-43	30	PUSH		
		PUSH	(30.9m)	
-44	31	PUSH	Fat CLAY (CH), very stiff to hard, gray	V
			-sand layer with a clay seam, 30.9m to 31.2m	
-45	32	PUSH	-with many sand pockets, partings, and seams, and with shells and shell fragments, 31.2m to 37.8m	
			-sand layer with a clay seam, 32.6m to 32.9m	
-46	33	PUSH	-with a sand layer, 33.2m to 33.5m	
-47	34	30/40cm	-with a sand layer at 34.1m	
-48	35	PUSH		
-49	36	PUSH		
-50	37		-with a sand layer at 37.0m	
			-with a sand layer at 37.6m	
			(37.8m)	
-51	38		Fat CLAY (CH), very stiff to hard, gray	VI
			-with sand pockets, partings, and seams, and many shell fragments	
-52	39	PUSH		



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

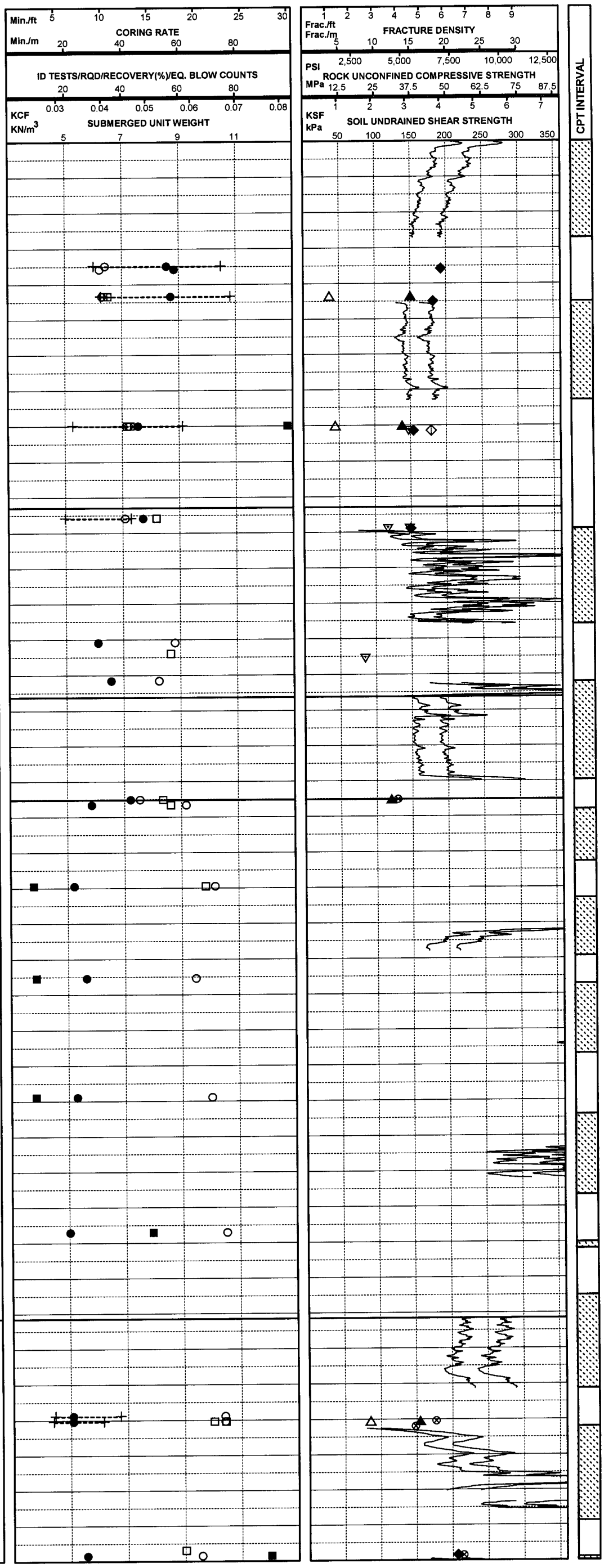
PLATE 98-8.6a

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-53				Fat CLAY (CH), very stiff to hard, gray	VI
-54	41				
-55	42				
-56	43		PUSH		
-57	44		PUSH	-with silt pockets and partings, below 43.9m -with organic partings, 43.9m to 50.3m	
-58	45				
-59	46				
-60	47				
-61	48		PUSH	-gray below 47.5m	
-62	49				
-63	50			(50.3m)	
-64	51		PUSH	Laminated CLAY and Sandy SILT (CH/ML), dense to very stiff, gray -with silty sand seams inclined at 20 degrees, at 50.4m -with a sand layer at 51.7m	VII
-65	52				
-66	53				
-67	54		PUSH		
-68	55		50/30cm	(55.6m)	
-69	56			Fat CLAY (CH), very stiff, gray	VIII
-70	57				
-71	58		PUSH	-with silt pockets, 58.2m to 58.2m (58.5m)	
-72	59			Fine SAND with silt (SP-SM), dense to very dense, gray to dark gray -with clay seams and layers -with clay partings, organic pockets, and organic seams, at 58.5m	IX
-73	60				
-74	61		33/30cm		
-75	62			-with a clay layer, 62.2m to 62.8m	
-76	63		76		
-77	64				
-78	65			-with a clay layer, 65.2m to 65.7m	
-79	66				
-80	67		60/20cm		
-81	68			-clay layer with sand seams, 68.3m to 69.2m	
-82	69			-with a clay layer at 69.5m	
-83	70			-silty sand at 70.4m	
-84	71		50/30cm		
-85	72				
-86	73			(73.2m)	
-87	74			Lean CLAY (CL), hard, gray	X
-88	75				
-89	76		PUSH		
-90	77				
-91	78			-with a sand layer, 77.9m to 78.2m -sandy silt layer with clay pockets, partings, and seams, 78.6m to 79.9m	
-92	79		PUSH		



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

FUGRO

PLATE 98-8.6b

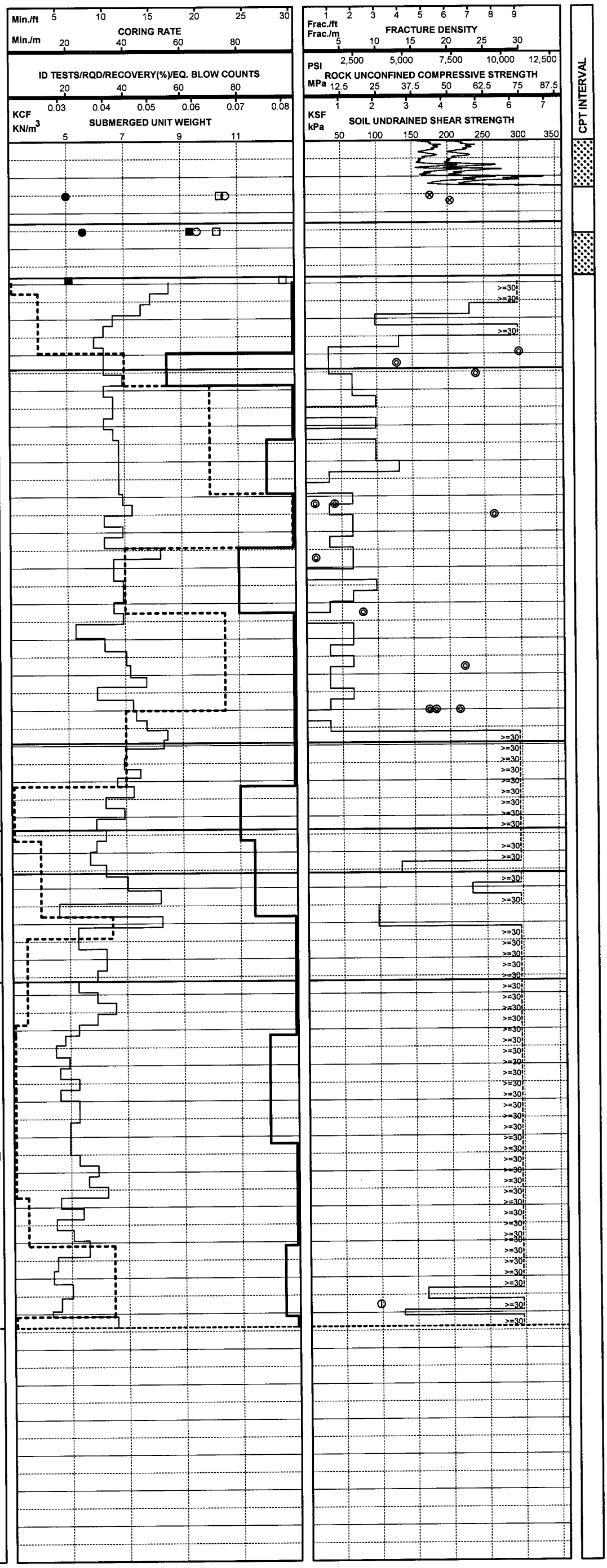
PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

MATERIAL DESCRIPTION	STRATUM NO.
Lean CLAY (CL), hard, gray -with silt pockets, sand pockets, and silt seams, at 81.7m (82.3m)	X
Sandy SILT (ML), very dense, gray -interlayed with silt and clay, at 82.6m (83.8m)	XI
SANDSTONE (Graywacke) (RX), medium gray, moderately to slightly weathered, moderately hard, fine grained, intensely to moderately fractured -fractures inclined at 30 (possible bedding), 60 and 80 degrees, slightly to moderately rough, with very thin to thin calcite filling (86.4m)	XII
CONGLOMERATE (RX), mottled light to dark gray, slightly weathered, moderately hard to hard, slightly to moderately fractured -fine to coarse gravel size clasts of light gray subrouded to subangular sandstone and siltstone, in a dark gray fine sandstone to siltstone matrix, fractures generally inclined at 35 and 50 to 60 degrees, moderately to slightly rough -fracture spacing 10 per meter, 86.9m to 92.4m -with interbedded siltstone, dark gray, moderately hard, intensely fractured, 92.4m to 93.0m -fractures inclined at 40 and 70 degrees, 3 to 7 per meter, moderately rough, with thin discontinuous calcite/ quartz filling, 93.0m to 94.5m -with interbedded siltstone, dark gray moderately hard, moderately fractured, 94.6m to 94.9m -very intensely fractured at 94.9m (96.9m)	XIII
SILTSTONE (RX), dark gray, fresh, moderately hard, thinly bedded, intensely fractured -smooth to slightly rough fractures with discontinuous calcite filling -with a 0.3m-thick sandstone bed, 97.2m to 97.5m -with a 0.3m-thick very intensely fractured zone, 97.5m to 97.8m -with a moderate gray, moderately thin claystone bed, soft, intensely to very intensely fractured, dipping at 50 degrees, at 99.1m (99.4m)	XIV
SANDSTONE (Graywacke) (RX), dark gray, fresh, hard, fine grained, very thickly bedded, intensely fractured (100.6m)	XV
SILTSTONE (RX), light gray, fresh, moderately hard, thinly to thickly bedded, intensely fractured -slightly rough to smooth fractures inclined at 0, 40 and 80 degrees, very thin to clean, spacing 13 to 20 per meter -with a thin fracture zone dipping at about 15 degrees at 100.6m -with a 150-mm-thick very intensely fractured zone at 101.0m -with thinly interbedded sandstone, 101.8m to 102.1m -with a 200-mm-thick sandstone bed at 102.6m (103.6m)	XVI
SANDSTONE (Graywacke) (RX), medium dark gray, fresh, hard, intensely to very intensely fractured -fractures inclined at about 30, 60, and 70 degrees with very thin to thin discontinuous calcite filling, fractures with discontinuous very thin calcite/ quartz fillings and small pyrite patches, spacing 7 to 10 per meter, 103.6m to 109.7m -with a thin sandstone bed at 103.9m -with two very thin to thin (50- to 175-mm thick) siltstone beds, dipping at 30 degrees, at 108.7m and 108.8m -with two thin fracture zones dipping at 50 degrees, at 110.2m and 110.5m -with a moderate to thick (200-mm) siltstone bed at 111.6m	XVII

TOTAL DEPTH: 113.4 m BACKFILLED WITH: Cement Grout



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/15/98

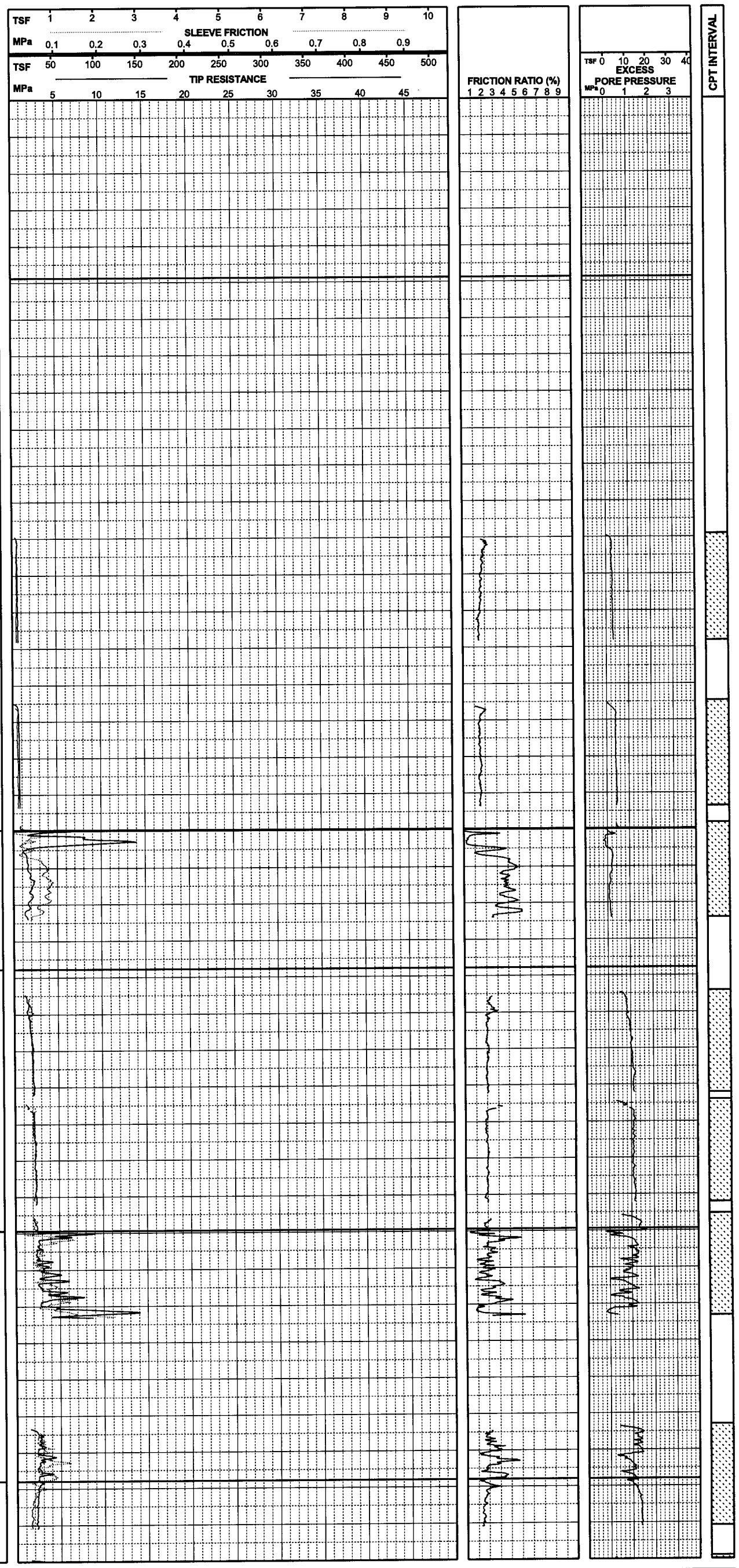
PLATE 98-8.6c

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-13		WOH	Fat CLAY (CH), very soft to soft, olive gray -with sand pockets and partings -olive gray to dark gray to 1.8m	
-14	1	WOH	-with a few shell fragments at 0.3m	
-15	2	WOH	-gray at 2.1m	I
-16	3	WOH	-with a few shell fragments, 2.7m to 4.3m	
-17	4	WOH	(4.9m)	
-18	5	3/60cm	Fat CLAY (CH), soft to stiff, gray -with sand seams and mica flakes, 4.9m to 6.4m	
-19	6	3/60cm		
-20	7	3/60cm	-with a clayey sand layer at 7.0m	
-21	8	3/60cm		
-22	9	3/60cm		
-23	10	PUSH	-platy and expansive, 10.1m to 11.6m -with a few silt pockets and gas blisters, at 10.4m	
-24	11	PUSH	-with shell fragments, 11.3m and 13.1m	
-25	12	SAVE		
-26	13	PUSH	-expansive and with gas blisters, below 12.8m	II
-27	14	PUSH	-with silt pockets and partings, 13.7m to 15.2m	
-28	15	PUSH		
-29	16	1	-with a few shell fragments at 15.8m	
-30	17	PUSH	-with a few silt pockets at 16.8m	
-31	18	PUSH		
-32	19	PUSH	-with organic matter pockets at 18.6m	
-33	20	PUSH	-with a few shell fragments at 19.5m (20.0m) Fat CLAY (CL/CH), very stiff, greenish gray to grayish green, slickensided and desiccated	
-34	21	PUSH	-dense gray sand with silt and a clay seam, 20.0m to 20.4m -silty clay, 20.4m to 21.9m	
-35	22	PUSH	-with roots, 21.0m to 22.6m	III
-36	23	PUSH	-with silt pockets and partings, at 22.9m (23.8m)	
-37	24	SAVE	Fat CLAY (CH), very stiff, olive gray to gray	
-38	25	29	-with silt pockets and partings, 25.6m to 29.9m	
-39	26	PUSH	-with a few shells, shell fragments, and shell hash, below 26.5m	
-40	27	PUSH		
-41	28	PUSH		IV
-42	29	PUSH		
-43	30	PUSH		
-44	31	PUSH	(30.9m) Fat CLAY (CH), very stiff to hard, gray -sand layer with a clay seam, 30.9m to 31.2m	
-45	32	PUSH	-with many sand pockets, partings, and seams, and with shells and shell fragments, 31.2m to 37.8m	
-46	33	PUSH	-sand layer with a clay seam, 32.6m to 32.9m -with a sand layer, 33.2m to 33.5m	
-47	34	30/40cm	-with a sand layer at 34.1m	V
-48	35	PUSH		
-49	36	PUSH		
-50	37		-with a sand layer at 37.0m -with a sand layer at 37.6m (37.8m)	
-51	38		Fat CLAY (CH), very stiff to hard, gray -with sand pockets, partings, and seams, and many shell fragments	VI
-52	39	PUSH		



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/16/98

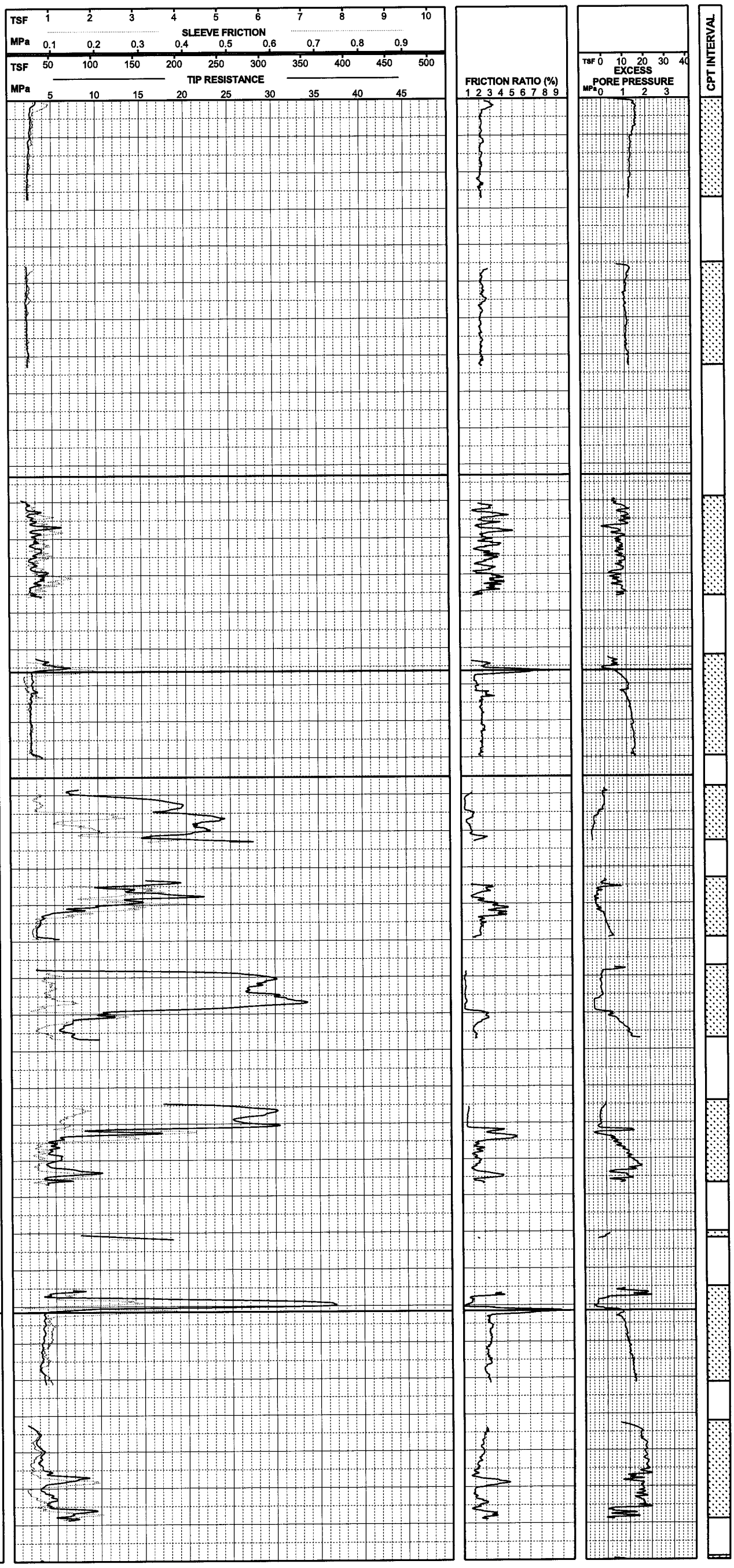
PLATE 98-8.7a

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-53				Fat CLAY (CH), very stiff to hard, gray	VI
-54	41				
-55	42				
-56	43		PUSH		
-57	44		PUSH	-with silt pockets and partings, below 43.9m -with organic partings, 43.9m to 50.3m	
-58	45				
-59	46				
-60	47				
-61	48		PUSH	-gray below 47.5m	
-62	49				
-63	50			(50.3m)	
-64	51		PUSH	Laminated CLAY and Sandy SILT (CH/ML), dense to very stiff, gray -with silty sand seams inclined at 20 degrees, at 50.4m -with a sand layer at 51.7m	VII
-65	52				
-66	53				
-67	54		PUSH		
-68	55		50/30cm	(55.6m)	
-69	56			Fat CLAY (CH), very stiff, gray	VIII
-70	57				
-71	58		PUSH	-with silt pockets, below 58.2m (58.5m)	
-72	59			Fine SAND with silt (SP-SM), dense to very dense, gray to dark gray -with clay seams and layers -with clay partings, organic pockets, and organic seams, at 58.5m	IX
-73	60				
-74	61		33/30cm		
-75	62			-with a clay layer, 62.2m to 62.8m	
-76	63		76		
-77	64				
-78	65			-with a clay layer, 65.2m to 65.7m	
-79	66				
-80	67		60/20cm		
-81	68			-clay layer with sand seams, 68.3m to 69.2m	
-82	69			-with a clay layer at 69.5m	
-83	70		50/30cm	-silty sand at 70.4m	
-84	71				
-85	72				
-86	73			(73.2m)	
-87	74			Lean CLAY (CL), hard, gray	X
-88	75				
-89	76		PUSH		
-90	77				
-91	78			-with a sand layer, 77.9m to 78.2m -sandy silt layer with clay pockets, partings, and seams, 78.6m to 79.9m	
-92	79		PUSH		



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/16/98

FUGRO

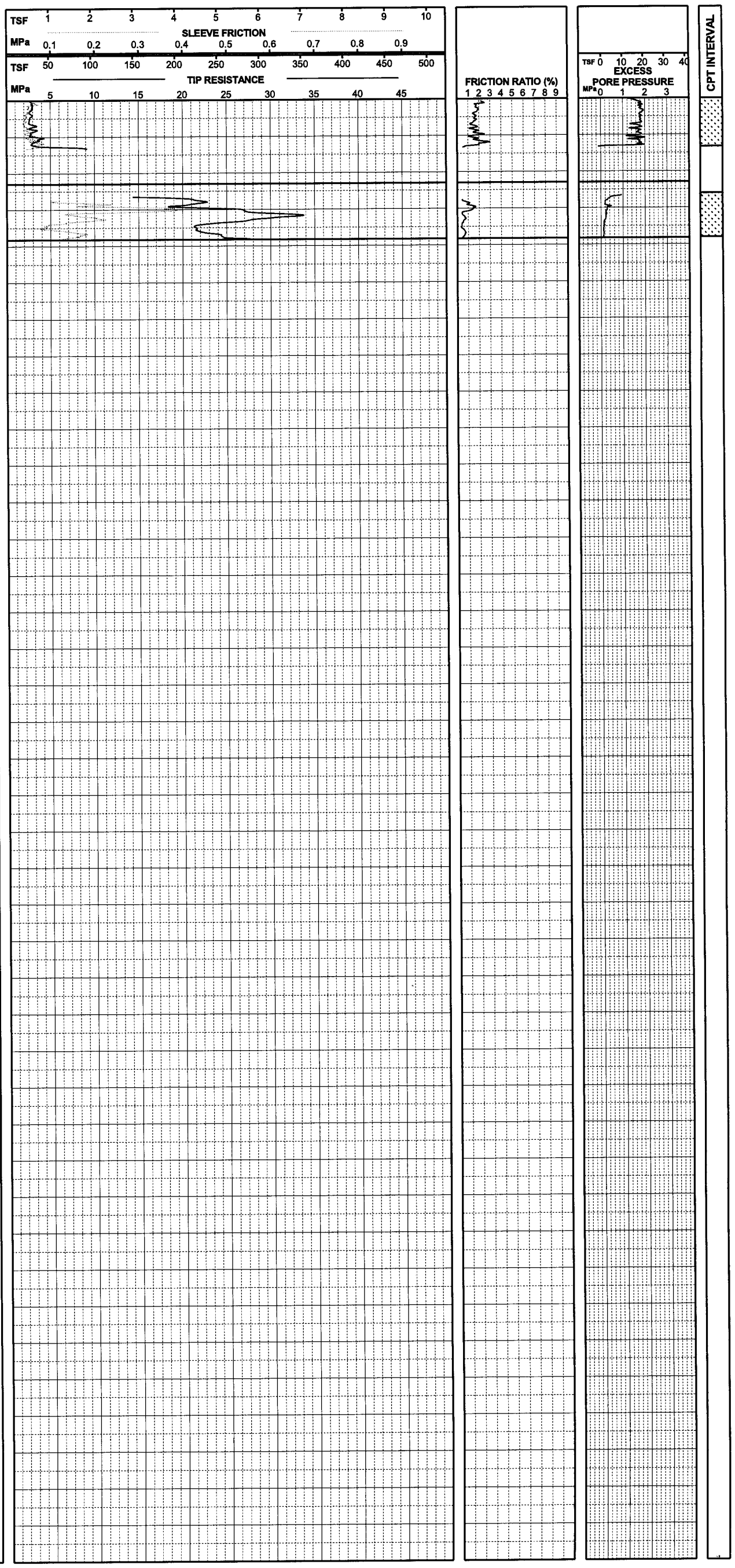
PLATE 98-8.7b

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	SOIL TYPE	SAMPLER	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
-93					Lean CLAY (CL), hard, gray	
-94	81					X
				31/30cm	-with silt pockets, sand pockets, and silt seams, at 81.7m	
-95	82				(82.3m)	
				30/25cm	Sandy SILT (ML), very dense, gray -interlayed with silt and clay, at 82.6m	
-96	83					XI
				30/10cm		
-97	84			30/10cm 100-0		
-98	85					
-99	86					
-100	87					
-101	88					
-102	89					
-103	90					
-104	91					
-105	92					
-106	93					
-107	94					
-108	95					
-109	96					
-110	97					
-111	98					
-112	99					
-113	100					
-114	101					
-115	102					
-116	103					
-117	104					
-118	105					
-119	106					
-120	107					
-121	108					
-122	109					
-123	110					
-124	111					
-125	112					
-126	113					
-127	114					
-128	115					
-129	116					
-130	117					
-131	118					
-132	119					



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/16/98

FUGRO

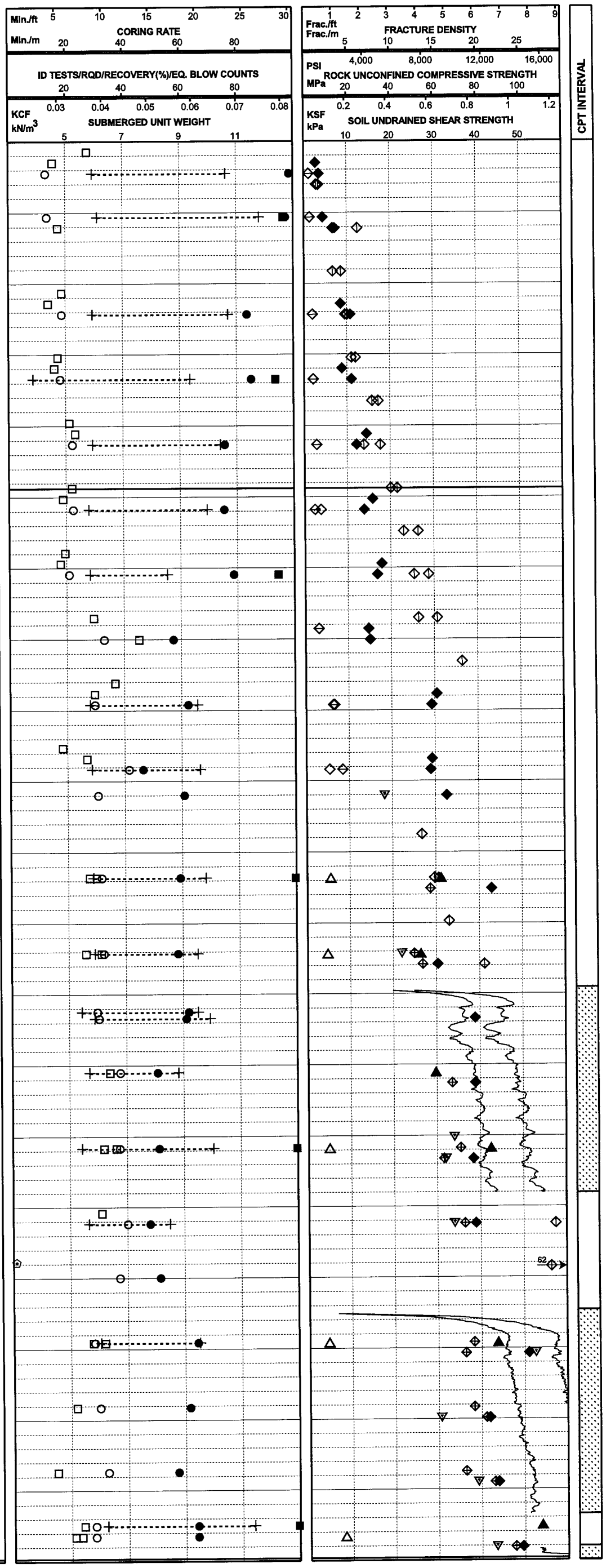
PLATE 98-8.7c

PROJECT NO: 98-42-0035
BORING: 98-8 (North of Pier E3)
START DATE: 3/4/98
COMPLETION DATE: 3/11/98
DRILLER: Fugro-McClelland Marine Geosciences
DRILLING METHOD: Mud Rotary Boring

Coordinates: E1836651 N647876
CA State Plane Zone 3, NAD83, Meters

MUDLINE ELEVATION: -12.8 m (MSL)

ELEVATION, m.	DEPTH, m.	BLOW COUNT	MATERIAL DESCRIPTION	STRATUM NO.
			Fat CLAY (CH), very soft to soft, olive gray	I
			-with sand pockets and partings	
			-olive gray to dark gray to 1.8m	
			-with a few shell fragments at 0.3m	
-13	1	WOH		
-14	2	WOH	-gray at 2.1m	
-15			-with a few shell fragments, 2.7m to 4.3m	
-16	3	WOH		
-17	4	WOH		
			(4.9m)	
-18	5	3/60cm	Fat CLAY (CH), soft to stiff, gray	II
			-with sand seams and mica flakes, 4.9m to 6.4m	
-19	6	3/60cm		
-20	7	3/60cm	-with a clayey sand layer at 7.0m	
-21	8	3/60cm		
-22	9	3/60cm		
-23	10	PUSH	-platy and expansive, 10.1m to 11.6m	
		PUSH	-with a few silt pockets and gas blisters, at 10.4m	
-24	11	PUSH	-with shell fragments, 11.3m and 13.1m	
-25	12	SAVE		
-26	13	PUSH	-expansive and with gas blisters, below 12.8m	
-27	14	PUSH	-with silt pockets and partings, 13.7m to 15.2m	
-28	15	PUSH		
-29	16	1	-with a few shell fragments at 15.8m	
-30	17	PUSH	-with a few silt pockets at 16.8m	
-31	18	PUSH		
-32	19	PUSH	-with organic matter pockets at 18.6m	
		PUSH	-with a few shell fragments at 19.5m	
			(20.0m)	



LOG OF BORING AND TEST RESULTS

BORING 98-8

SFOBB East Span Seismic Safety Project

Report Date: 06/18/98

FUGRO

PLATE 98-8.8

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
0.2	1					5.8																					
0.3	2					4.6							2.8														
0.5	3	99	76	29	1.47								3.5		1.1												
0.6	400															2.9											
0.6	401															3.4											
1.1	4	97	88	31	1.16		96		2.70				4.4		1.4												H
1.2	5					4.7							7.2														
1.2	402															6.7											
1.2	403															12.4											
1.8	404															6.7											
1.8	405															8.6											
2.1	6					4.9																					
2.3	7					4.4							8.6														
2.4	8	84	77	30	1.14								10.8		2.0												
2.4	8													2.0													

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

80035STMB(8/12/98/08:50 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
2.4	406															9.6											
2.4	407															10.1											
3.0	9					4.7																					
3.0	408															11.0											
3.0	409															12.0											
3.2	10					4.6							8.8														
3.4	11	85	64	9	1.39		94						11.1		2.2												H
3.7	410															15.8											
3.7	411															15.8											
3.7	412															17.2											
4.0	12					5.1																					
4.1	13					5.3							14.5														
4.3	14	76	74	29	1.03								12.2		2.9												
4.3	413															17.7											
4.3	414															13.9											

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ϕ = Effective Friction Angle

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H = Hydrometer
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CS = Cyclic Simple Shear
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

8003SSM(8/12/98)0:05:50 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
4.9	15					5.2																					
4.9	415															20.1											
4.9	416															21.5											
5.0	16					4.9							15.8														
5.2	17	75	70	28	1.14								13.8		2.4												
5.2	17													3.8													
5.5	417															23.0											
5.5	418															26.3											
5.8	18					4.9																					
5.9	19					4.8							17.9														
6.1	20	79	55	28	1.86		94						16.9														H
6.1	419															28.7											
6.1	420															25.4											
6.7	21					5.9																					
6.7	421															30.6											

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UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

80035SMB(8/12/98/09:50 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
6.7	422															26.3											
6.9	22												14.7		3.2												
7.0	23	57				7.5							15.1														
7.3	423															36.4											
7.6	24					6.7																					
7.8	25					6.0							30.5														
7.9	26	62	66	28	0.91								29.3		6.7												
7.9	26													6.3													
8.5	27					4.8																					
8.7	28					5.7							29.3														
8.8	29	46	67	29	0.47								29.0		8.5												
8.8	29													5.5													
9.2	30	61										18.2	32.6														
9.8	500															26.8											
10.4	32	59	68	29	0.77		100			30.6																	H

Identification Tests
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Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

80035SMB(8/12/98/09:40 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
10.4	501															29.7											
10.4	32	59				5.7											31.2										
10.4	32					6.0												5.5									
10.5	33									28.7			42.9														
11.0	502															33.0											
11.4	35	58	65	29	0.81					24.9																	
11.4	35																										
11.4	35	58				5.6											26.4										
11.4	35					6.1												4.7									
11.6	36									26.8		22.0	30.3														
11.6	503															41.2											
12.3	37	62	65	25	0.92				2.74																		C,RC,CS
12.3	38	61	70	29	0.79								38.9														
13.1	40	51	58	27	0.76																						
13.1	40	51				6.4											29.7										

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
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Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

8003SSMB(0/12/98/0:05 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
13.3	41									33.5			38.9														
14.0	42											34.0															
14.2	43	51	71	24	0.58		100			35.4																	H
14.2	43	51				6.2											42.5										
14.2	43					6.6												4.9									
14.3	44									31.6		32.1	38.4														
15.1	46					6.1																					
15.2	47	48	55	27	0.75					36.4		34.0	38.9														
15.2	504															57.5											
15.8	505															62.2											
16.0	48	51																									
16.9	50	65	65	31	0.98					38.3																	
16.9	50	65				5.8											43.9										
16.9	50					6.2												4.5									
17.1	51									36.4		52.7	51.0														

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

8003SSMB(8/12/98/09:50 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
17.8	53	62				5.2				38.3																	
18.0	54									41.2		30.6	41.9														
18.7	56	57				4.5				36.4																	
18.9	57									43.1		39.3	44.0														
19.5	58	64	84	33	0.61		100																				H
19.5	58					5.4											54.0										
19.7	59	64				5.1																					
19.7	59					5.4												8.2									
19.8	60									47.9		43.6	49.5														
20.3	61	22					12																				
20.4	62	33	60	23	0.26																						
20.4	62					8.5												49.5									
20.6	63											77.1	84.9														
21.3	64	44											136.4														
22.3	65	48				6.7																					

Identification Tests
LL = Liquid Limit
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Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

8003SSMB(8/12/98/08:50 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
22.4	66	48	75	25	0.47	6.7	98																				H
22.4	66					7.0												52.4									
22.6	67										167.6		119.5														
23.2	68					6.3																					
23.2	506															258.6											
23.3	69	53	88	34	0.35						95.8																
23.3	69	53				6.1											102.5										
23.5	70										143.6																
23.8	507															192.0											
24.3	71	55	87	24	0.49				2.71																		C
24.4	72	55	83	34	0.43								176.2														
25.1	73	61																									
26.1	75	56	76	29	0.58		98																				H
26.1	75					6.2												32.6									
26.1	75					6.4											154.2										

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LL = Liquid Limit
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Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

8003SSMB(@12/28/98 5:30 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
26.2	76										143.6		173.8														
27.0	78					6.4					143.6																
27.1	79	59	82	33	0.53						155.6		194.3														
27.9	81	62				6.2																					
28.0	82										172.4		197.9														
28.8	84	55	85	31	0.44						167.6																
28.8	84	55				6.3											149.5										
28.8	84					6.2												35.7									
29.0	85										167.6		194.3														
29.7	87	60				5.8																					
29.9	88										167.6		187.1														
30.6	90	42				7.3					167.6																
30.8	91										174.8																
31.5	93	47	61	25	0.62		92				177.2																H
31.5	93	47				6.6											137.9										

Identification Tests
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Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

B0035SMEB(8/12/98/08:51 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
31.5	93					6.6												36.8									
31.7	94										167.6		176.2														
32.2	95	51				7.7																					
32.3	96												143.6														
33.1	97										167.6		155.7														
33.2	98	56				7.1																					
33.4	99	29									177.2																
34.1	101	57				6.7																					
34.2	103	62																									
35.1	104									119.7	134.1																
35.2	105	55	78	32	0.50																						
35.2	105	55				6.7											133.1										
35.2	105					6.5												31.9									
35.4	106	52								131.7	119.7		193.1														
36.0	107									129.3	143.6																

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
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Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

80035SMB(8/12/98/09:51 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
36.1	108					6.4																					
36.3	109									124.5	129.3		211.2														
39.6	110										134.1																
39.8	111	40	61	25	0.41		86																				H
39.8	111	40				7.5											135.2										
39.8	111					6.8												87.6									
39.9	112										155.6		217.2														
43.5	113	56	75	30	0.57				2.73																		C
43.6	114	58											193.1														
44.3	116	57	78	33	0.54																						
44.3	116	57				6.4											150.3										
44.3	116					6.5												36.9									
44.5	117												182.2														
48.0	119	46	61	23	0.59		98																				H
48.0	119	46				7.3											138.5										

Identification Tests
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UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

0003SSMB/8/12/98/08:51 AM

Earth Mechanics

FUGRO

98-8

DEPTH (m)	Sample No.	IDENTIFICATION TESTS: Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	STRENGTH ESTIMATE (kPa): Torvane	Pocket Pen.	Fall Cone	MINIATURE VANE TESTS (kPa): Undist.	Remold.	Resid.	REMOTE VANE (kPa)	UU TRIAXIAL (kPa): Undist.	Remold.	MULTI-STAGE TRIAXIAL: c (kPa)	ϕ (deg.)	DIRECT SHEAR TESTS: Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	q_u TESTS (MPa): UC	Point Load Test	ADDITIONAL TESTS
48.0	119					7.2												44.8									
48.2	120											147.5	154.5														
48.2	508															179.1											
50.6	121	47	43	20	1.18	8.2																					
50.9	123											117.3	149.7														
54.1	124	31																									
54.4	125					8.7																					
55.2	127	36																									
58.5	128										129.3																
58.5	128	42				8.4											120.5										
58.7	129	28				8.6																					
61.0	131	22				9.8	8																				
63.6	132	26					9																				
66.9	133	23					9		2.69																		
70.7	134	20					49																				

Identification Tests
LL = Liquid Limit
PL = Plastic Limit
LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
K = Ko Consolidated Triaxial Test

SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

80035SMB(8/12/97/09:51 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
75.9	135	21	37	15	0.27																						C
76.0	136	21	32	14	0.39				2.70		177.2																
76.0	136	21				10.4											154.9										
76.0	136					10.0												85.8									
76.2	137										148.4																
79.7	139					9.0																					
79.9	140	26					90				215.5		207.6														
81.5	141	20				10.4					175.2																
81.7	142										203.5																
82.5	143	26				10.3	63																				
83.9	144					12.6	21																				
86.0	149																									74.7	
86.1	148a																									32.0	
86.6	148b																									59.5	
90.2	151a																									3.2	

Identification Tests
LL = Liquid Limit
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LI = Liquidity Index
Fines = % Passing No. 200 Sieve

Strength Tests
UU = Unconsolidated Undrained
UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
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SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

PLATE 98-8.9m

80035SMB(8/12/98/7/09:51 AM)

Earth Mechanics

FUGRO

98-8		IDENTIFICATION TESTS								STRENGTH ESTIMATE (kPa)			MINIATURE VANE TESTS (kPa)			REMOTE VANE (kPa)	UU TRIAXIAL (kPa)		MULTI-STAGE TRIAXIAL		DIRECT SHEAR TESTS				q_u TESTS (MPa)		ADDITIONAL TESTS
DEPTH (m)	Sample No.	Moist. Content (%)	LL (%)	PL (%)	LI	Submg. Unit Weight (kN/m³)	Fines (%)	Organic Content (%)	Specific Gravity	Torvane	Pocket Pen.	Fall Cone	Undist.	Remold.	Resid.		Undist.	Remold.	c (kPa)	ϕ (deg.)	Peak c (kPa)	Peak ϕ (deg.)	Post Peak c (kPa)	Post Peak ϕ (deg.)	UC	Point Load Test	
90.2	151b																									10.1	
90.5	151c																									65.8	
91.7	152a																									3.4	
93.3	152b																									19.8	
94.8	152c																									55.3	
96.0	153b																									42.8	
96.0	153e																									45.2	
96.0	153d																									53.5	
112.8	164																									24.6	

Identification Tests
LL = Liquid Limit
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Fines = % Passing No. 200 Sieve

Strength Tests
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UC = Unconfined Compression
c = Effective Cohesion
ϕ = Effective Friction Angle

Additional Tests
H = Hydrometer
C = Consolidation Test
RC = Resonant Column
CS = Cyclic Simple Shear
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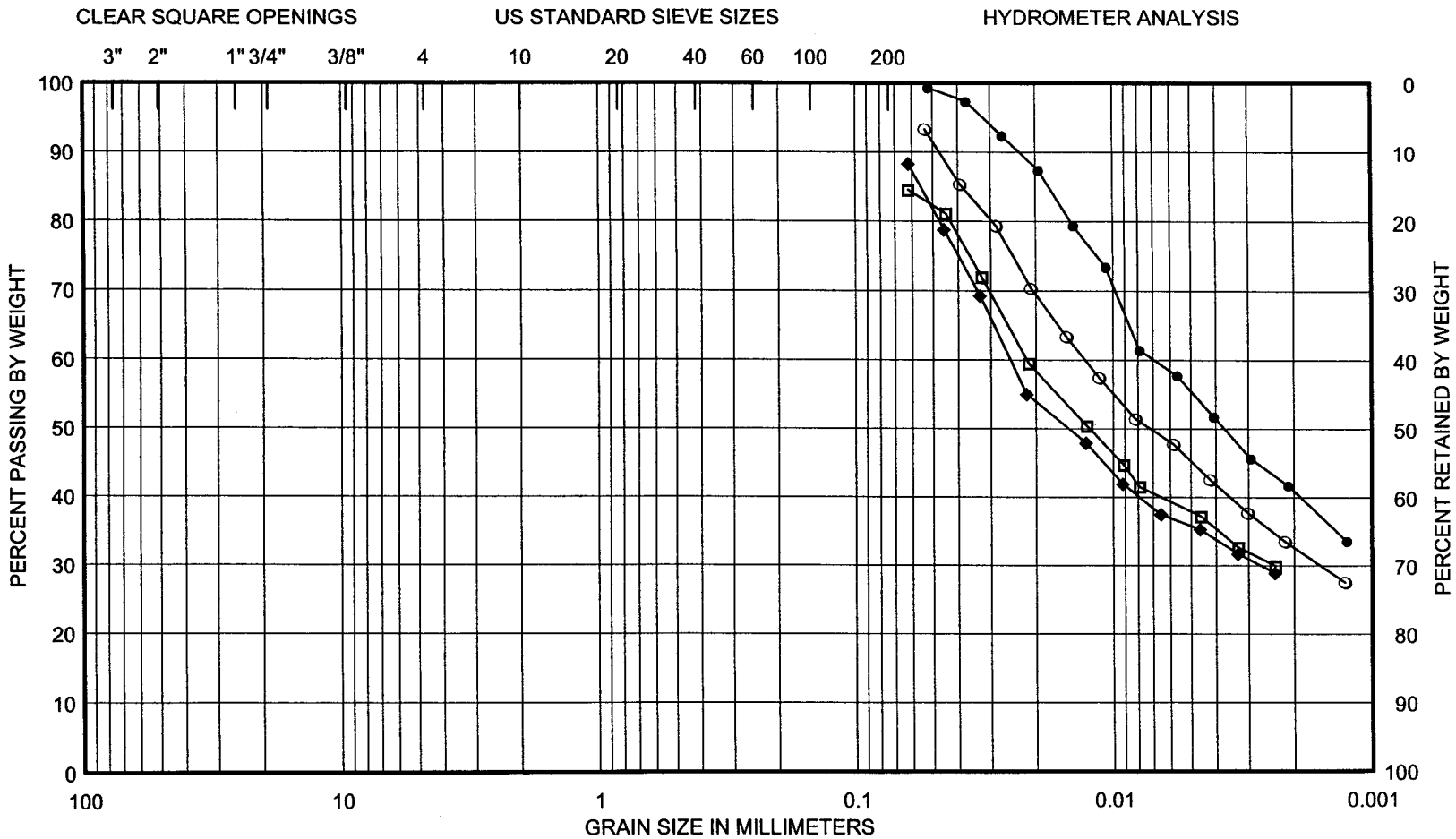
SUMMARY OF LABORATORY TEST RESULTS
BORING 98-8
SFOBB East Span Seismic Safety Project

00035SMB(8/12/98/08:57 AM)



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
4	1.1		FAT CLAY (CH)
11	3.4		FAT CLAY (CH)
20	6.1		FAT CLAY (CH)
32	10.4		FAT CLAY (CH)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-8

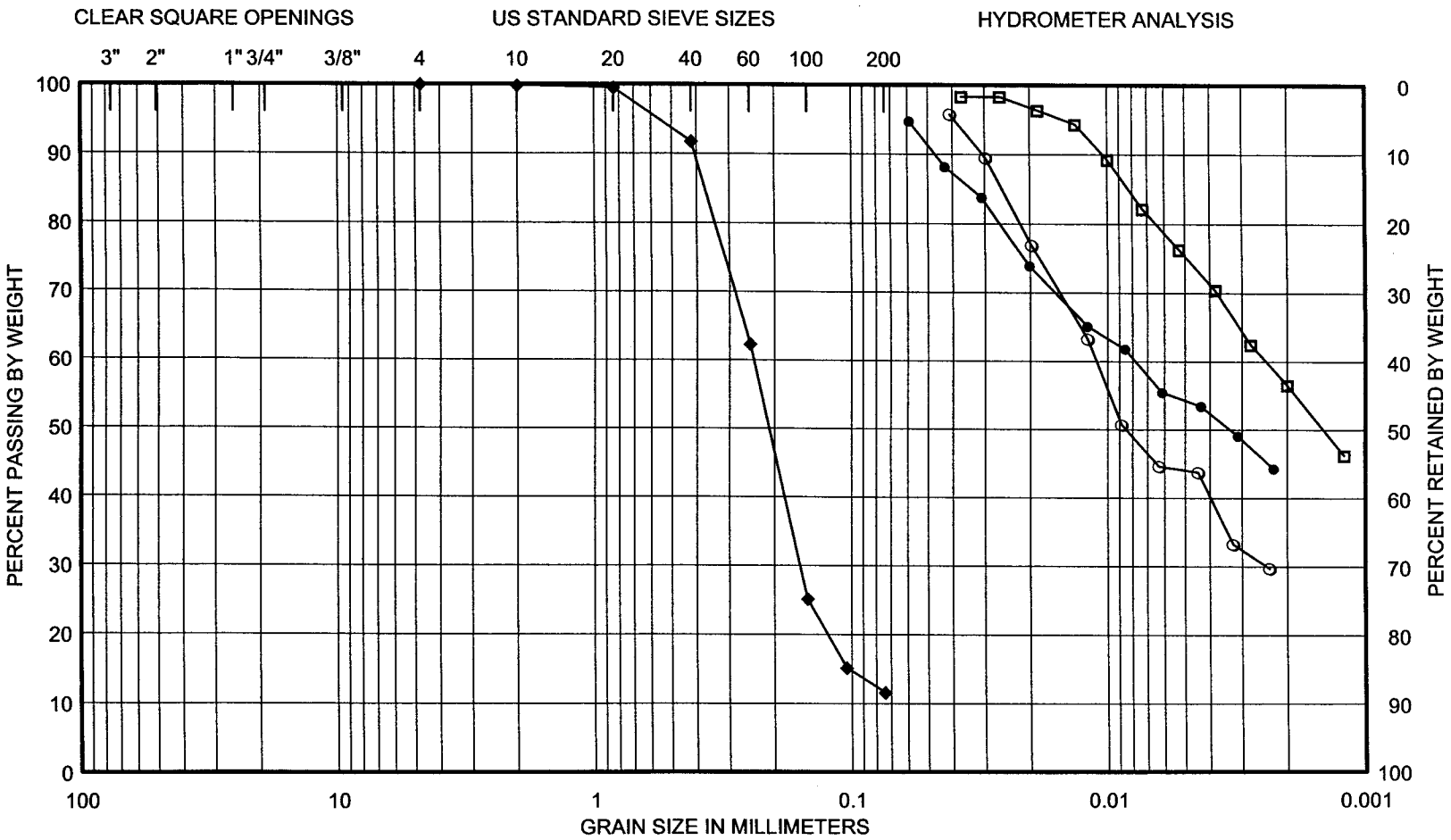
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-8.10a



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
43	14.2	○—○	FAT CLAY (CH)
58	19.5	□—□	FAT CLAY (CH)
61	20.3	◆—◆	FINE SAND (SP-SM) with silt
66	22.4	●—●	FAT CLAY (CH)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-8

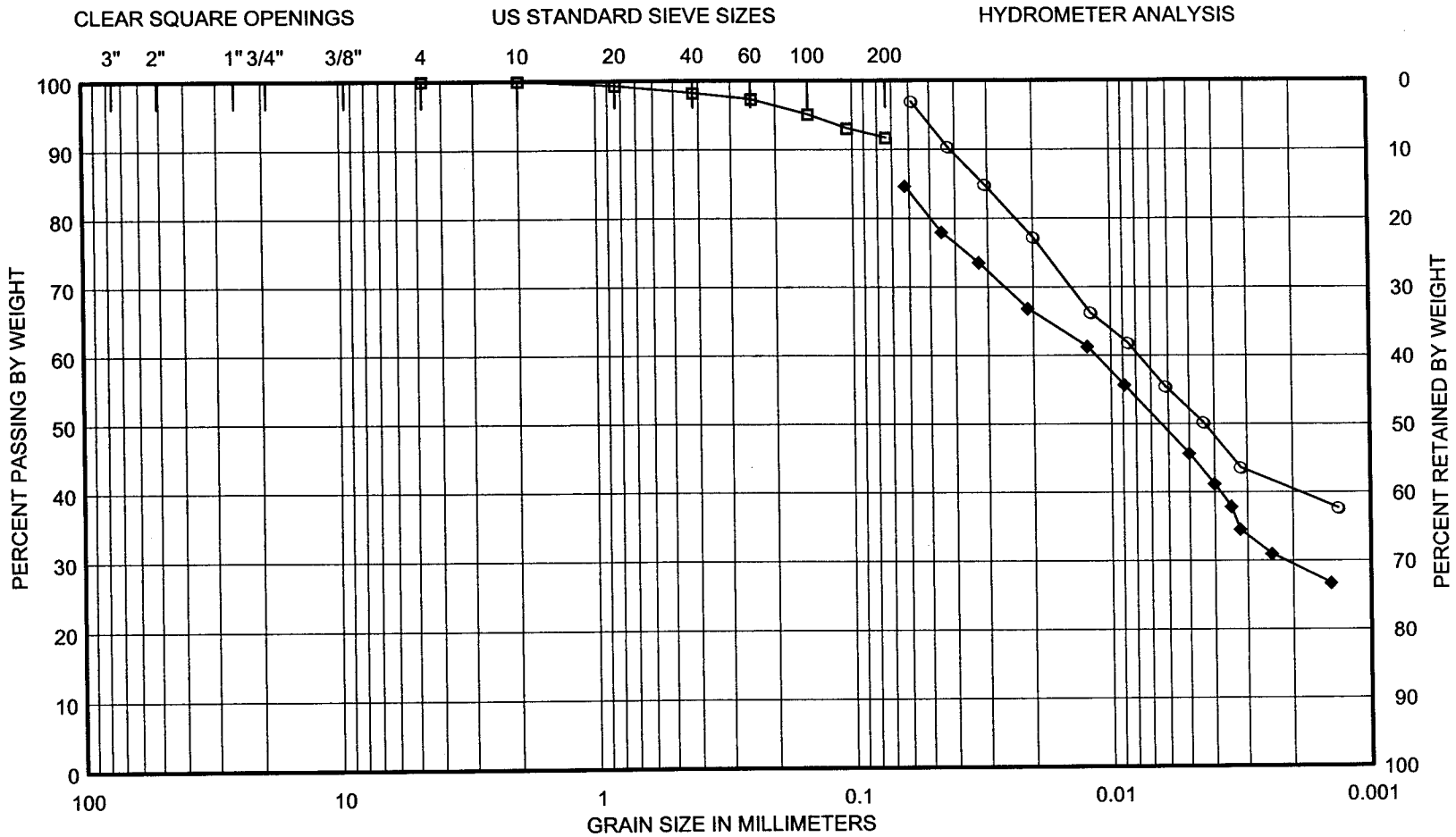
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-8.10b



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
75	26.1	○—○	FAT CLAY (CH)
93	31.5	□—□	FAT CLAY (CH)
93	31.5	◆—◆	FAT CLAY (CH)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-8

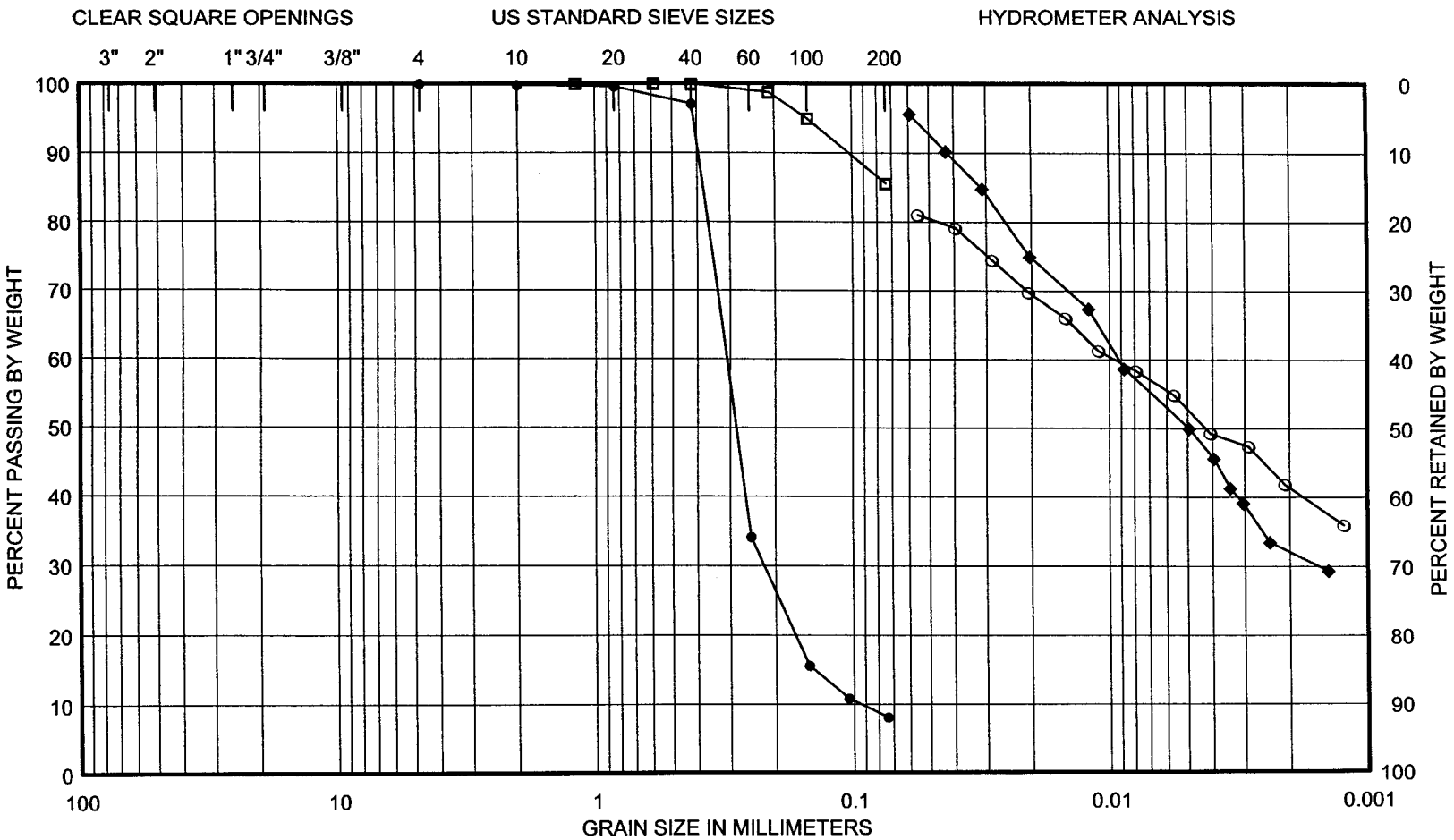
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-8.10c



GRAVEL		SAND			SILT (nonplastic)
COARSE	FINE	COARSE	MEDIUM	FINE	to CLAY (plastic)

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
111	39.8	○—○	FAT CLAY (CH)
111	39.8	□—□	FAT CLAY (CH)
119	48.0	◆—◆	FAT CLAY (CH)
131	61.0	●—●	FINE SAND (SP-SM) with silt

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-8

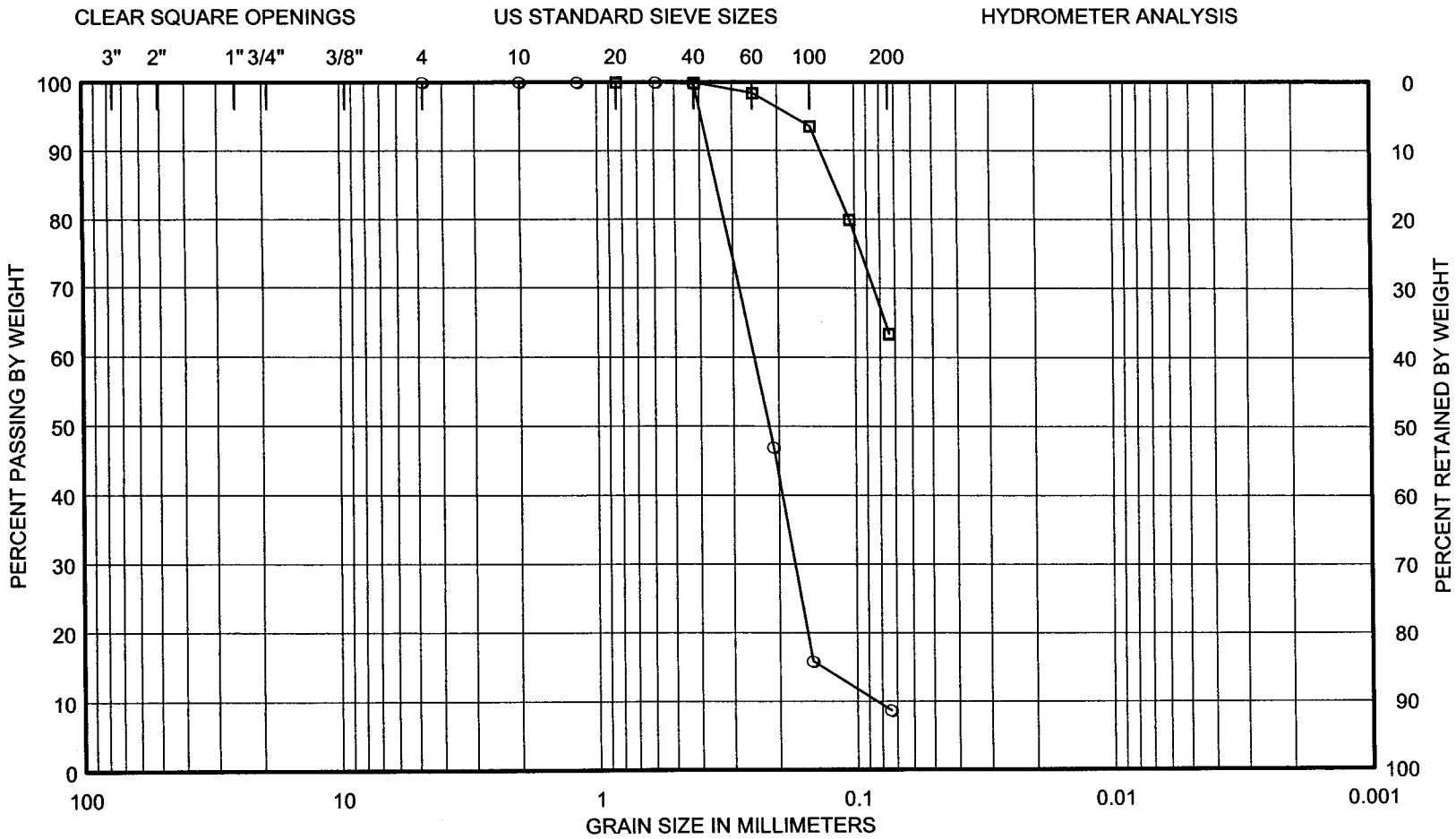
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

Earth Mechanics

FUGRO

PLATE 98-8.10d



GRAVEL		SAND			SILT (nonplastic) to CLAY (plastic)
COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	DEPTH (m)	CURVE	CLASSIFICATION
133	66.9	○——○	FINE SAND (SP-SM) with silt
143	82.5	□——□	SANDY SILT (ML)

GRAIN SIZE DISTRIBUTION CURVES

Boring 98-8

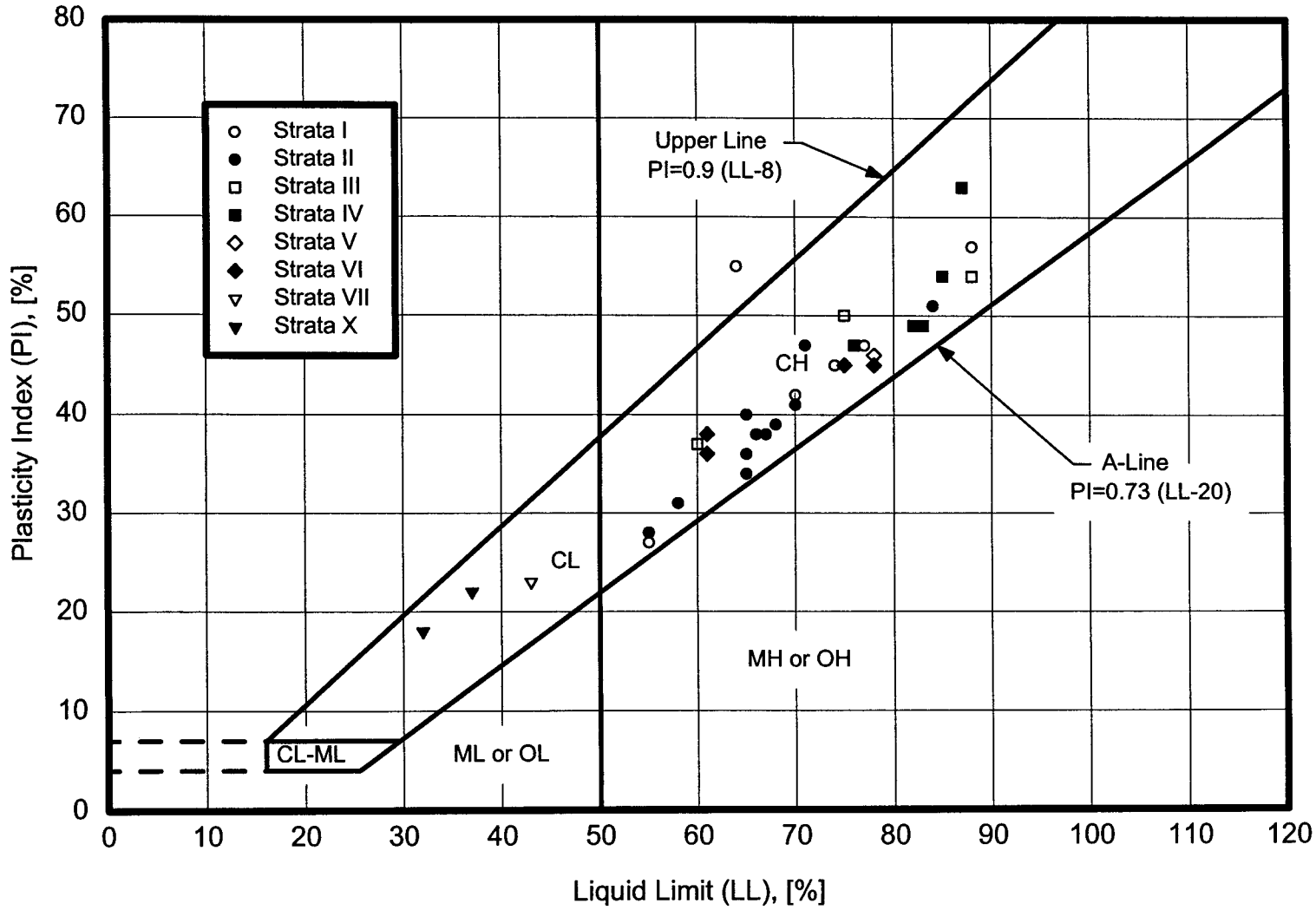
SFOBB - East Span Seismic Safety Project

SFOBB Task Order No. 5
Project No. 98-42-0054

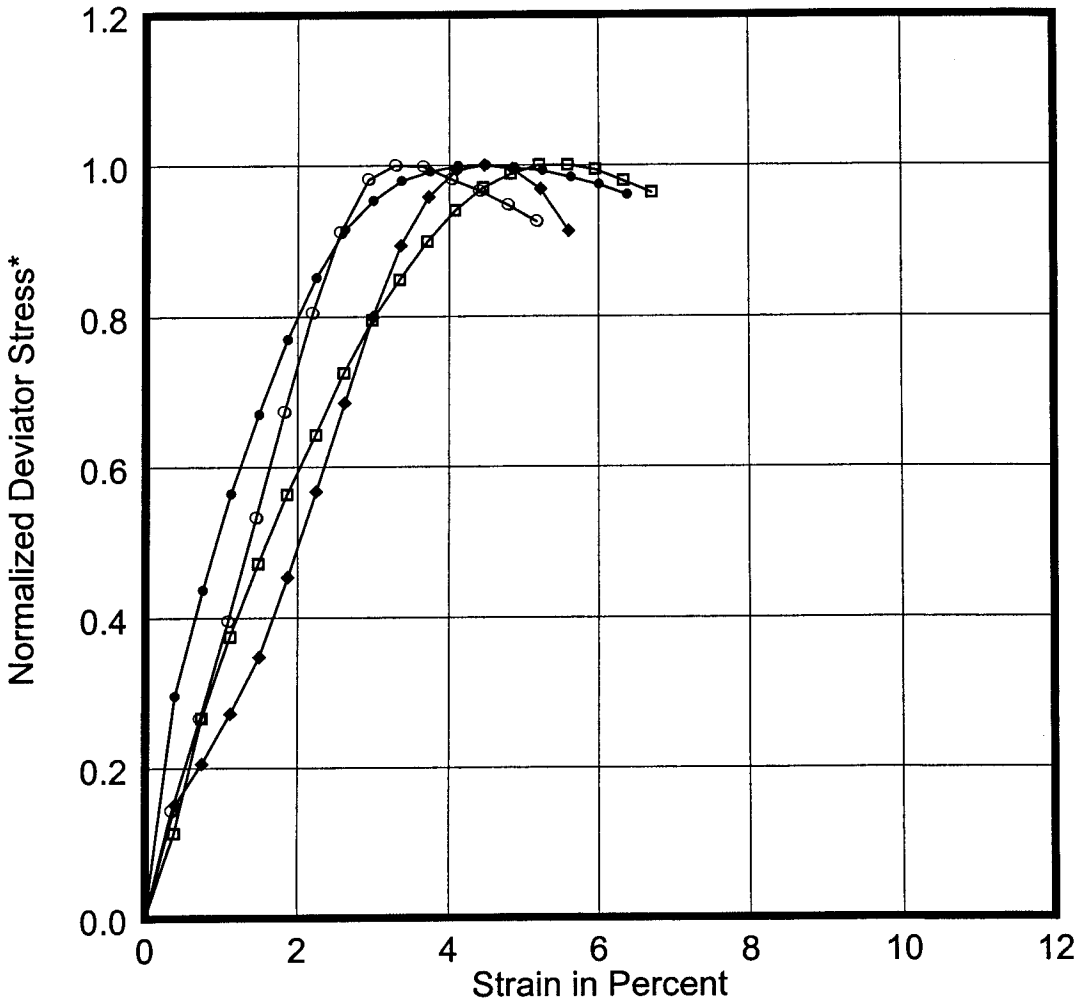
Earth Mechanics

FUGRO

PLATE 98-8.10e



PLASTICITY CHART
Boring 98-8
SFOBB East Span Seismic Safety Project

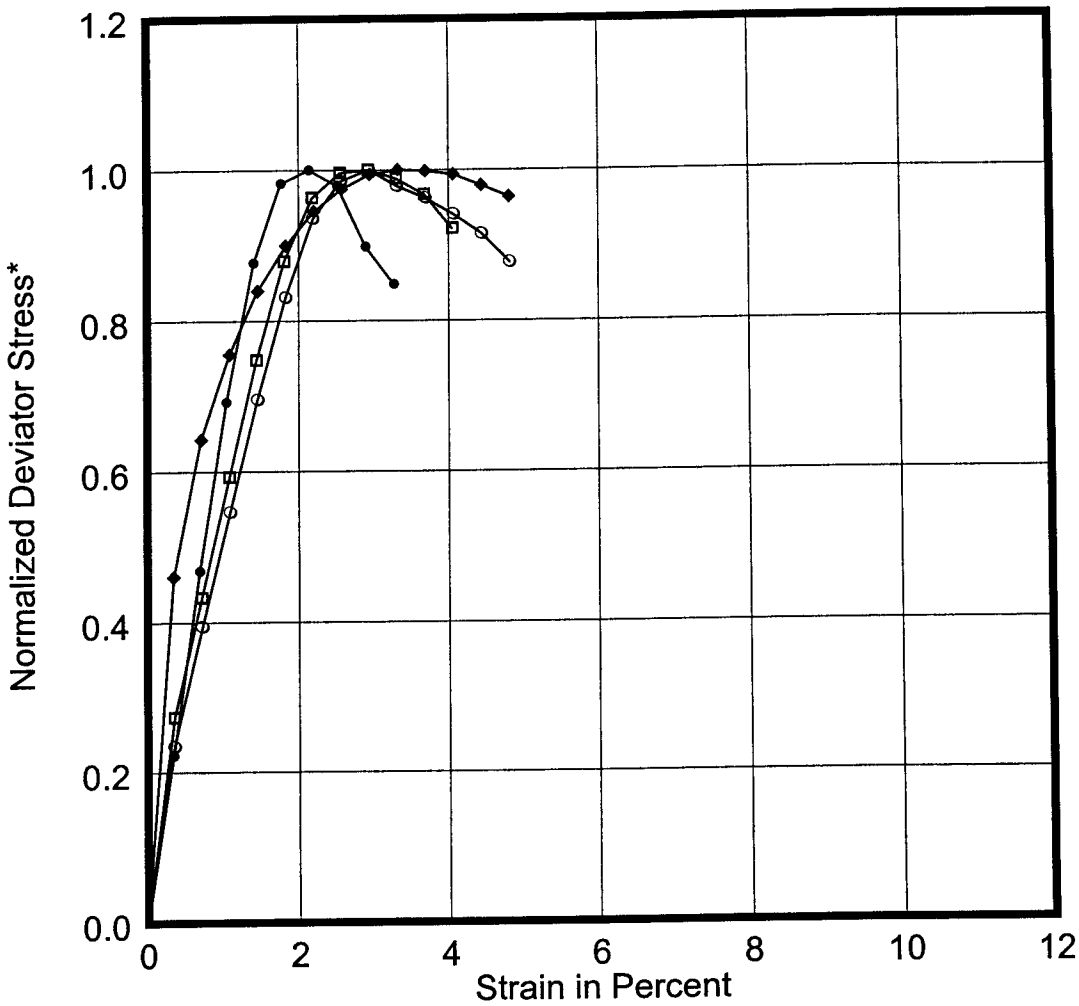


Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	32	10.4	UU	241	62	1.4
□——□	35	11.4	UU	276	53	1.6
◆——◆	40	13.1	UU	310	59	2.0
●——●	43	14.2	UU	310	85	0.9

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-8
SFOBB - East Span Seismic Safety Project

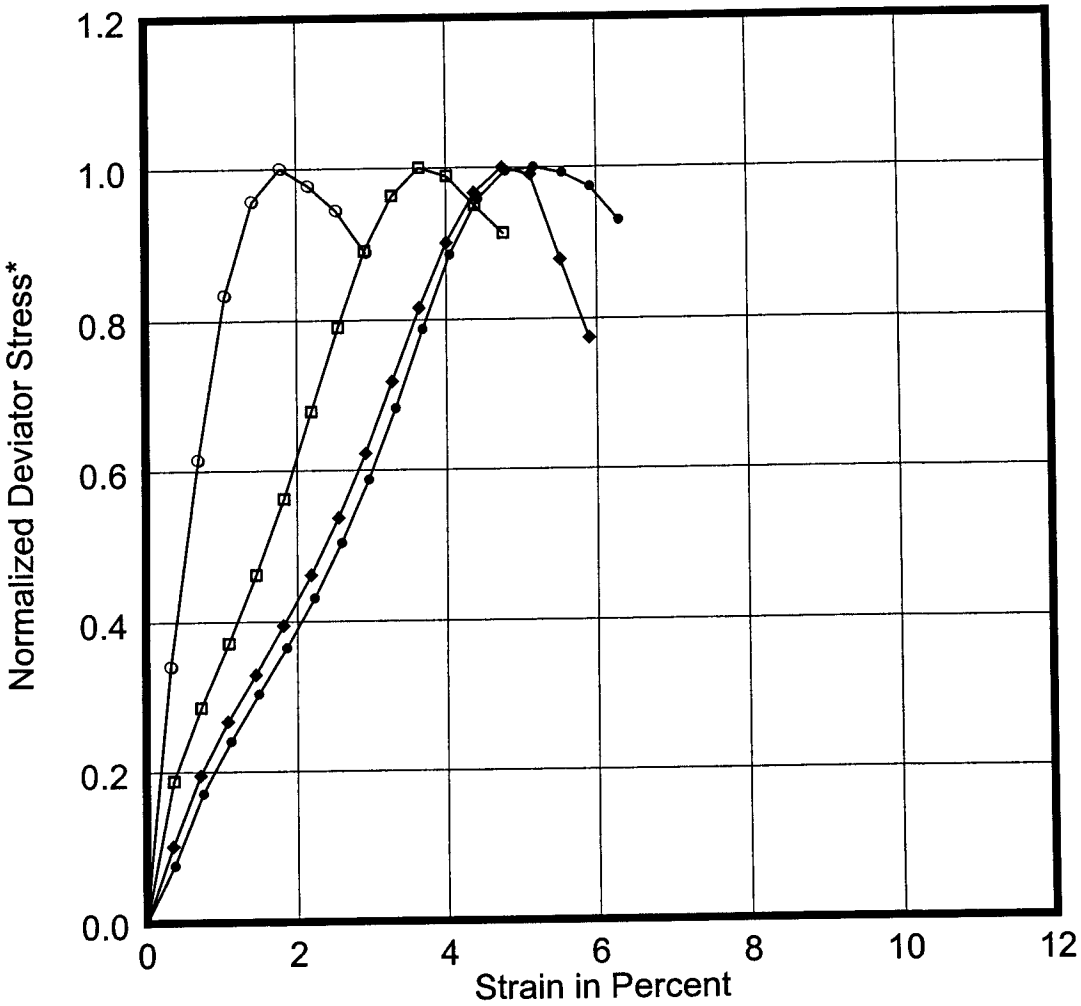


Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	50	16.9	UU	379	88	1.0
□——□	58	19.5	UU	448	108	0.9
◆——◆	69	23.3	UU	827	205	0.4
●——●	75	26.1	UU	1724	308	0.7

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-8
SFOBB - East Span Seismic Safety Project

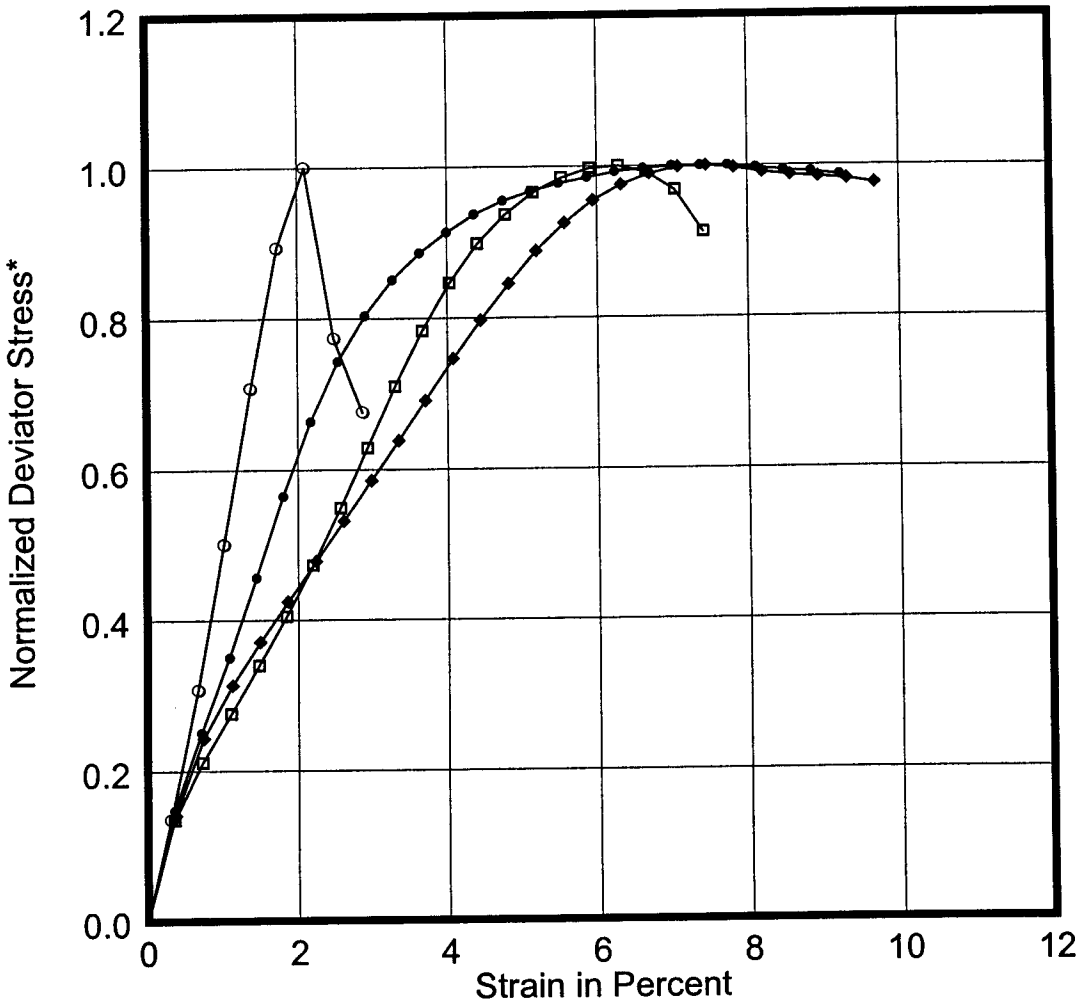


Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	84	28.8	UU	1724	299	0.5
□——□	93	31.5	UU	1724	276	1.6
◆——◆	105	35.2	UU	827	266	2.4
●——●	111	39.8	UU	896	270	2.6

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-8
SFOBB - East Span Seismic Safety Project

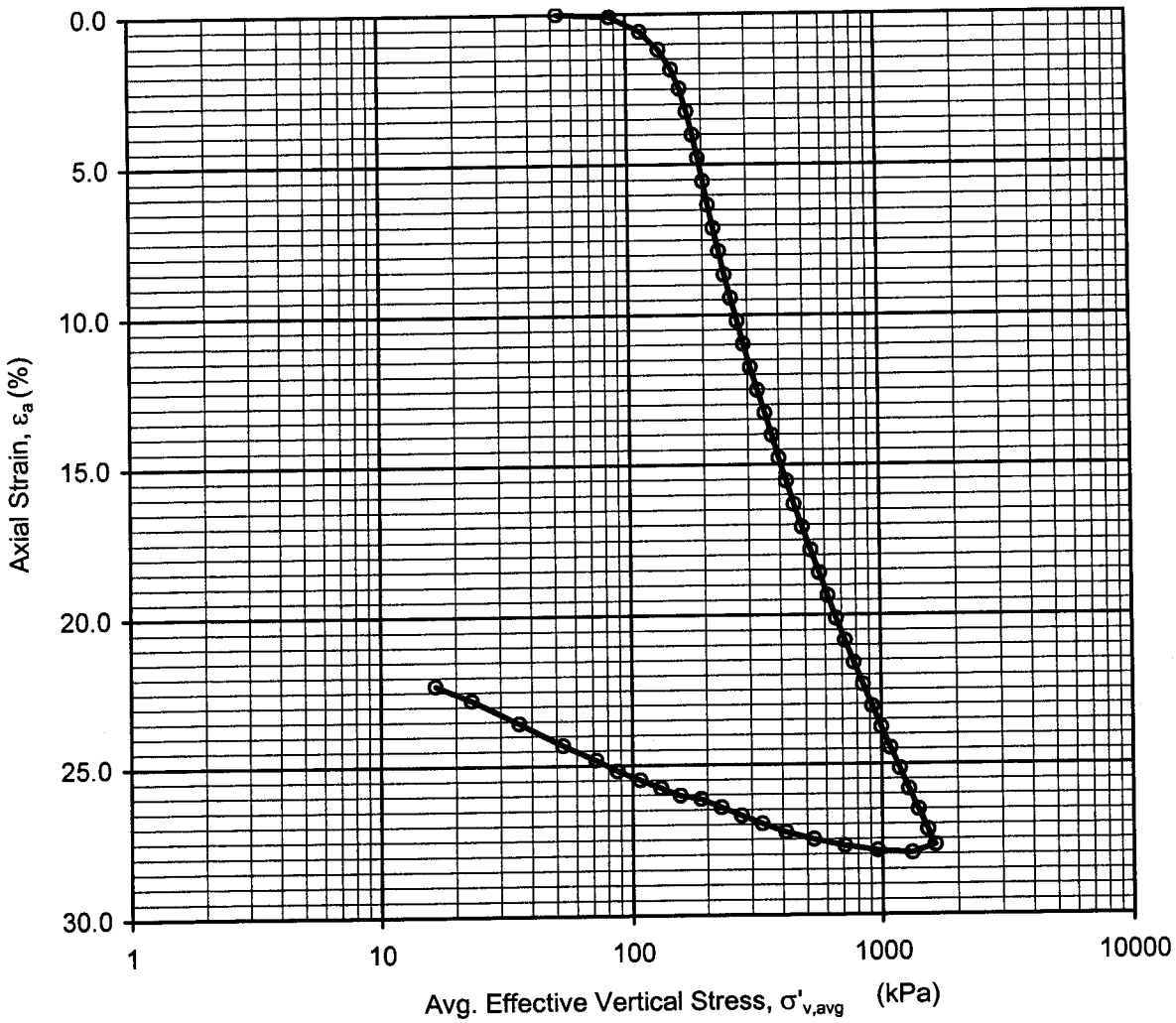


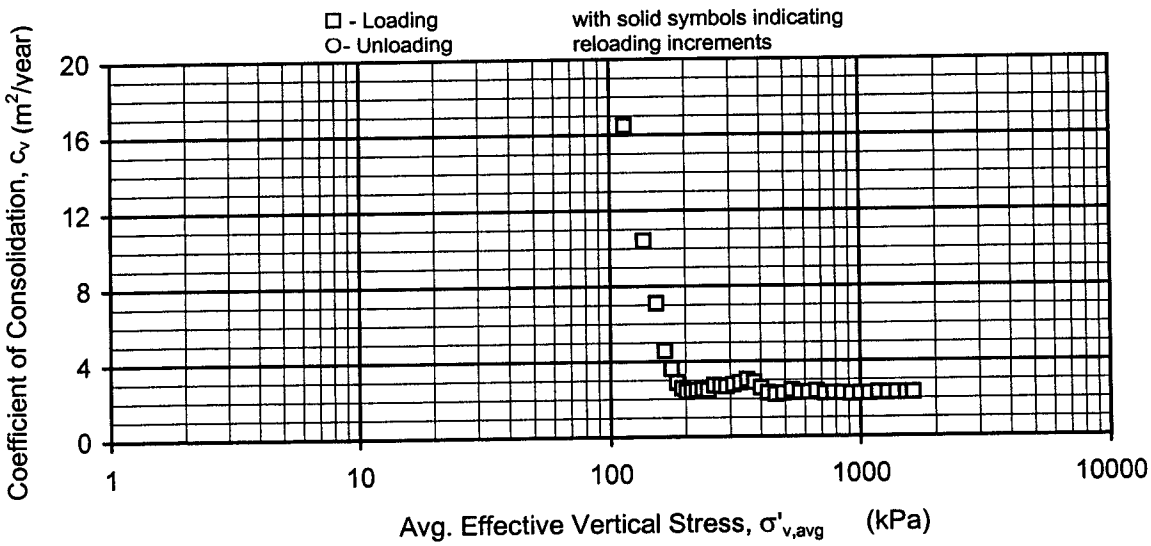
Curve	Sample No.	Depth [m]	Test Type	Confining Pressure [kPa]	Maximum Deviator Stress [kPa]	ε50 [%]
○——○	116	44.3	UU	1000	301	1.0
□——□	119	48.0	UU	1103	277	2.3
◆——◆	128	58.5	UU	1310	241	2.4
●——●	136	76.0	UU	1724	310	1.6

* Normalized with respect to maximum deviator stress.

STRESS-STRAIN CURVES
Unconsolidated-Undrained Triaxial Compression Test

Boring 98-8
SFOBB - East Span Seismic Safety Project

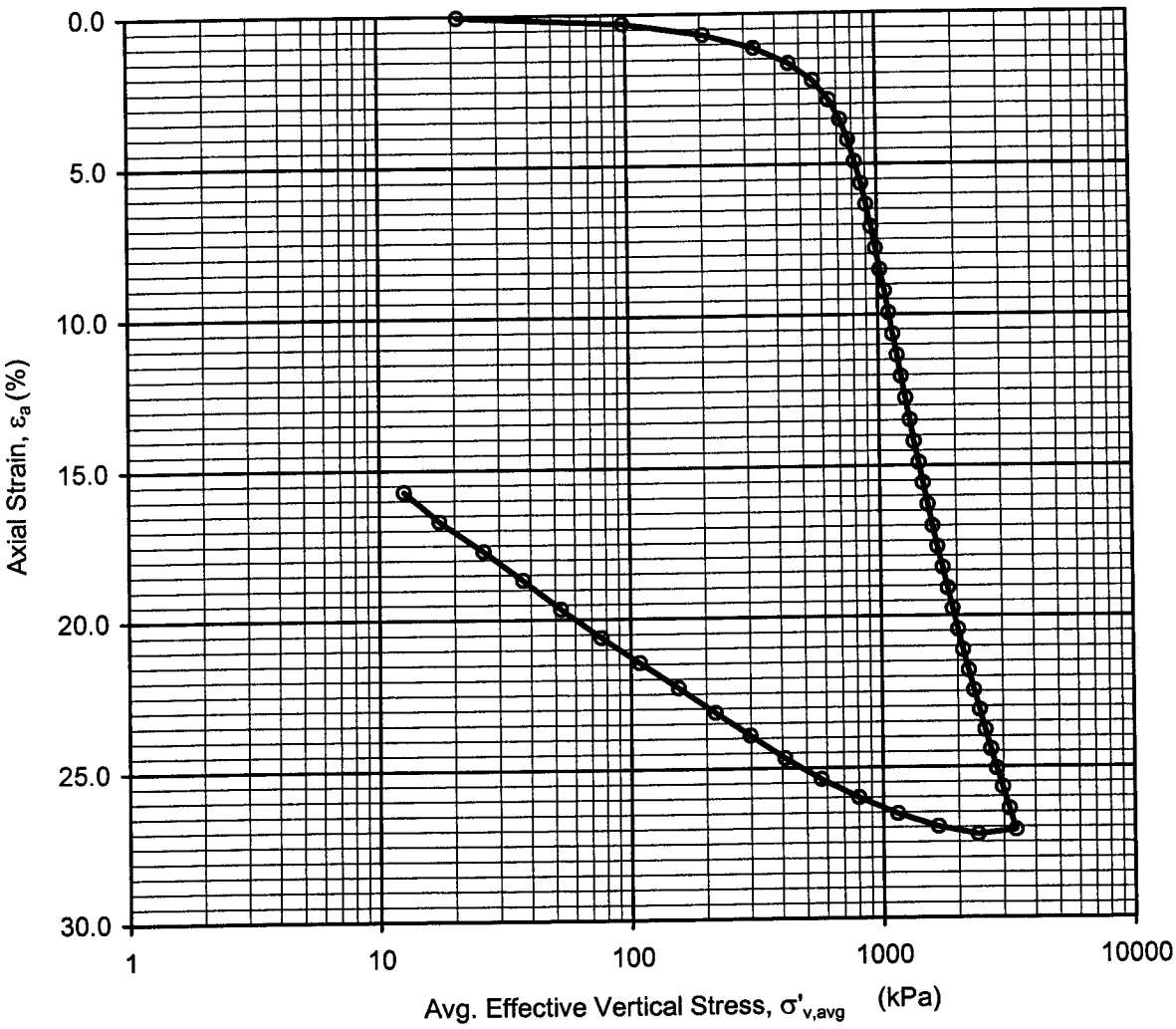


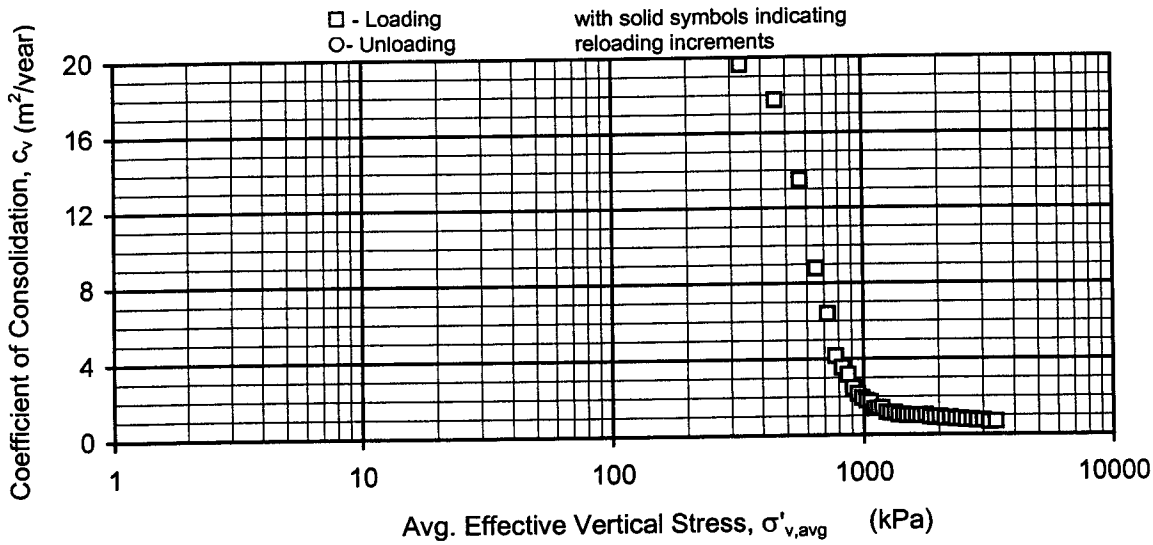


CRS CONSOLIDATION TEST RESULTS

Sample No. 37 - Penetration: 12.2 m
Boring 98-8
SFOBB East Span Seismic Safety Project

PLATE 98-8.13a

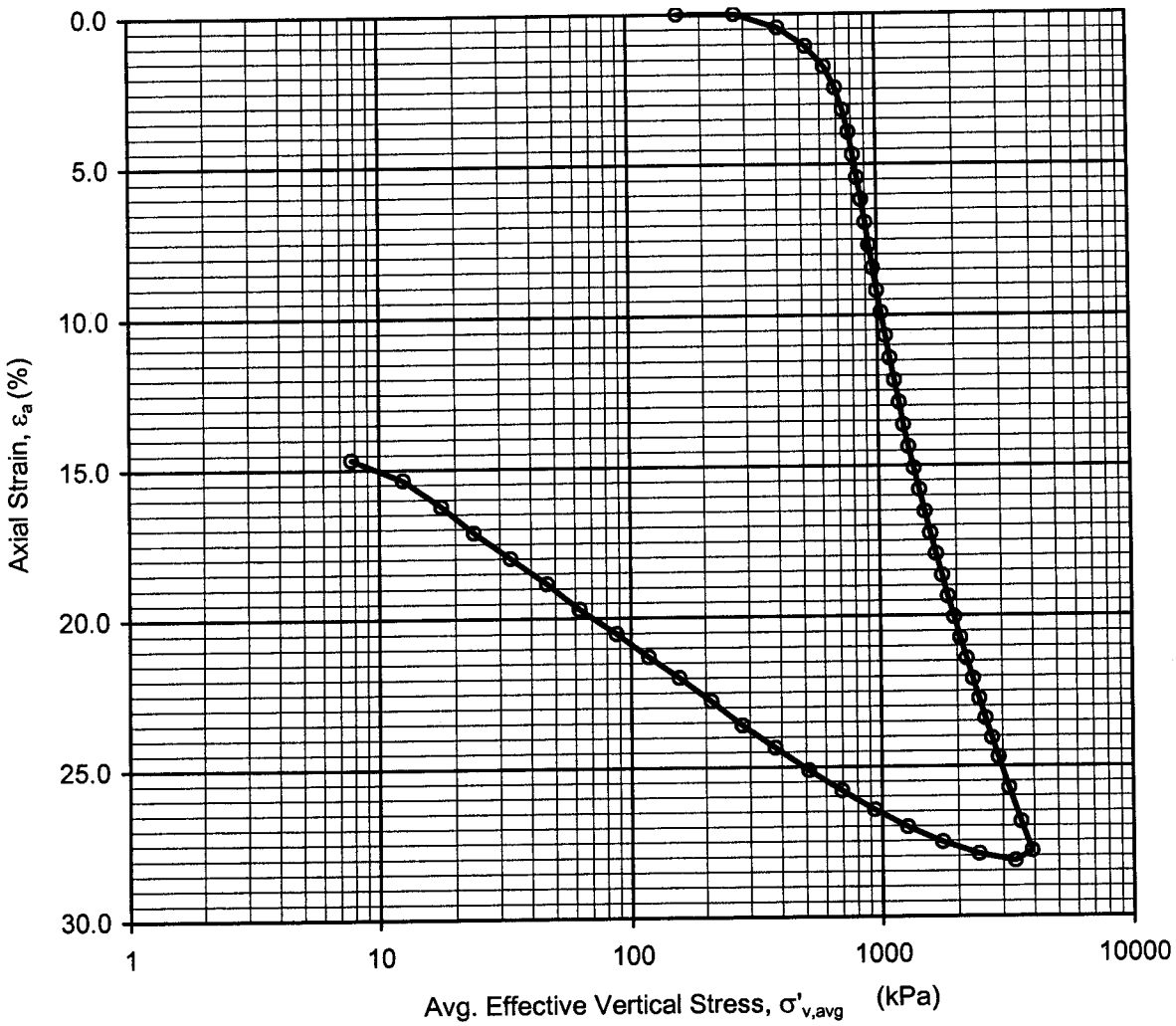


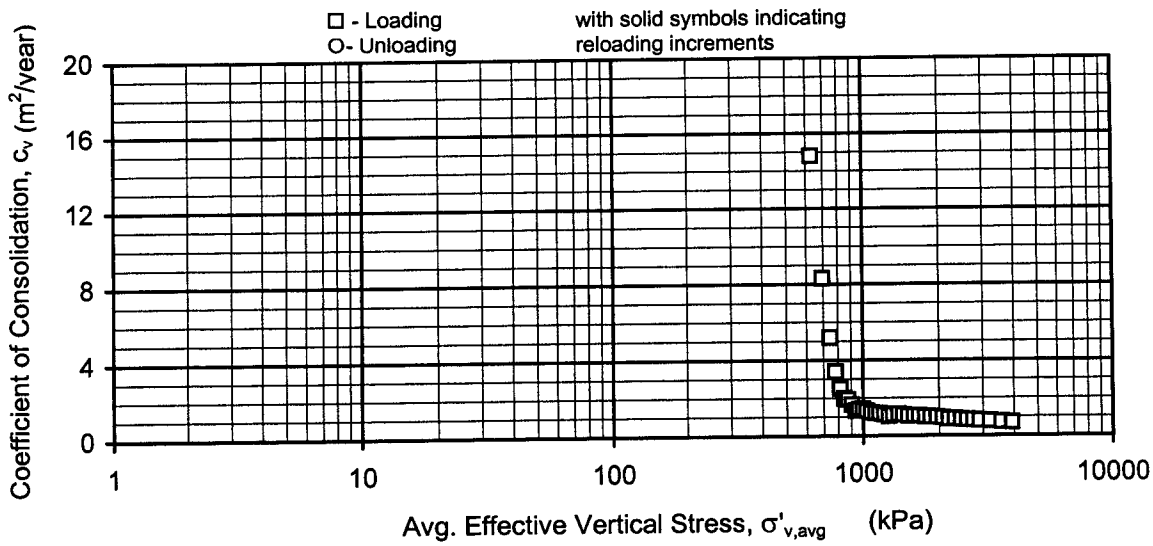


CRS CONSOLIDATION TEST RESULTS

Sample No. 71 - Penetration: 24.3 m
Boring 98-8
SFOBB East Span Seismic Safety Project

PLATE 98-8.13b

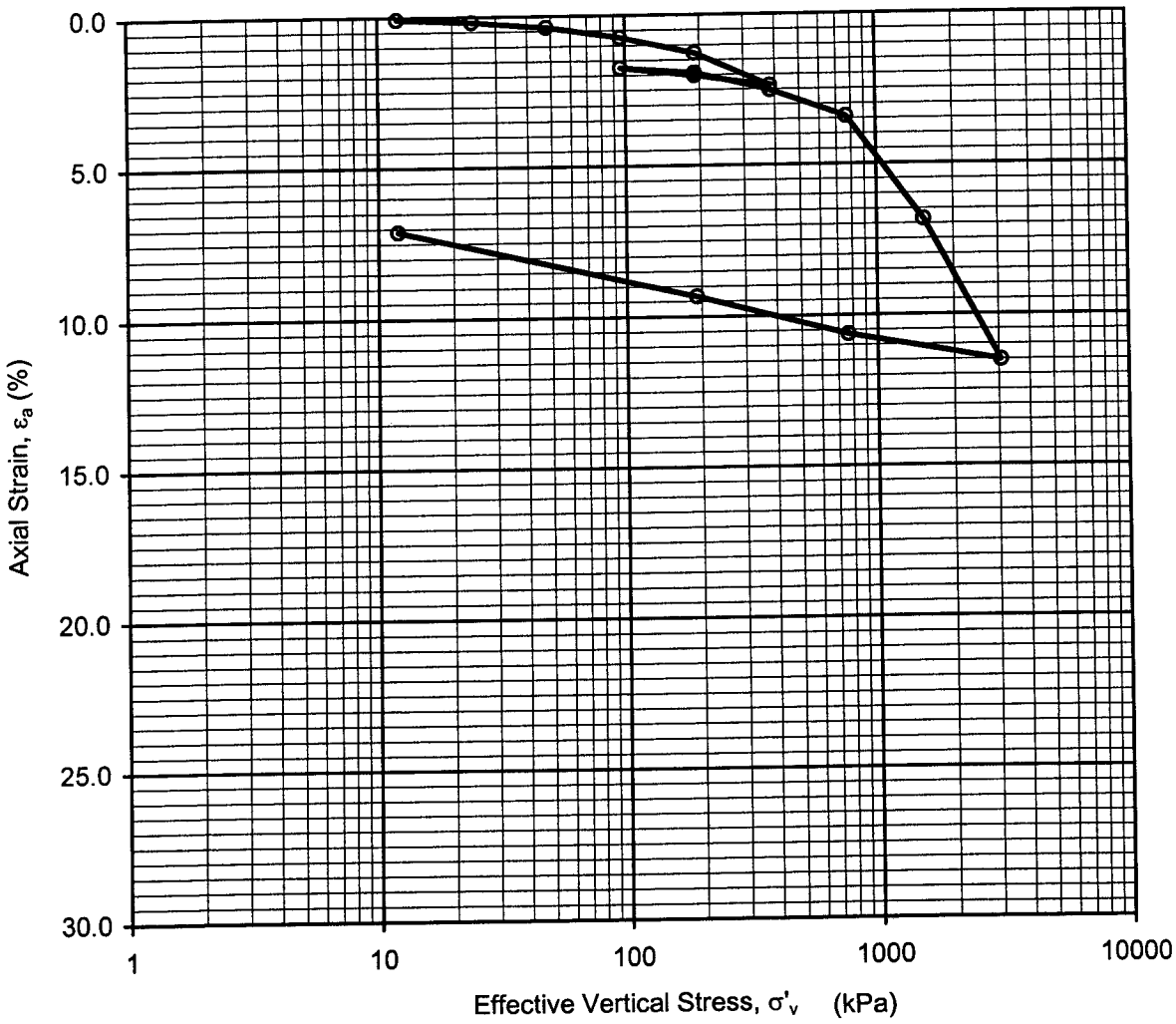


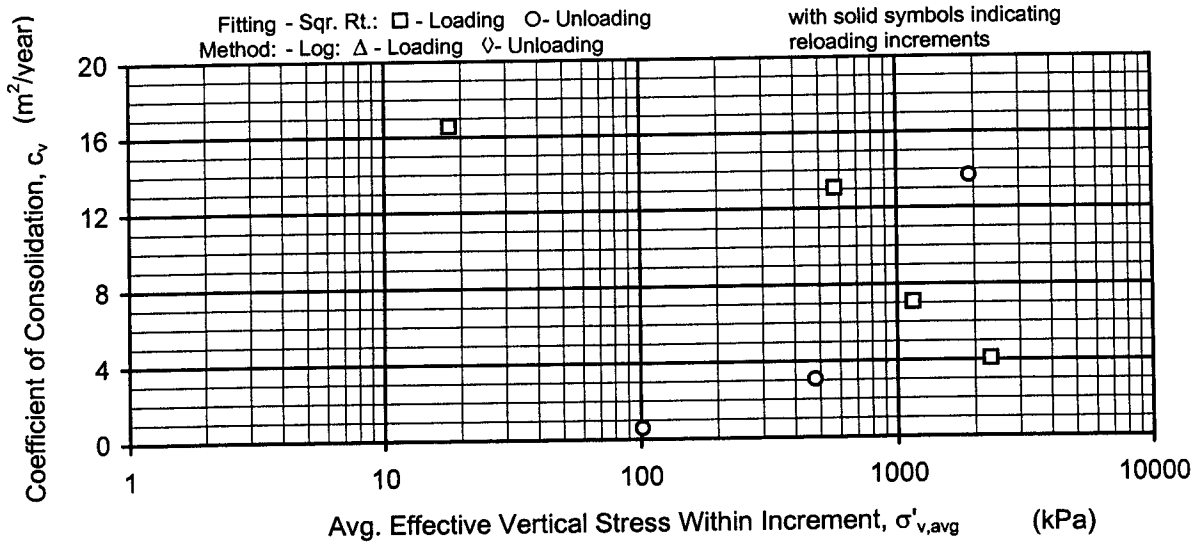


CRS CONSOLIDATION TEST RESULTS

Sample No. 113 - Penetration: 43.5 m
Boring 98-8
SFOBB East Span Seismic Safety Project

PLATE 98-8.13c

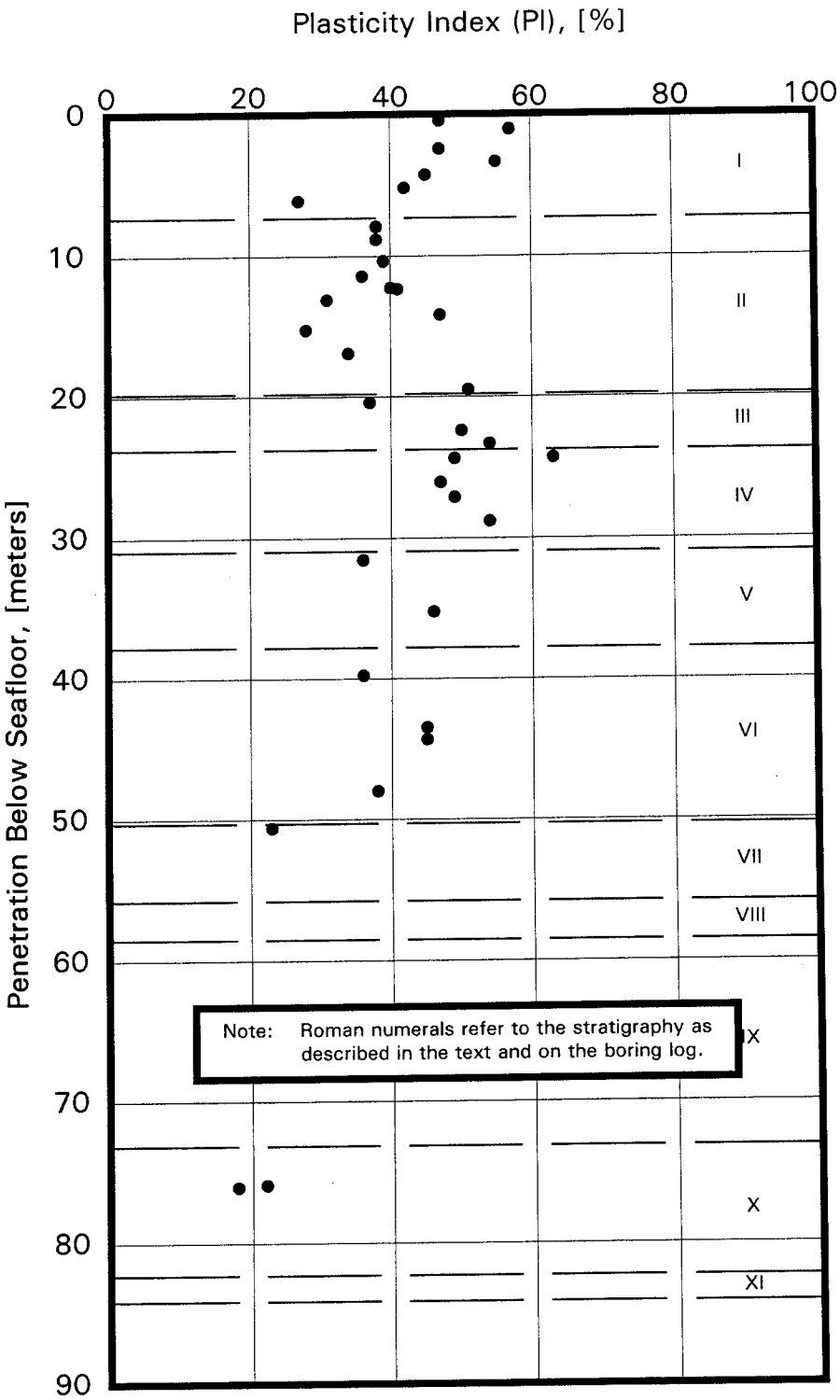




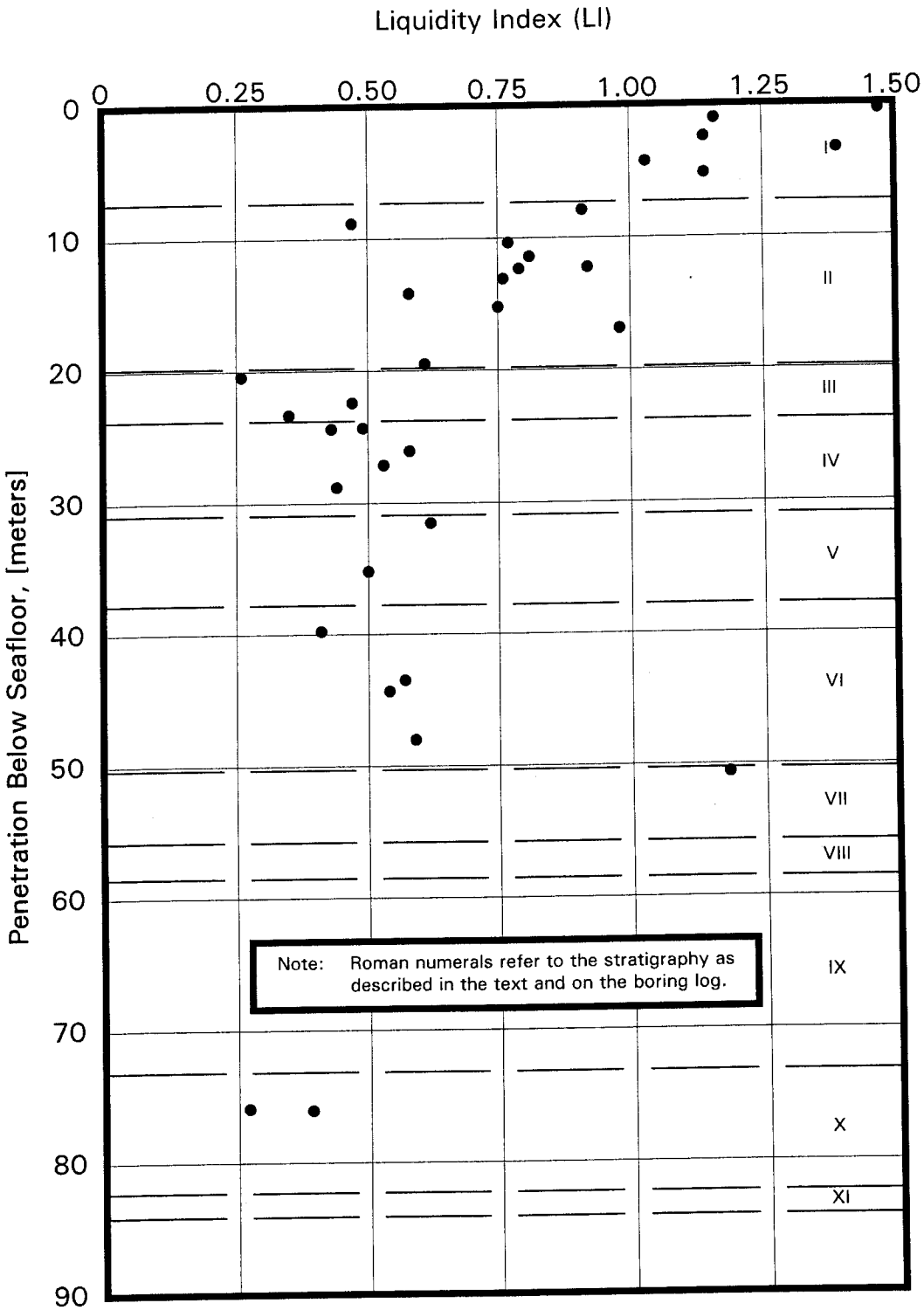
INCREMENTAL CONSOLIDATION TEST RESULTS

Sample No. 135 - Penetration: 75.9 m
Boring 98-8
SFOBB East Span Seismic Safety Project

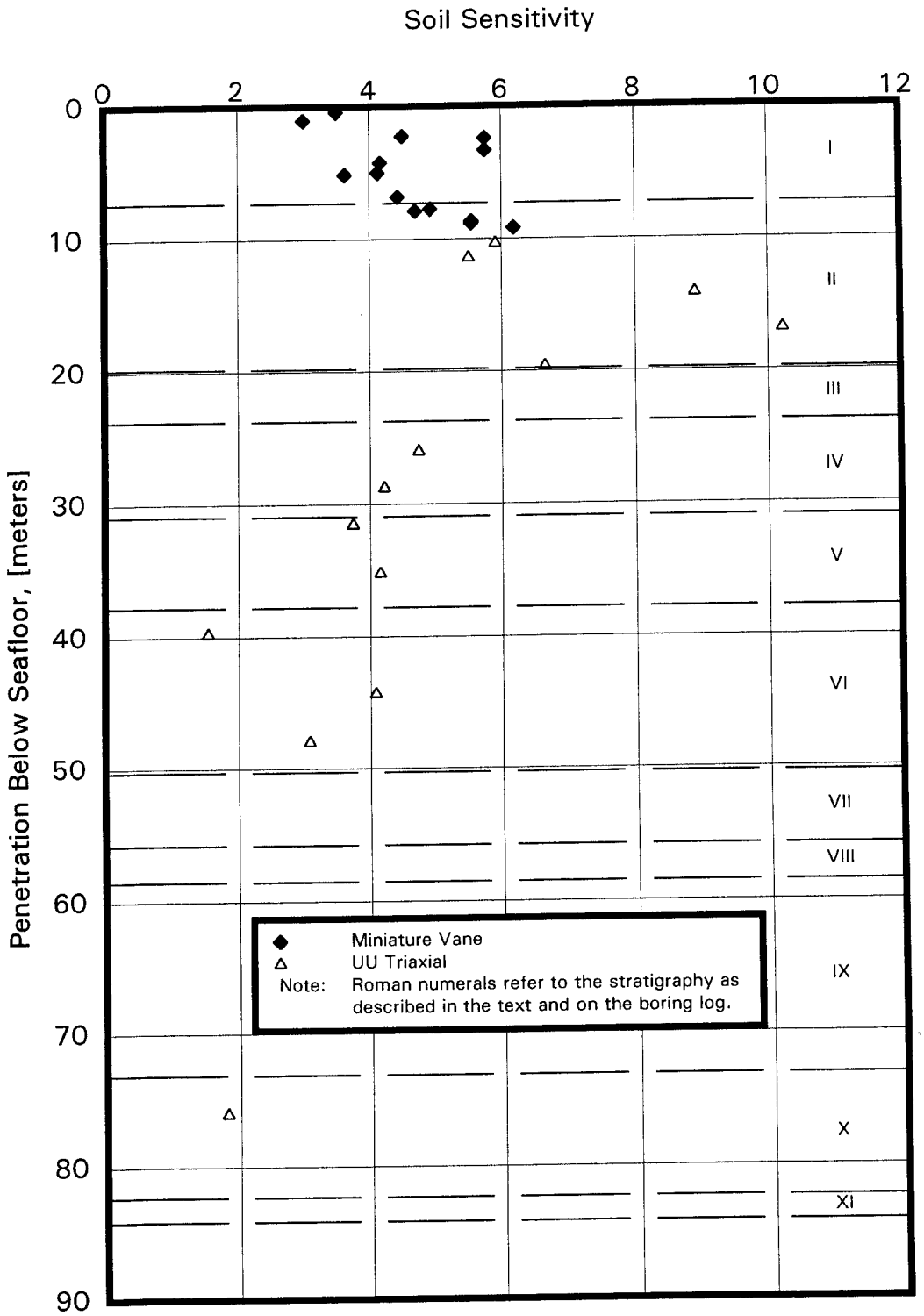
PLATE 98-8.13d



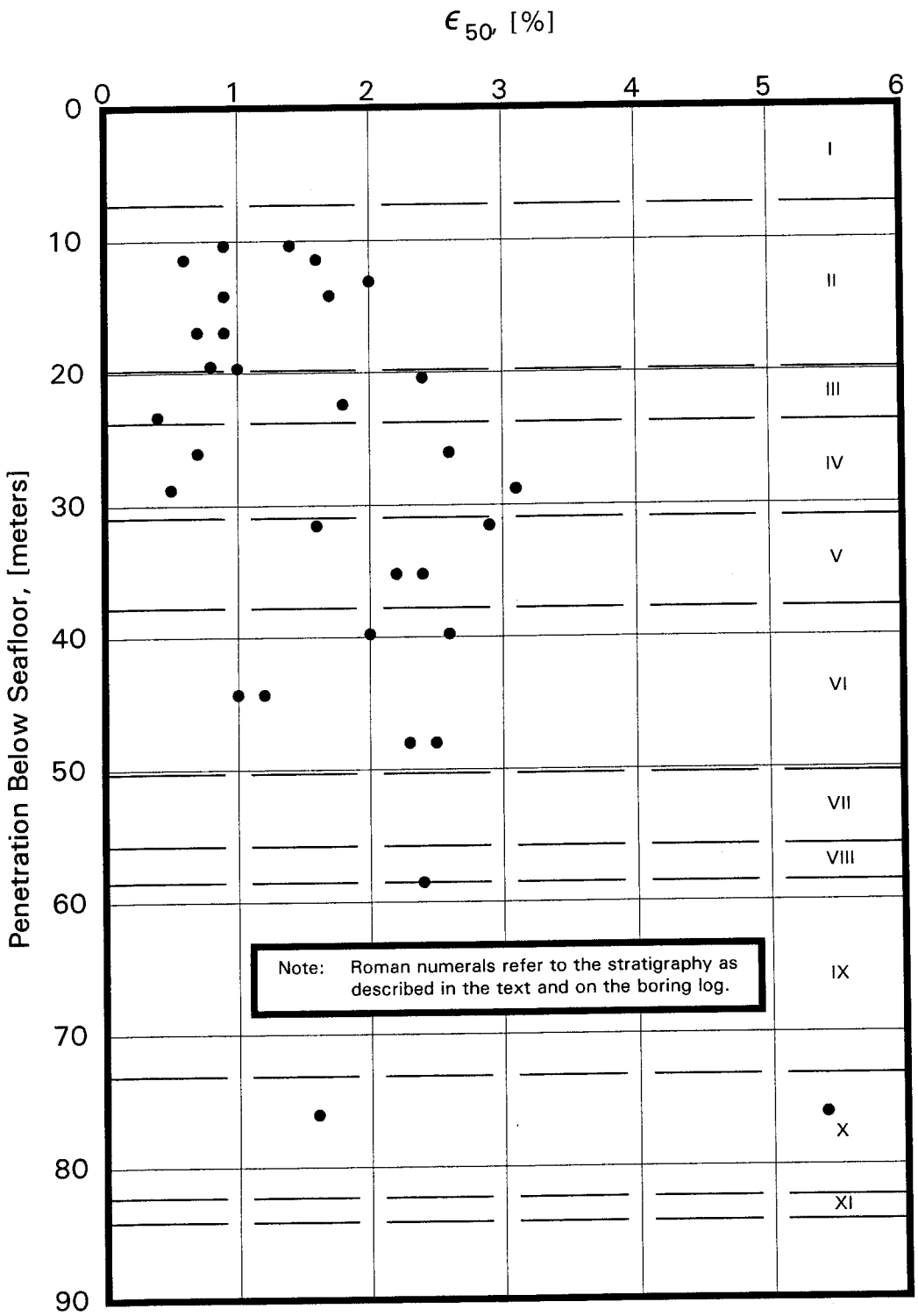
PLASTICITY INDEX PROFILE
Boring 98-8
SFOBB East Span Seismic Safety Project



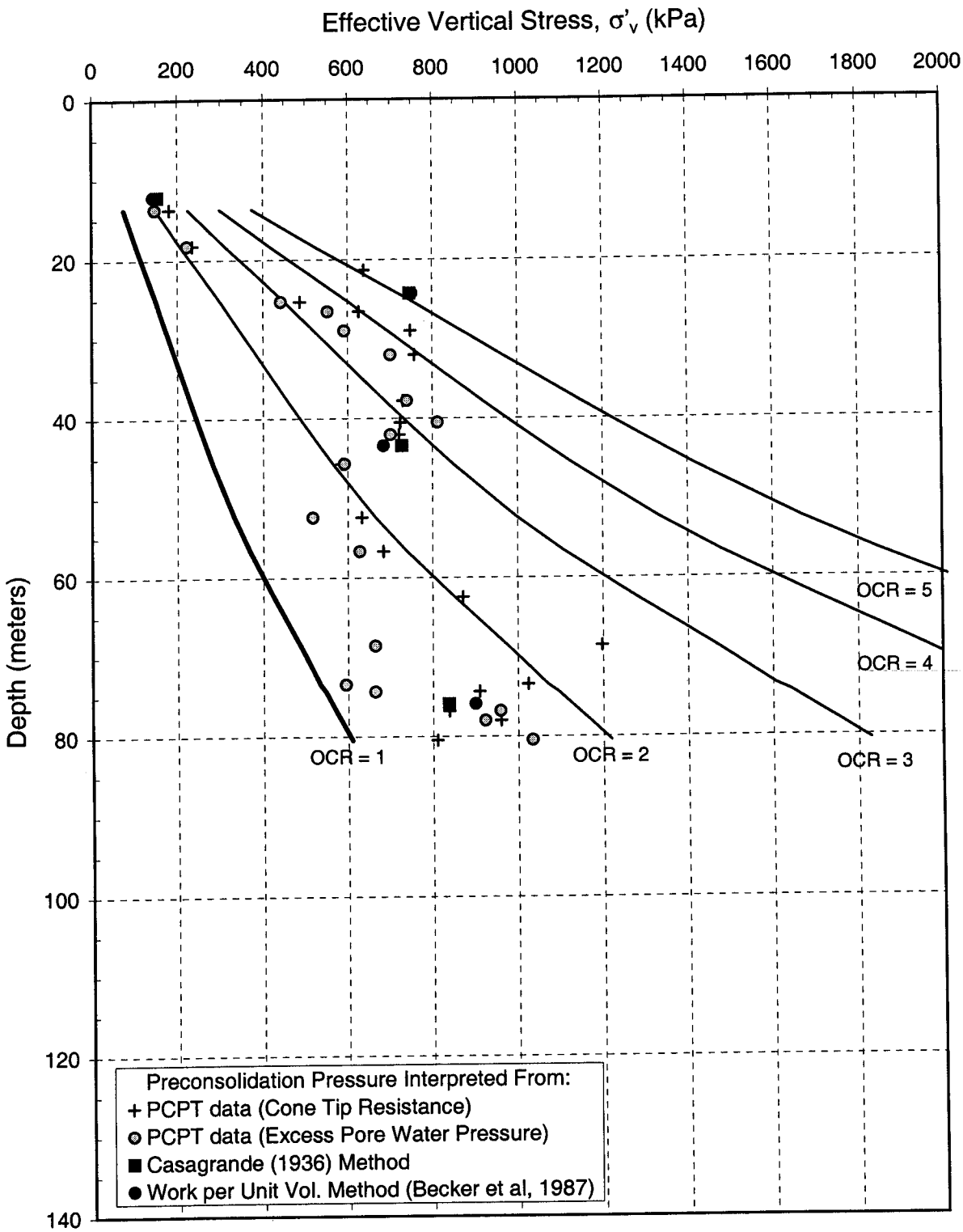
LIQUIDITY INDEX PROFILE
Boring 98-8
SFOBB East Span Seismic Safety Project



SOIL SENSITIVITY PROFILE
Boring 98-8
SFOBB East Span Seismic Safety Project



ϵ_{50} PROFILE
Boring 98-8
SFOBB East Span Seismic Safety Project



PRECONSOLIDATION STRESS PROFILE
Boring 98-8
SFOBB East Span Seismic Safety Project

PLATE 98-8.18