



September 29, 2011
Project No. 121627

Pacific Gas & Electric Company
Geosciences
245 Market Street, Mail Code N4C
P.O. Box 740000
San Francisco, California 94177

Attention: [Redacted]

**SUBJECT: Geotechnical Evaluation (Update 1)
Pacific Gas and Electric Company
Gas Transmission Line 132 [Redacted]
South San Francisco, California**

Dear [Redacted]

Per your request, Kleinfelder evaluated liquefaction hazard near the existing Pacific Gas & Electric Company (PG&E) Gas Transmission Line 132 in the vicinity of [Redacted] [Redacted] in South San Francisco, California. Our services were authorized by PG&E Contract Work Authorization (CWA) No. 245, dated August 31, 2011.

A letter report of a less extensive evaluation was submitted on September 7, 2011. In response to input from the PG&E design team, the evaluation reported herein expands upon and supersedes the conclusions contained in the September 7 report.

BACKGROUND INFORMATION

We understand that in the vicinity of the [Redacted] the top of the 30-inch diameter pipeline is about 3 feet below existing grade. A design team including [Redacted] and others (under separate contract to PG&E) is evaluating the effects of seismically-induced soil liquefaction on the existing pipeline. To support this evaluation, [Redacted] and PG&E requested that Kleinfelder review available geotechnical information and evaluate the liquefaction hazard along the pipeline alignment in the immediate vicinity of [Redacted]. PG&E provided the following information for use in our evaluation.

- Photographic map of the pipeline alignment in the immediate vicinity of [Redacted] [Redacted]

- Mapped liquefaction hazard, interpreted by PG&E, in the [Redacted] vicinity with the pipeline alignment superimposed. According to PG&E, the liquefaction hazard map is derived from a geographic information system (GIS) database that is published on the Association of Bay Area Governments (ABAG) website. According to the ABAG website, the liquefaction hazard map is based on United States Geological Survey (USGS) Open-File Report Nos [Redacted]. The PG&E liquefaction hazard map identifies the [Redacted] to be an area of “moderate to high” liquefaction susceptibility.

Kleinfelder’s liquefaction hazard evaluation was based on the pipeline information described above and on geotechnical information presented in reports by other consultants. For this assignment, Kleinfelder did not conduct a subsurface exploration and laboratory testing program to evaluate subsurface conditions. Geotechnical information used in our evaluation is contained in the following geotechnical investigation reports prepared by others for the Bay Area Rapid Transit (BART) system extension to San Francisco International Airport (SFO).

- Harding Lawson Associates (HLA, 1999), “Final Design Phase Submittal – Geotechnical Engineering Design Report, BART Extension to SFO – Module 2, Contract 12YC-120, San Mateo County, California,” prepared for HNTB Corporation, March 25, 1999.
- Geotechnical Consultants, Inc. (GTC, 1995), “San Francisco Bay Area Rapid Transit District Proposed SFO Extension – Geotechnical Data Report, Segment No. 1,” prepared for Bay Area Transit Consultants, January, 1995.

The above-referenced geotechnical reports include boring logs and the results of cone penetration tests (CPTs) conducted along the alignment of the BART SFO extension. As shown on Plate 1, Line 132 roughly parallels the BART SFO Extension along much of its alignment in the vicinity of the [Redacted] with explorations generally located within 50 to 850 feet of the mapped Line 132 location.

ASSUMPTIONS

Key assumptions employed in our evaluation are summarized below.

- The subsurface conditions (soil stratigraphy and groundwater conditions) along the BART SFO Extension alignment, as shown on the subsurface profile drawings in Appendix A and on the boring logs in Appendix B of this report, adequately represent the subsurface conditions along the Line 132 alignment. Note that the explorations (borings and CPTs) conducted for the BART SFO Extension project are widely spaced (generally about 300 to 500 feet apart) and are located up to 850 feet from the mapped location of Line 132 (see Plate 1).

- The reported “design” groundwater depth, shown on the Appendix B subsurface profile drawings, represents a conservative groundwater depth for liquefaction evaluation purposes.

SUBSURFACE CONDITIONS

Subsurface conditions described in this report are based on information contained in the above-referenced 1999 HLA and 1995 GTC geotechnical reports. It should be noted that most of the HLA and GTC explorations considered in our analyses are far enough away from the pipeline such that our evaluation cannot be considered site-specific. As such, our assumptions of similar soil profile are approximate at best.

According to the 1999 HLA report, the [Redacted] at the time of the 1999 reporting was about 8 to 10 feet deep and lined with rip-rap. Currently, the creek channel is lined with concrete.

The 1999 HLA report includes a geologic map of the site that is based on USGS Open-File Report No. [Redacted]. This geologic map identifies the mapped zone of “moderate to high” liquefaction susceptibility (from the PG&E map described above) at [Redacted] [Redacted] as Holocene-age alluvial fan deposits, described as “medium dense to dense, gravelly sand or sandy gravel that generally grades upward to sandy or silty clay.”

Generalized subsurface conditions, including stratigraphy and design groundwater depth, are illustrated on the Plan and Profile sheets in Appendix A. The Appendix A Plan and Profile sheets are taken directly from the 1999 HLA report.

In the vicinity of the pipeline crossing, the HLA report describes localized deposits of artificial fill consisting of clay, silt, sand, and gravel that overlie recent alluvial sediments and [Redacted] formation soils. At our analysis locations in the immediate vicinity of the creek crossing, the fill materials are reported to be up to about 5 feet thick. The alluvium is reported to range in thickness from less than a few feet at the mapped margins of the alluvium to 45 to 55 feet and consists of medium dense silty sand, clayey sand, and poorly-graded sand with silt interlayered with medium stiff to stiff fat clay, sandy lean clay and silt. Underlying the alluvium the HLA and GTC borings and CPTs show dense to very dense sands and stiff to very stiff clays of the Colma formation.

Groundwater depths used in our analyses are based on the design groundwater depths reported in the 1999 HLA geotechnical report. At the boring locations used in our analyses, the design groundwater depth generally varies from about 14 to 22 feet below ground surface. The design groundwater level is based on groundwater observations made during drilling and on long-term measurements in standpipe piezometers (observation wells) by HLA. We note that the “design” groundwater depths reported by HLA and as illustrated in Appendix A, are up to 5 to 10 feet higher than the high water level measurements from borings and observation wells reported in the 1999 HLA report.

LIQUEFACTION ANALYSIS METHODOLOGY AND RESULTS

In the past decade, several concentrated efforts have been made to establish a uniform guideline for field-based, simplified liquefaction analyses. Youd et al. (2001)¹ published general guidelines for liquefaction analyses, which presented the consensus of a task committee comprising more than 20 members from all over the country. Subsequent earthquakes in Turkey and Taiwan provided additional data to researchers, especially for low plasticity clays and silts, which resulted in significant modifications to liquefaction evaluation methods, especially for soils with higher fines contents. Two of the most widely used methods have been presented by Seed et al. (2003)² and Idriss and Boulanger (2008)³. Based on the above discussions, liquefaction potential analyses were performed using the methods proposed by Seed et al. (2003) and Idriss and Boulanger (2008) using the standard penetration test (SPT) data and CPT data reported in the 1995 GTC and 1999 HLA reports. It should be noted that these methods of analyses are deterministic in nature and do not address the probability of liquefaction occurring at the site.

In order to perform liquefaction analyses, estimates of earthquake magnitude and peak ground acceleration (PGA) are needed. Using the USGS interactive deaggregation website⁴, a modal earthquake magnitude $M_w = 8.0$ representing a seismic event on the San Andreas fault was estimated and used in the analysis. PGA for our liquefaction analyses was taken as $S_{DS}/2.5$ (0.56g), where S_{DS} was estimated using the USGS Java ground motion parameter calculator⁵ assuming a Site Class D.

The USGS Java calculator is based on USGS 2002 ground motion maps. It should be noted that $S_{DS} = 2/3 \cdot S_{MS}$, where S_{MS} is the spectral acceleration at a period of 0.2 second for the Maximum Considered Earthquake (MCE). According to 2010 California Building Code (CBC), the MCE is defined as the smaller of the probabilistic value and 150% of the median deterministic value from the controlling fault. The probabilistic value corresponds to 2 percent probability in 50 years (return period of about 2,475 years). In order to estimate PGA for other return periods, a site-specific probabilistic seismic hazard analysis (PSHA) should be performed. However, in lieu of site-specific

¹ Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Liam Finn, W.D.L., Harder, L.F., Jr., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F., III, Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., Stokoe, K.H., II (2001), Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical and Geoenvironmental Engineering, V. 127, No. 10, p 817-833.

² Seed, R.B., Cetin, K.O., Moss, R.E.S., Kammerer, A.M., Wu, J., Pestana, J.M., Riemer, M.F., Sancio, R.B., Bray, J.D., Kayen, R.E., and Faris, A. (2003), "Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework," 26th Annual ASCE Los Angeles Geotechnical Spring Seminar, Long Beach, California, April 30, 2003.

³ Idriss, I. M. and Boulanger, R.W. (2008), "Soil Liquefaction During Earthquakes," Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, California.

⁴ <https://geohazards.usgs.gov/deaggint/2008/>

⁵ <http://earthquake.usgs.gov/hazards/designmaps/javacalc.php>

PSHA, the USGS website for interactive deaggregation may be used for probabilities of exceedance of 1-, 2-, 5-, 10-, 20-, and 50-percent in 30, 50, 75, 100, and 200 years.

Groundwater depths used in our analyses are based on the design groundwater depths reported in the 1999 HLA geotechnical report, and as illustrated in Appendix A. The profile drawings in Appendix A include data from the 1995 GTC report.

The evaluation of liquefaction in response to an earthquake is based on a comparison of a soil's resistance to liquefaction and the cyclic load or demand placed on the soil by the earthquake. A safety factor against liquefaction is commonly defined as the ratio of the cyclic shear stress required to cause liquefaction (cyclic resistance ratio, or CRR) to the equivalent cyclic shear stress induced by the earthquake (cyclic stress ratio, or CSR). Per California Geological Survey Special Publication 117A, if the calculated safety factor against liquefaction (i.e., the ratio CRR/CSR) is less than about 1.3 the soil is considered to be liquefiable for design purposes.

A summary of liquefaction analysis results for $PGA = 0.56g$ is presented in Table 1. The information presented in Table 1 is ordered from north to south, beginning with CPT No. C-16, in the vicinity of the South San Francisco BART station at Sta. 427+90, and ending with C-41, at Sta. 347+75. Table 1 also presents approximate distances from the previous borings and/or CPTs and approximate distance of each boring or CPT from the pipeline. Using the distance between borings/CPTs and difference in total settlements between these borings/CPTs, an estimate of differential settlement over a development length may be estimated.

Table 1. Summary of Liquefaction Settlement Analysis Results (PGA = 0.56g)

Boring or CPT ID	Station (BART SFO Project)	Distance from Previous Exploration (feet)	Approximate Distance from Pipeline 132 (feet) ⁽¹⁾	Exploration Depth (feet)	Liquefiable Depth Interval (feet)	Computed Liquefaction Settlement (inches) and Computed Safety Factor ⁽³⁾
C-16 427+90		--	Not parallel to pipeline	30 ⁽²⁾	18.5 – 21.5 24.5 – 26.5	2" to 3" (FOS < 0.5)
B-15 425+00 140			Not parallel to pipeline	51.5	17 – 23.5	1" to 2" (FOS < 0.5)
B-107 423+80 120			Not parallel to pipeline	61	20 – 23	≤ 1" (FOS < 0.5)
C-24 421+60 220			Not parallel to pipeline	25	--	nil
B-18 421+40		20	300 (L)	81.5	17.5 – 18.5 33.5 – 38	1" to 2" (FOS < 0.5)
C-27 417+80 360			250 (L)	20	--	nil
B-23 414+50 330			200 (L)	51	17 – 21	1" to 2" (FOS < 0.5)
C-29 411+80 270			200 (L)	42	26 – 28 34 – 36	2" to 3" (FOS < 0.5)
B-24 408+25 355			250 (L)	50.5	33 – 40	1" to 2" (FOS < 0.5)
C-30 404+90 335			300 (L)	25	18 – 21	≤ 1" (FOS < 0.5)
C-31 401+75 315			400 (L)	50	19 – 21 30.5 – 31.5 37.5 – 49	3" to 5" (FOS < 0.5)
B-25 401+65		10	400 (L)	51.5	18 – 21.5 25 – 35	2" to 4" (FOS < 0.5)
C-32 398+00 365			450 (L)	50	18 – 21 42 – 43.5	2" to 3" (FOS < 0.5)
B-26 395+00 300			450 (L)	81.5	20 – 26 30.5 – 34	2" to 4" (FOS < 0.5)
B-202 391+90 310			400 (L)	61	20 – 26 40 – 44	1" to 2" (FOS < 0.7)
B-27 388+30 360			300 (L)	51	--	nil

Boring or CPT ID	Station (BART SFO Project)	Distance from Previous Exploration (feet)	Approximate Distance from Pipeline 132 (feet) ⁽¹⁾	Exploration Depth (feet)	Liquefiable Depth Interval (feet)	Computed Liquefaction Settlement (inches) and Computed Safety Factor ⁽³⁾
B-28	382+80 550		150 (L)	51	--	nil
C-36	379+10 370		< 50	50	21.5 – 25 29 – 33 39.5 – 44 46.5 – 49.5	2" to 6" (FOS < 0.5)
B-29	375+30 380		< 50	70	28.5 – 33.5 43.5 – 46.5	2" to 3" (FOS < 0.5)
C-37	371+50 380		200 (R)	50	32 – 36 44.5 – 46	1" to 2" (FOS < 0.5)
B-30	366+90 460		450 (R)	51.5	--	nil
B-203	364+00 290		600 (R)	56	24 – 28 46.5 – 49	1" to 2" (FOS < 0.8)
B-31	358+85 515		850 (R)	515	--	nil
C-39	358+65	20	850 (R)	29	--	nil
C-40	355+50 315		Not parallel to pipeline	26	16 – 15	≤ 1" (FOS < 0.5)
B-204	354+00 150		Not parallel to pipeline	60.5 16.5 – 27.5		3" to 4" (FOS < 0.5)
B-32	350+30 370		Not parallel to pipeline	51.5	--	nil
C-41	347+75 255		Not parallel to pipeline	38	32 – 37	≤ 1" (FOS < 0.5)

Notes on Table 1:

- (1) Approximate horizontal distance from pipeline alignment. Offset noted in left (L) or right (R) direction. See Plate 1 for locations.
- (2) Exploration does not fully penetrate alluvium.
- (3) Factor of safety against liquefaction triggering.

Based on our analyses, granular alluvial soils below the design groundwater level tend to be susceptible to liquefaction in the event of the earthquake scenario described above. At a given location along the pipeline alignment the total thickness of granular alluvium is expected to vary. At the HLA and GTC exploration locations that we analyzed, we estimate that up to 2 to 6 inches of total liquefaction-induced settlement can be expected during the earthquake scenario described above. In general,

depending on the pipe location, the differential settlement due to liquefaction could be on the order of 1 to 4 inches over 50 feet. At some locations such as B-18 and C-24, the differential settlements are up to about 2 inches over 20 feet. Similarly, differential settlement between C-31 and B-25 is about 1 inch for 10 feet. Our estimates are based on site conditions and the design groundwater elevations as reported in the 1999 HLA report.

As noted in Table 1, where liquefiable soils are identified for PGA = 0.56g the computed factor of safety against liquefaction is usually less than about 0.5. To investigate the effect of lower PGAs on liquefaction triggering and computed liquefaction settlement, we compared the results of our analyses with PGA = 0.56g at selected locations to analysis results for PGA = 0.2g and PGA = 0.4g. The results of these analyses are summarized below in Table 2.

Table 2. Comparison of Liquefaction Settlement with Variable PGA at Selected Locations

Boring or CPT ID	Station	PGA = 0.56g		PGA = 0.4g		PGA = 0.2g	
		Computed Settlement (inches)	Factor of Safety	Computed Settlement (inches)	Factor of Safety	Computed Settlement (inches)	Factor of Safety
C-31	401+75	3" to 5"	< 0.5	3" to 5"	< 0.5	2" to 4"	< 0.7
B-25	401+65	2" to 4"	< 0.5	2" to 4"	< 0.5	1" to 4"	0.5 to 1.1
B-26	395+00	2" to 4"	< 0.5	2" to 4"	< 0.5	1" to 2"	0.5 to 1.0
B-29	375+30	2" to 3"	< 0.5	2" to 3"	< 0.5	1" to 3"	0.5 to 0.8
B-204	354+00	3" to 4"	< 0.5	2" to 4"	< 0.6	1" to 2"	0.5 to 0.9

Based on the results presented in Table 2, the computed safety factor against liquefaction triggering and computed range in liquefaction settlement is largely unchanged when PGA is reduced from 0.56g to 0.4g. However, for PGA = 0.2g the computed safety factor begins to approach or exceed 1.0, and the corresponding liquefaction settlement is reduced.

As noted above, at the locations of our analyses the design groundwater depth generally varies from about 14 to 22 feet below ground surface. Liquefaction hazard is not a design issue at depths above the design groundwater depth. If the Redacted channel invert is 8 to 10 feet deep in the vicinity of the pipeline crossing, as described above, then the top of liquefiable soils is estimated to be 8 to 11 feet below the channel invert. We consider this depth interval to be too great for lateral spreading caused by liquefaction to occur.

LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same

locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data reported by Geotechnical Consultants, Inc. in 1995 and Harding Lawson Associates in 1999. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The borings and CPTs used in our analyses were conducted 13 to 17 years ago and anywhere from about 50 to over 800 feet away from the pipeline alignment. Kleinfelder makes no warranty as to the applicability or usefulness of the information from the 1995 GTC and 1999 HLA reports for the purposes of the pipeline study. Kleinfelder recommends that the analyses and conclusions developed during this study be confirmed with site-specific subsurface information collected during a subsurface exploration and laboratory testing program directed toward evaluating liquefaction along the pipeline alignment.

ATTACHMENTS

The following are attached and complete this report:

- Plate 1, Site Plan
- Appendix A, Plan and Profile Sheets by HLA (1999).
- Appendix B, Boring Logs and CPT Results by GTC (1995) and HLA (1999)

CLOSING

We appreciate the opportunity to be of service to PG&E on this project. If you have questions regarding this report, or if we may be of further assistance, please contact the undersigned.

Sincerely,

KLEINFELDER WEST, INC.

Redacted



Redacted

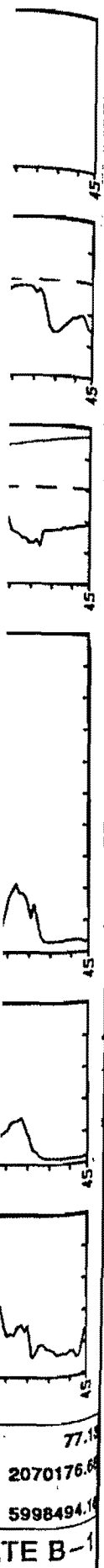
PLATES

APPENDIX A

PLAN AND PROFILE DRAWINGS FROM HLA (1999) REPORT

APPENDIX B

LOGS OF BORINGS AND CPTs FROM GTC (1995) AND HLA (1999) REPORTS

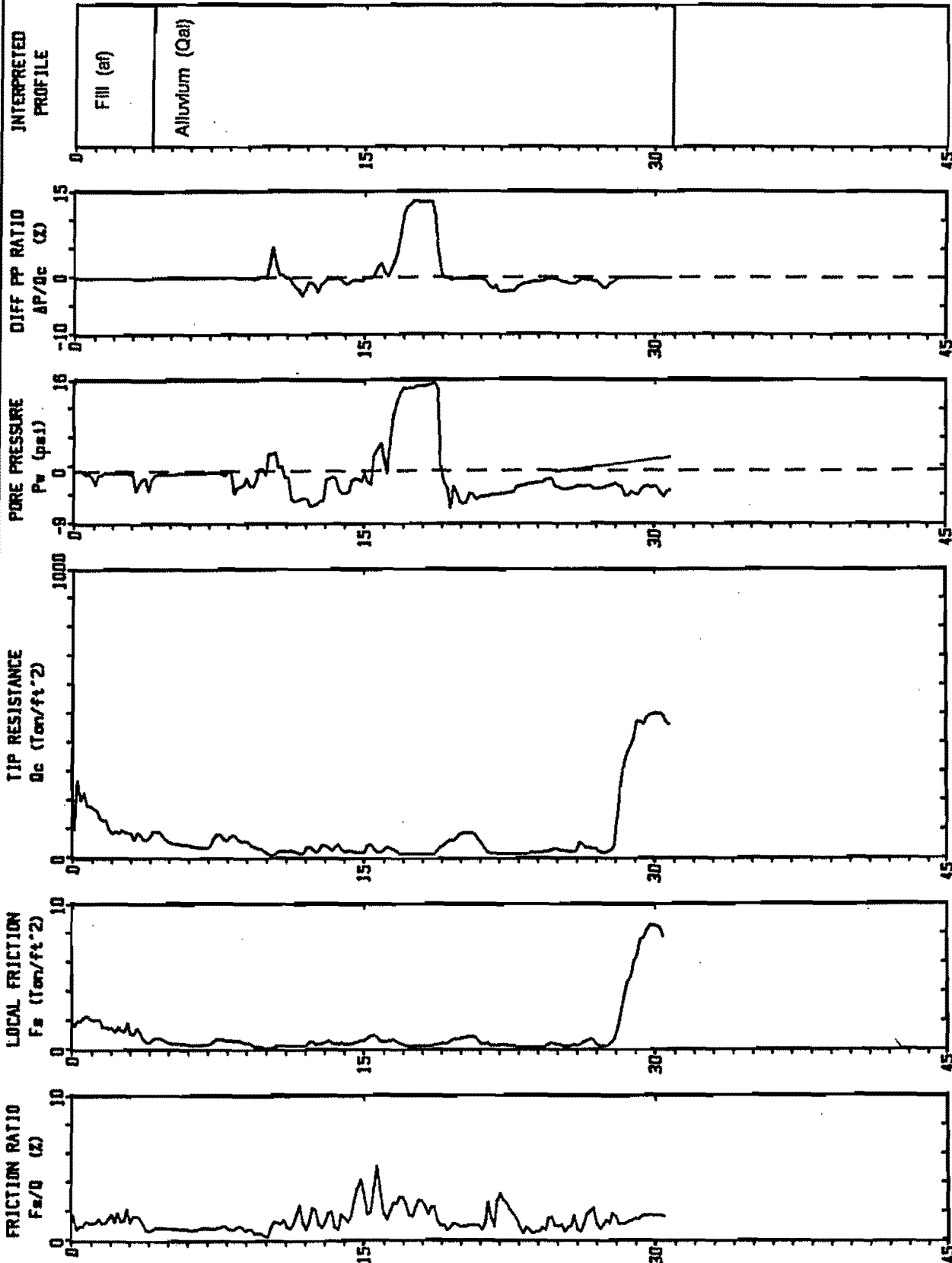


Sounding : 94Z178 Pg 1 / 1
 Job No. : SF940J1

CPT Date : 06-02-84 13:14
 Cone Used : HD 322 TC -U2

Operator :
 Location : C-16A

Re
 dac
 ted



Max Depth : 30.84 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-16A

Elevation:	67.69
Northing:	2070289.03
Easting:	5998822.63

PLATE B-16

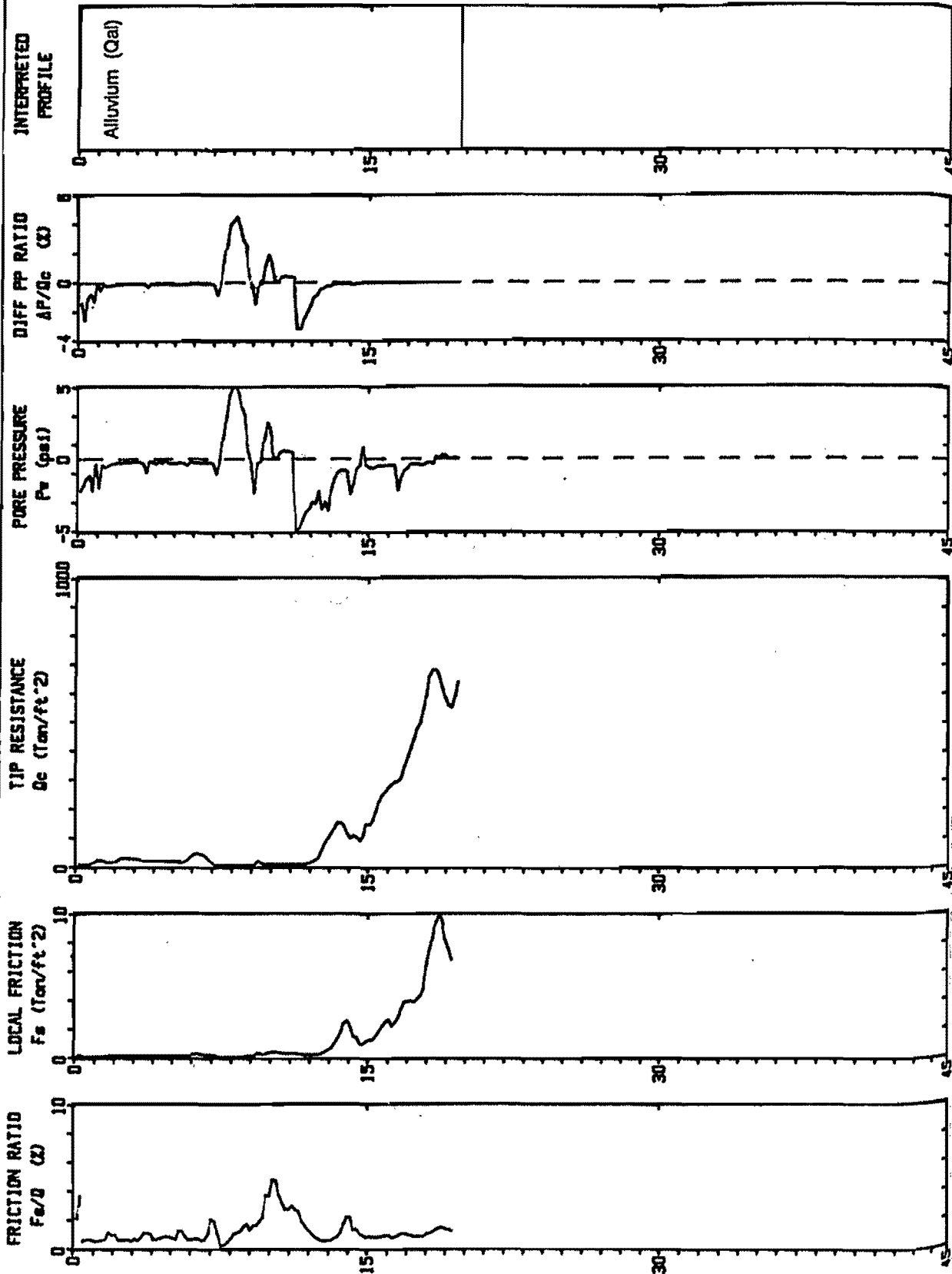
V B I

Sounding : 94Z152 Pg 1 / 1
Job No. : SF94011

CPT Date : 05-27-94 12:11
Cone Used : HD 322 TC -U2

Redacted

Operator :
Location : C-17



DEPTH (feet)

CPT-17

Elevation:
Northing:
Easting:

Redacted

PLATE B-

V B I

Sounding : 94Z171 Pg 2 / 2

CPT Date : 06-01-94 14:57

Redacted

Operator :

LOG OF DRILL HOLE

San Bruno Gas Line Rupture Investigation_DR_CPUC_213-Q03Atch01

#4401

4 7/8" Auger Extension

Redacted

LOGGED BY: Redacted
CHECKED BY: Redacted

DRILL HOLE NO.: B-15
DRILLING DATE: May 16, 1994
ELEVATION: 64.70 feet
DATUM: NGVD

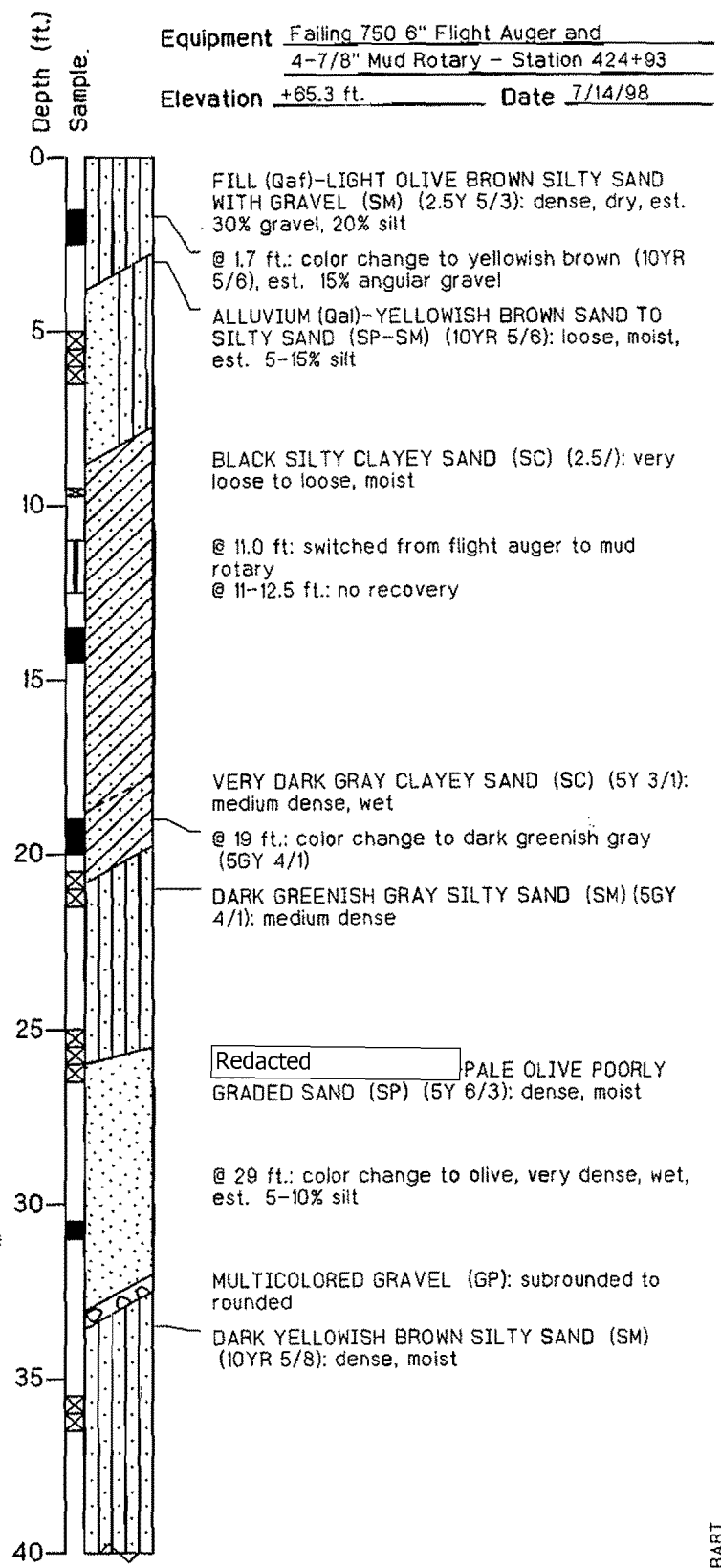
METHOD: 4 7/8" diameter Rotary Wash with cathead

DEPTH (ft)	UNCONFINED SHEAR STRENGTH (PSF)	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
6							"ARTIFICIAL FILL (af)" POORLY GRADED SAND with silt (SP-SM) brown, dry to damp, loose, layer of gravel at 6-inches, fine to coarse grained.						
12							"ALLUVIUM (Gal)" SILTY SAND (SM) brown, moist, medium dense, 20% fines.	97	17				GS
7							"ALLUVIUM (Gal)" CLAYEY SAND (SC) dark brown, wet, loose, with organics.	98	25				
5		0.8					"ALLUVIUM (Gal)" SANDY LEAN CLAY (CL) black, moist to wet, medium stiff.		19	25	14		
6		1.0					"ALLUVIUM (Gal)" SANDY LEAN CLAY to CLAYEY SAND (CL/SC) dark brown, moist to wet, loose sand to medium stiff to stiff clay.						Corr
9							"ALLUVIUM (Gal)" CLAYEY SAND (SC) dark gray to bluish-gray, moist lenses of gray-blue, fine gravel, fine grained sand, loose, 34% fines.						GS
8		.75					"ALLUVIUM (Gal)" LEAN CLAY (CL) black, moist, medium stiff with blue-green speckles.		24	43	15		
80/11"							"ALLUVIUM (Gal)" SANDY LEAN CLAY to CLAYEY SAND (CL/SC) dark gray to black moist medium stiff to loose, fine grained sand.	124	13				
							Redacted						
							SILTY SAND (SM) light gray, moist, very dense, fine grained sand, some gravel. Fine gravel and coarse sand at 32 feet.						
							Redacted						
86/10"							POORLY GRADED SAND with silt (SP-SM) light gray, very moist, very dense, medium to fine grained sand, some black veins and occasional red stains.						
71							"COLMA FORMATION (Gc)" SILTY SAND (SM) orange-brown, moist, very dense, weakly cemented.						
63							Light orange-brown at 46 feet.						
82							Orange-brown with black speckles and dark orange bands, 2-inch layer of sandy lean clay (CL) light gray.						
Bottom of drill hole at 51 1/2 feet. No water measured to a depth of 45 feet on 6/13/94. Installed piezometer. Perched groundwater measured at 18.3 feet in adjacent Auger boring on Sept. 15, 1994, after 24 hours.													

Laboratory Tests

	Pocket Pen (tsf)**	Moisture Content (%)	Dry Density (pcf)	Blows/ft.
		7.4	104	48*
MA, Hydrom -200=43% LL=24, PI=10	20.2		109	13*
MA -200=19%	19.8		111	19*
MA, Hydrom -200=40%				15
MA -200=23% PI=Non Plastic				47
				50/5**
MA -200=23%				44

Equipment Falling 750 6" Flight Auger and
4-7/8" Mud Rotary - Station 424+93
 Elevation +65.3 ft. Date 7/14/98



* Blow counts are S&H sampler blow counts.
 ** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.



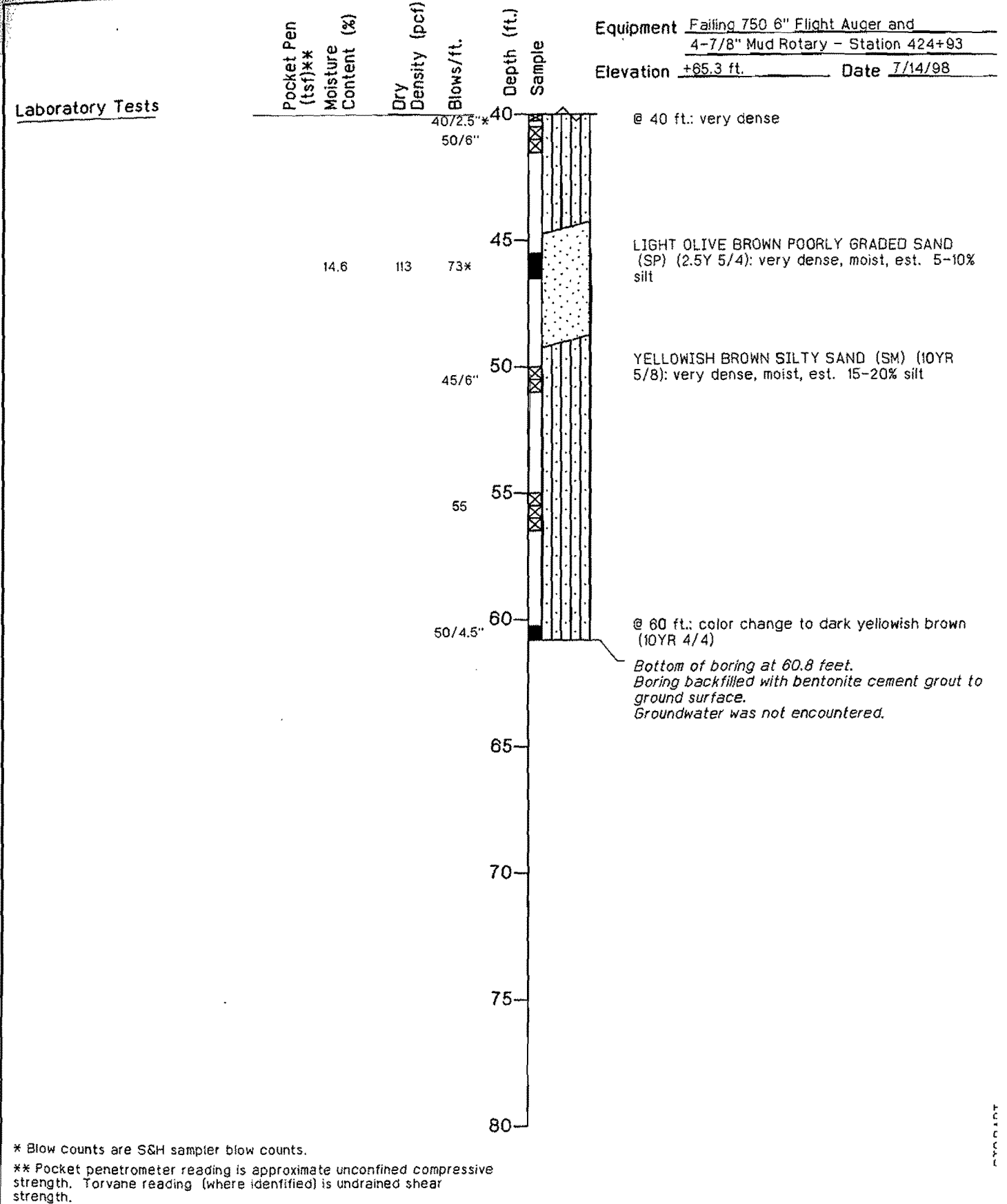
Harding Lawson Associates
 Engineering and
 Environmental Services

Log of Boring B-107
 Module 1 - BART Extension to SFO
 San Mateo County, California

Figure
A-7

DRAWN CEG	JOB NUMBER 40646 3E	APPROVED	DATE 8/98	REVISED DATE
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GTC/BART



* Blow counts are S&H sampler blow counts.
 ** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.



Harding Lawson Associates
 Engineering and Environmental Services

Log of Boring B-107
 Module 1 - BART Extension to SFO
 San Mateo County, California

A-7

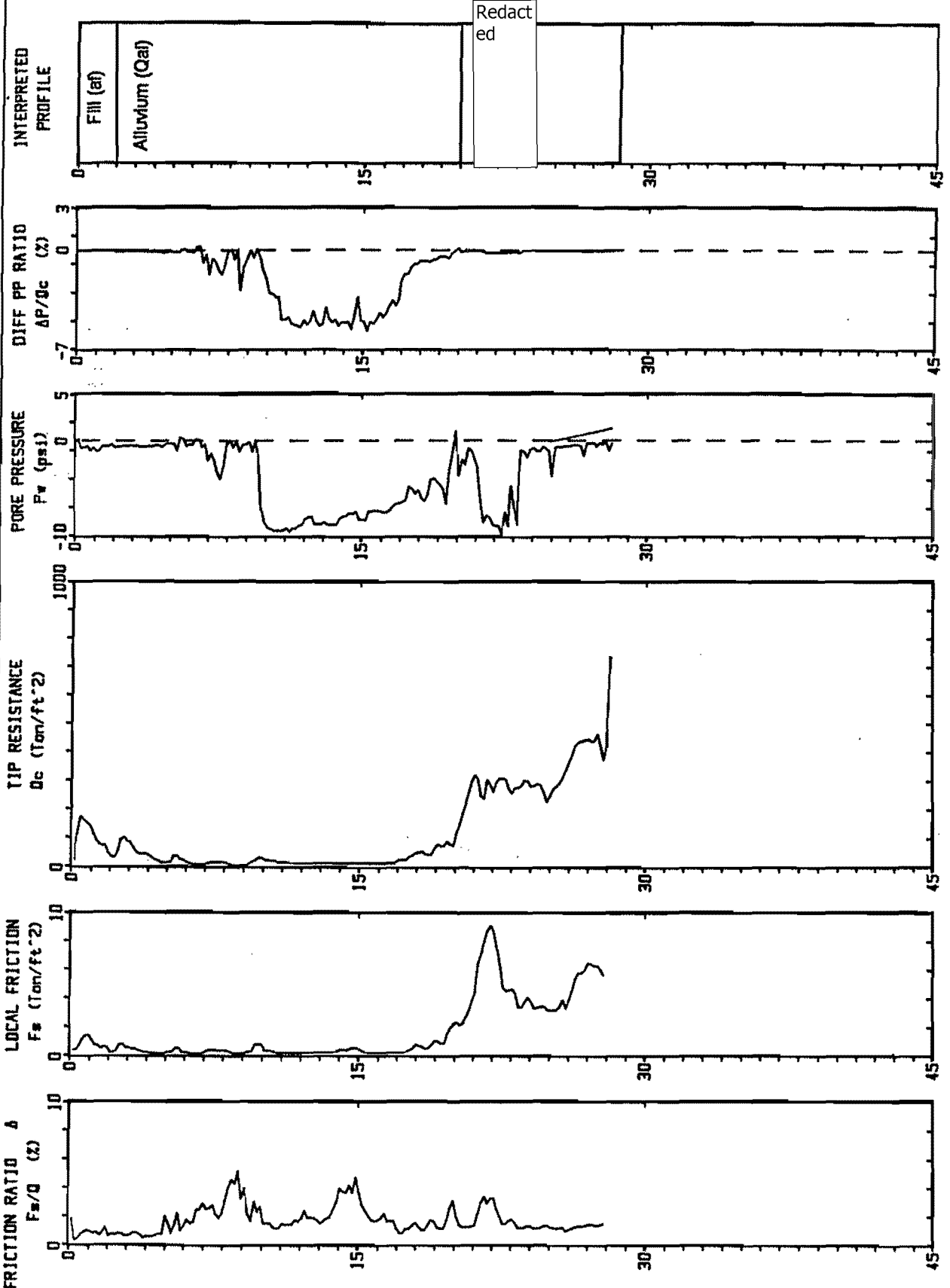
DRAWN CEG	JOB NUMBER 40646 3E	APPROVED	DATE 8/98	REVISED DAT
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Sounding : 94Z157 Pg 1 / 1
 Job No. : SF94011

CPT Date : 05-31-94 09:19
 Cone Used : HO 322 TC -U2

Operator : Redacted
 Location : C-22



Max Depth : 28.22 ft

Depth Increment : .05 m

DEPTH (feet)

Elevation: 64.41
Redacted

CPT-22

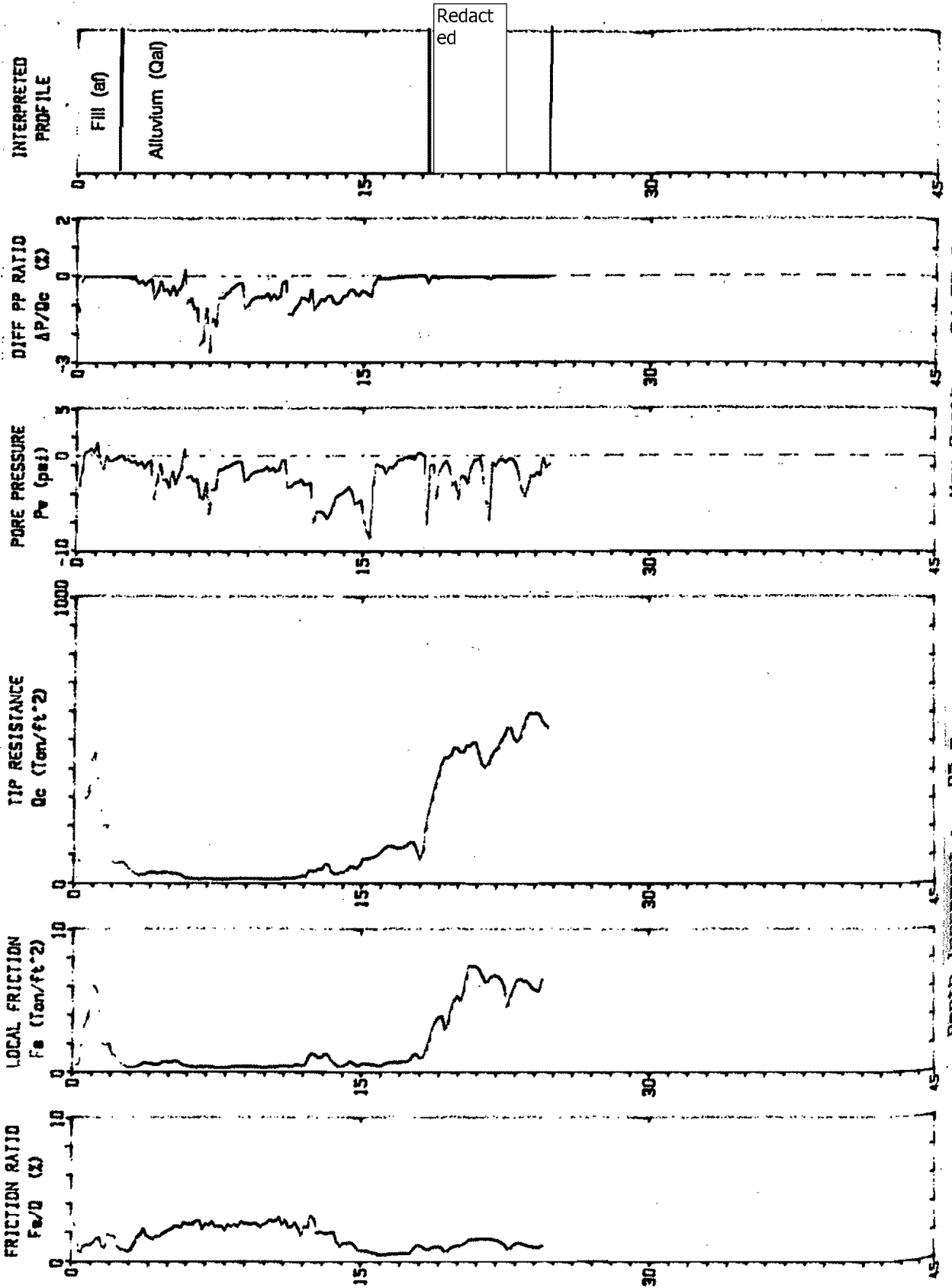
PLATE B-22

Sounding : 94Z153 Pg 1 / 1
Job No. : SF84011

CPT Date : 05-27-84 12:44
Cone Used : HD 322 TC -U2

Operator :
Location : C-24

Redacted



DEPTH (feet)

CPT-24

Elevation: 62.48
Redacted

PLATE B-24

Sounding : 94Z156 Pg 1 / 1
Job No. : SF84011

CPT Date : 08-01-84 10:47
Cone Used : HD 322 TC -U2

Operator :
Location : C-25

Redacted

LOG OF DRILL HOLE

PROJECT: 04011
 PART: SFO Airport Extension
 Location: [Redacted]
 METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: [Redacted]
 CHECKED BY: [Redacted]

DRILL HOLE NO.: B-18
 DRILLING DATE: May 16, 1994
 ELEVATION: 62.50 feet
 DATUM: NGVD

LIMIT (%)	UNCONFINED SHEAR STRENGTH (PSF)	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
							"ARTIFICIAL FILL (af)" SILTY SAND (SM) with layers of gravel.						
							"ALLUVIUM (Gal)" SILTY SAND (SM) light brown, dry, dense.						
		12					"ALLUVIUM (Gal)" SILT (ML) light brown, moist, loose to medium dense, some fine grained sand.	103	21				GS
		9					"ALLUVIUM (Gal)" CLAYEY SAND (SC) light red-brown, moist, medium dense, 40% fines.						
		19		2.0			"ALLUVIUM (Gal)" LEAN CLAY (CL) black, moist, stiff to very stiff, some coarse red-brown sand, slightly organic.	112	19	26	13	1040	
		16					"ALLUVIUM (Gal)" CLAYEY SAND (SC) medium gray-brown and red-brown, moist, medium dense, fine grained sand, weakly cemented, 30% fines.						GS
							[Redacted]						
		82/10"					SILTY SAND (SM) medium orange-brown, moist, very dense, fine to medium grained sand, weakly cemented, 14% fines.						GS
		77/10"					Gray-brown and orange-brown, thin layers of fine gravel and coarse sand.						
		82/8"					Weakly cemented.						
							[Redacted]						
		27					CLAYEY SAND (SC) medium orange-brown, moist, medium dense, fine and medium grained sand, some coarse angular gravel, very clayey.						
							Very dense.						
		80/11"					[Redacted]						
							SILTY SAND (SM) orange, moist, very dense, fine to medium grained sand, locally weakly cemented, 14% fines.						GS
		76											
		80/10"					Dark orange mottling.						

LOG OF DRILL HOLE

San Bruno Gas Line Rupture Investigation_DR_CPUC_213-Q03Atch01

JOB NO.: SF94011
 PROJECT: BART SFO Airport Extension
 LOCATION: Redacted
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: Redacted
 CHECKED BY: Redacted

DRILL HOLE NO.: B-18
 DRILLING DATE: May 18, 1994
 ELEVATION: 82.50 feet
 DATUM: NGVD

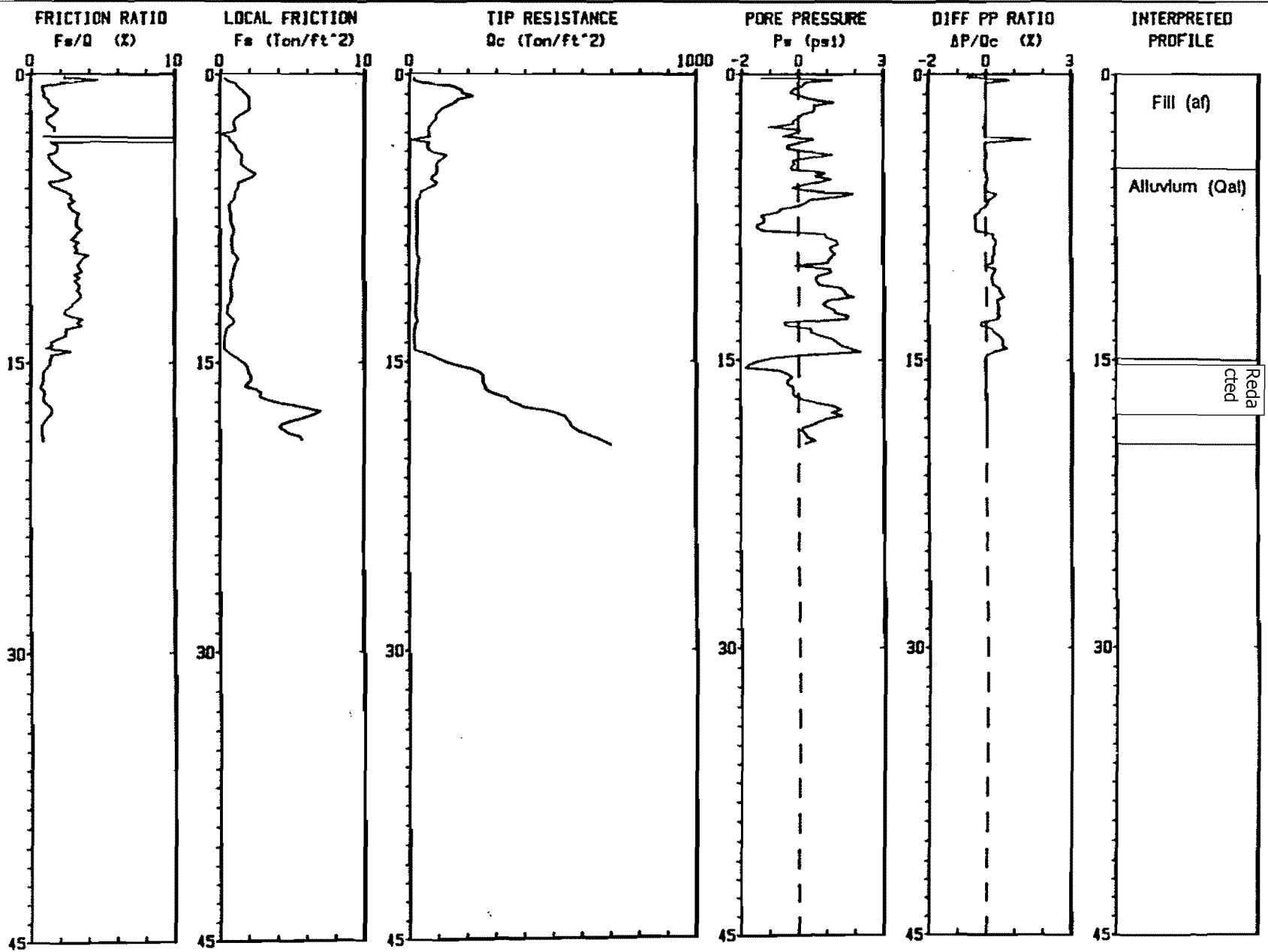
DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVAKE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
65	50/5"	78/11"					Medium orange-brown. 12% fines. Frequent black banding, <1-inch thick.						65
81 1/2							Bottom of drill hole at 81 1/2 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.						

V B I

Operator : Redacted
 Location : C-27

CPT Date : 05-27-94 13:24
 Cone Used : HD 322 TC -U2

Sounding : 942154 Pg 1 / 1
 Job No. : SF94011



Depth Increment : .05 m

Max Depth : 19.36 ft

(942154) HLD330
 CPT-27

Elevation: 59.16
 Redacted

PLATE B-27

LOG OF DRILL HOLE

San Bruno GT-Line Rupture Investigation_DR_CPUC_213-Q03Atch01

JOB NO.: SF04011

PROJECT: BART SFO Airport Extension

LOCATION: Redacted

DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: Redacted

CHECKED BY:

DRILL HOLE NO.: B-23

DRILLING DATE: May 17, 1994

ELEVATION: 56.04 feet

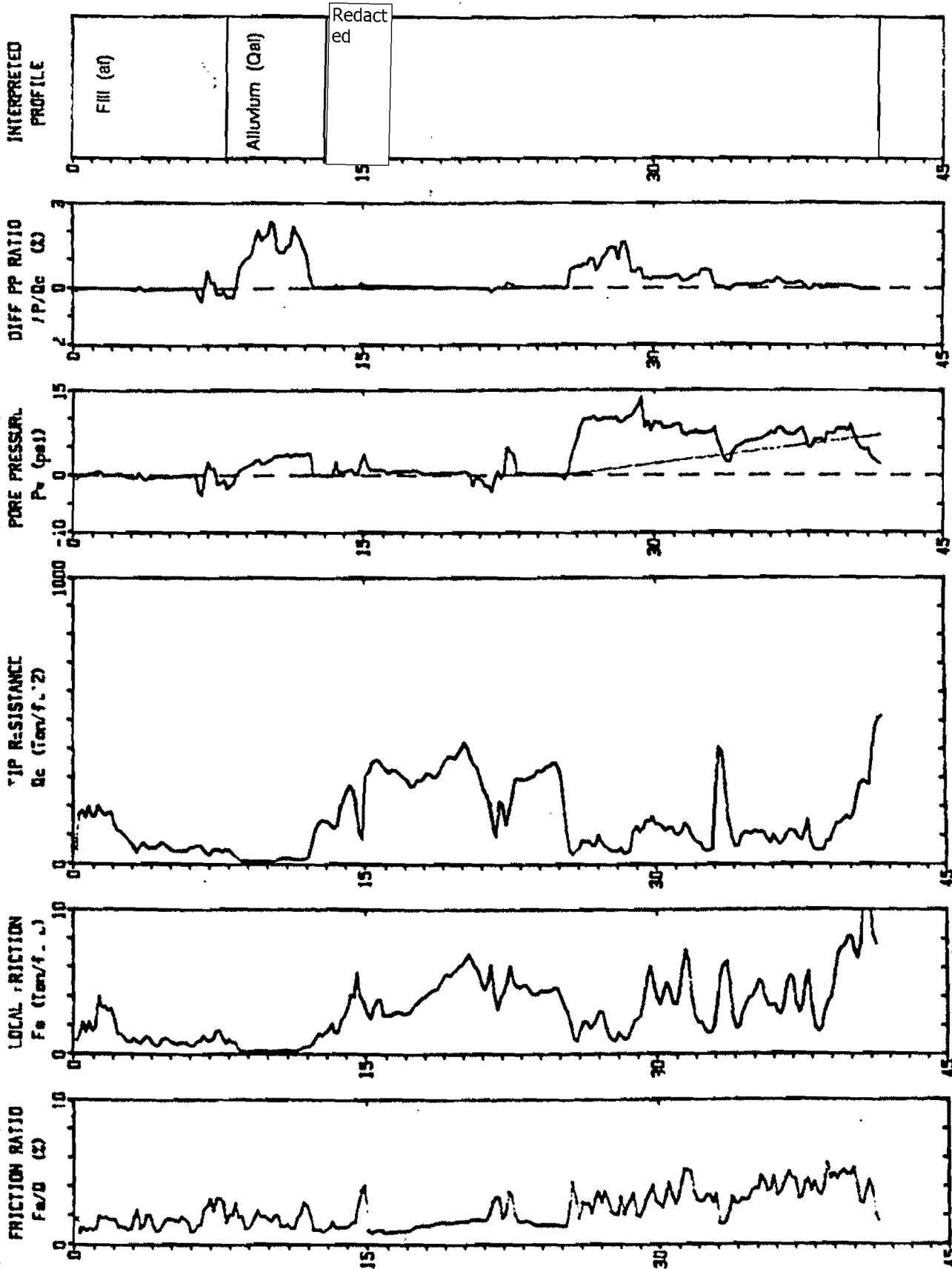
DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
4							"ARTIFICIAL FILL (af)" SILTY SAND (SM) brown, damp, loose, some fine gravel, some clay locally. Aluminum foil at 3 feet.						
12							"ARTIFICIAL FILL (af)" CLAYEY SAND (SC) dark brown, moist, medium dense, fragments of burnt wood and roots, fine gravel throughout, fine to coarse sand. Gravel at 7 feet.						
18							Black, moist.	107	22	28	15		
20							"ALLUVIUM (Gal)" LEAN CLAY (CL) black, moist, soft, some fine grained sand. Increasing clay.						
20							"ALLUVIUM (Gal)" SILTY SAND (SM) dark blue-gray, loose, fine grained sand, 19% fines.						GS
18							"ALLUVIUM (Gal)" LEAN TO ORGANIC CLAY (CL/OL) black, moist, soft to medium stiff.	98	31	47	28		
30							"ALLUVIUM (Gal)" SILTY SAND with gravel (SM) light gray-brown with orange veins, moist, fine grained sand, fine gravel, medium dense, 35% fines.	111	25	19			GS
30							Redacted SILTY SAND (SM) light orange-brown, with veins of dark orange, moist to wet, very dense.						
30							Redacted SILTY SAND to CLAYEY SAND (SC/SM) light orange-brown, moist, very dense, some orange veins, weakly cemented.						
40							Redacted SILTY SAND (SM) orange, moist, very dense. With light gray-brown patches.						
40							Orange-brown, friable.						
50							Bottom of drill hole at 51 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.						

Sounding : 842155 Pg 1 / 1
Job No. : SF84011

CPT Date : 05-27-94 14:07
Cone Used : HD 322 TC -U2

Operator : [Redacted]
Location : C-29



Max Depth : 41.87 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-29

Elevation:	54.66
Redacted	[Redacted]

PLATE B-29

SB_GT&S_0037420

LOG OF DRILL HOLE

San Bruno Gas Line Rupture Investigation_DR_CPUC_213-Q03Atch01

JOB NO: SF0401
 PROJECT: BART SEQ Airport Extension
 LOCATION: [Redacted]
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: [Redacted]
 CHECKED BY: [Redacted]

DRILL HOLE NO.: B-24
 DRILLING DATE: May 17, 1994
 ELEVATION: 52.01 feet
 DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PROTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION		DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
											LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
						•••••	"ARTIFICIAL FILL (af)" SANDY GRAVEL (GW/GP) gray gravel with brown sand, damp, medium dense.							
18		18				/ / / / /	"ALLUVIUM (Gai)" SILTY SAND with gravel (SM) brown, damp, loose to medium dense.	102	18					GS
10		10				/ / / / /	"ALLUVIUM (Gai)" CLAYEY SAND (SC) gray-brown and orange-brown, moist, medium dense, fine grained sand, 44% fines. Interbedded layers of silt (ML) and silty sand (SM) 2 to 4-inches thick at 7 feet. Black, loose, at 10 feet, 40% fines.							GS
75		75				•••••	[Redacted] SILTY SAND (SM) light gray-brown with orange bands, moist, fine to medium grained sand, very dense, some roots, 14% fines.	107	17					GS
20		50				/ / / / /	Dark orange-brown, locally weakly cemented.							
		50				/ / / / /	Light gray-orange, wet.							
30		65				/ / / / /	Weakly cemented.							
21		21		3.25		/ / / / /	[Redacted] CLAYEY SAND (SC) light gray with light orange staining, moist, medium dense, fine grained sand, 40% fines.							GS
40		56				•••••	[Redacted] SILTY SAND (SM) orange, moist, very dense, fine sand with dark orange staining.							
30/10"		30/10"				•••••	Medium to fine grained sand at 45 feet, some black speckles.							
50		50/6"				•••••	Dark orange with black speckles.							
						•••••	Bottom of drill hole at 50 1/2 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.							

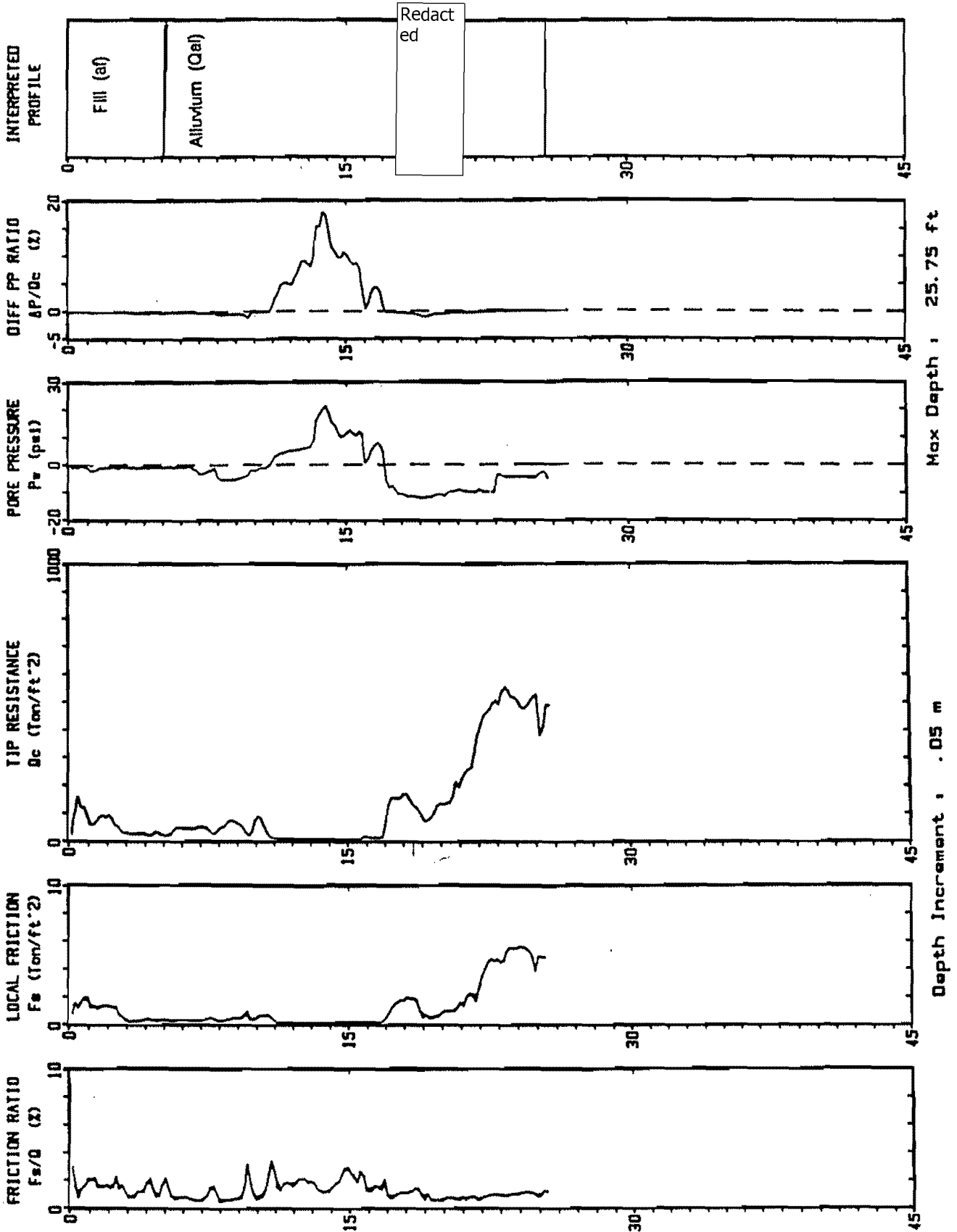
V B I

Sounding : 94Z158 Pg 1 / 1
Job No. : SF94011

CPT Date : 05-31-94 10:04
Cone Used : HQ 322 TC -U2

Redacted

Operator :
Location : C-30



Max Depth : 25.75 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-30

Elevation: 49.25
Redacted

PLATE B-30

LOG OF DRILL HOLE

Site: BART SFO Airport Extension
Investigation: DR_CPUC_213-Q03Atch01

JOB NO: SF84011
 PROJECT: BART SFO Airport Extension
 LOCATION: [Redacted]
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: [Redacted]
 CHECKED BY: [Redacted]

DRILL HOLE NO.: B-25
 DRILLING DATE: May 18, 1994
 ELEVATION: 47.00 feet
 DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER CORR. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
0 - 5		5				[Symbol]	"ARTIFICIAL FILL (af)" SILTY SAND (SM) brown, damp, loose, with gray gravel, pile of broken concrete blocks from 6-inches to 2 feet. 2 feet: Golf ball, cobbles, rocks to 4 feet. No samples at 2 1/2 feet, concrete blocks in hole.						
5 - 10		20				[Symbol]	"ALLUVIUM (Gal)" SILTY SAND (SM) blue-gray, moist to wet, loose, fine grained sand, roots.						
10 - 38		20				[Symbol]	"ALLUVIUM (Gal)" SILTY SAND (SM) blue-gray, moist to wet, medium dense, fine grained sand, roots, 2-inch thick layer of clayey silt (ML) at 10 1/2 feet. Dense, black at 17 feet. 18 1/2 feet: Blue-gray. Medium dense.	104	20	30	12		
38 - 40		15				[Symbol]	"ALLUVIUM (Gal)" SANDY LEAN CLAY (CL) dark gray, moist, stiff, fine grained sand, green-blue and orange lenses, occasional fine gravel. 25 feet: Green-blue gray with white speckles.						
40 - 30		21				[Symbol]	"ALLUVIUM (Gal)" CLAYEY SAND (SC) dark gray, moist, medium dense, fine grained sand, some roots, 28% fines.	102	21				GS OS
30 - 40		31	1.5			[Symbol]	"ALLUVIUM (Gal)" SANDY LEAN CLAY (CL) gray-brown, moist, stiff, sandy/silty lenses.	98	25	31	14		C
40 - 40		50/6"				[Symbol]	"ALLUVIUM (Gal)" SILTY SAND (SM) gray, moist, dense, fine grained sand, some brown veins [Redacted] POORLY GRADED SAND with silt and gravel (SP-SM) light gray, moist, very dense, medium to fine grained sand, fine gravel.						
40 - 50		20				[Symbol]	[Redacted] SILTY CLAY (CL-ML) dark brown, moist, very stiff, veins of gray sand, fine grained sand, sulfur odor, organic content 15% [Redacted]						OR
50 - 51 1/2		33				[Symbol]	SILTY SAND (SM) gray and gray-brown, moist, dense. Bottom of drill hole at 51 1/2 feet. Groundwater measured at 27.5 feet depth on 6/13/94. Piezometer installed.						

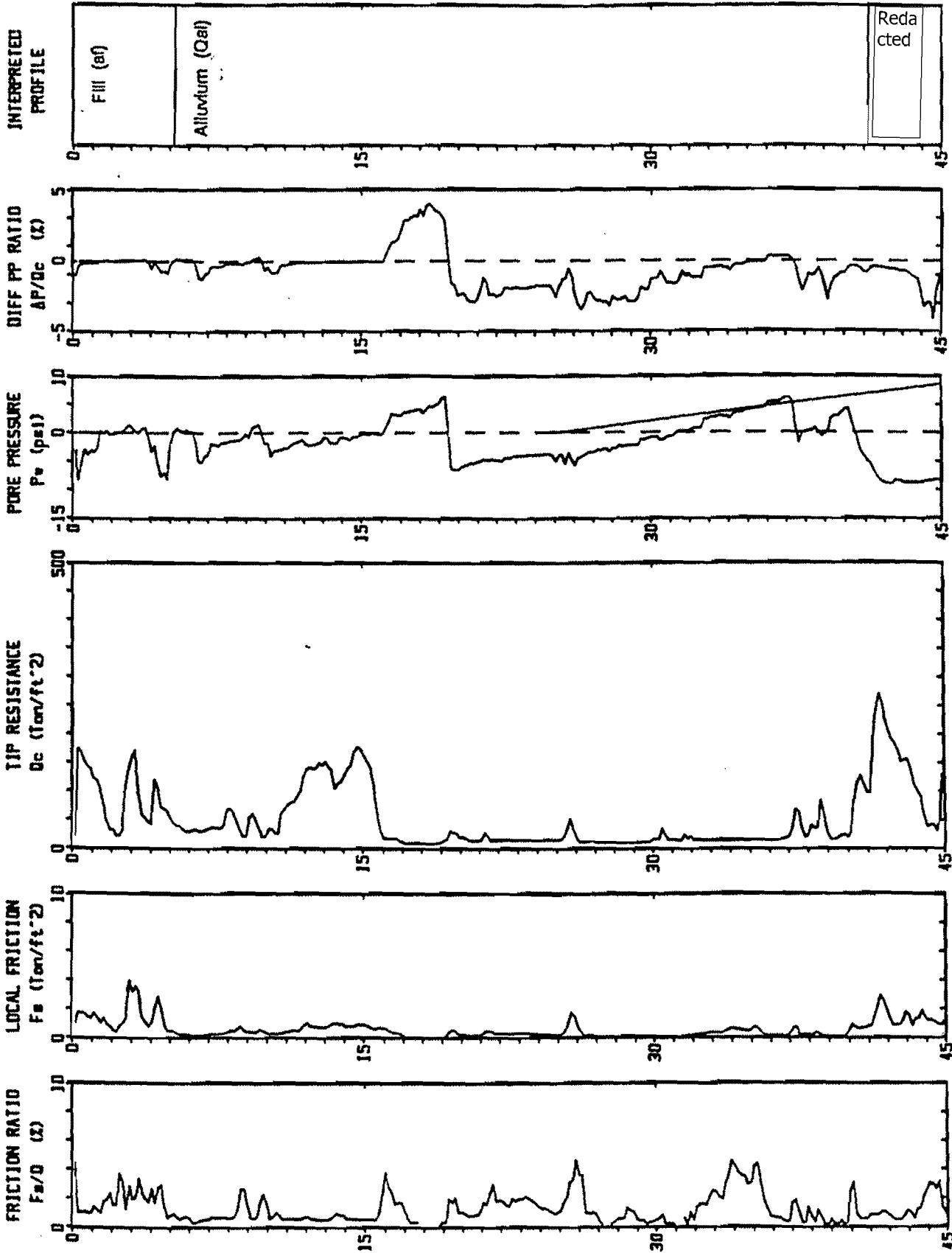
V B I

Operator :
Location : C-31

CPT Date : 05-31-84 11:06
Cone Used : HD 322 TC -U2

Sounding : 94Z159 Pg 1 / 2
Job No. : SF94011

Redacted



DEPTH (feet)

CPT-31

Elevation: 46.96
Redacted

PLATE B-31

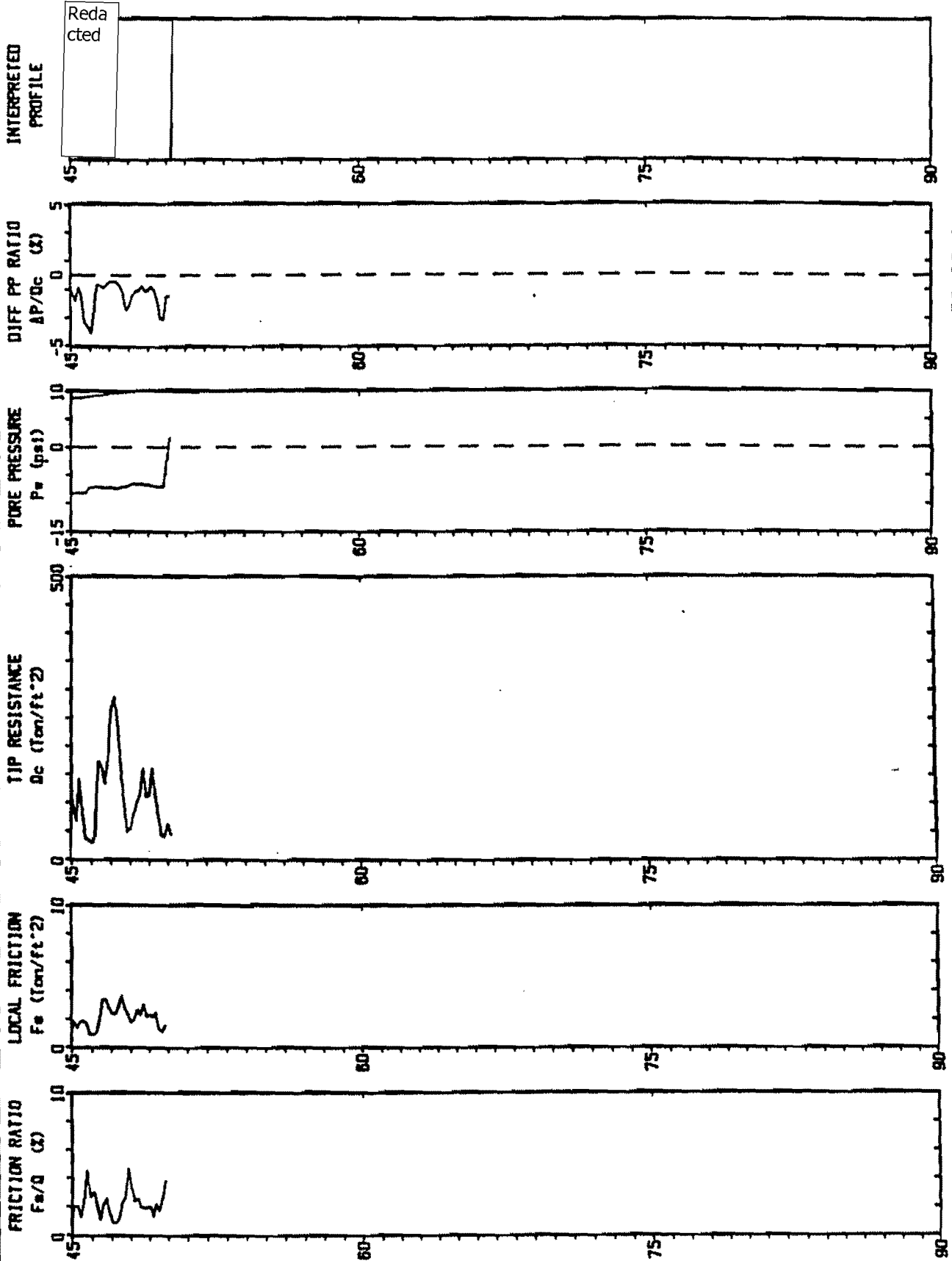
SB_GT&S_0037424

V B I

Operator : Redacted
Location : C-31

CPT Date : 05-31-84 11:08
Cone Used : HO 322 TC -U2

Sounding : 94Z159 Pg 2 / 2
Job No. : SF94011



Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-31 (Cont.)

PLATE B-31

SB_GT&S_0037425

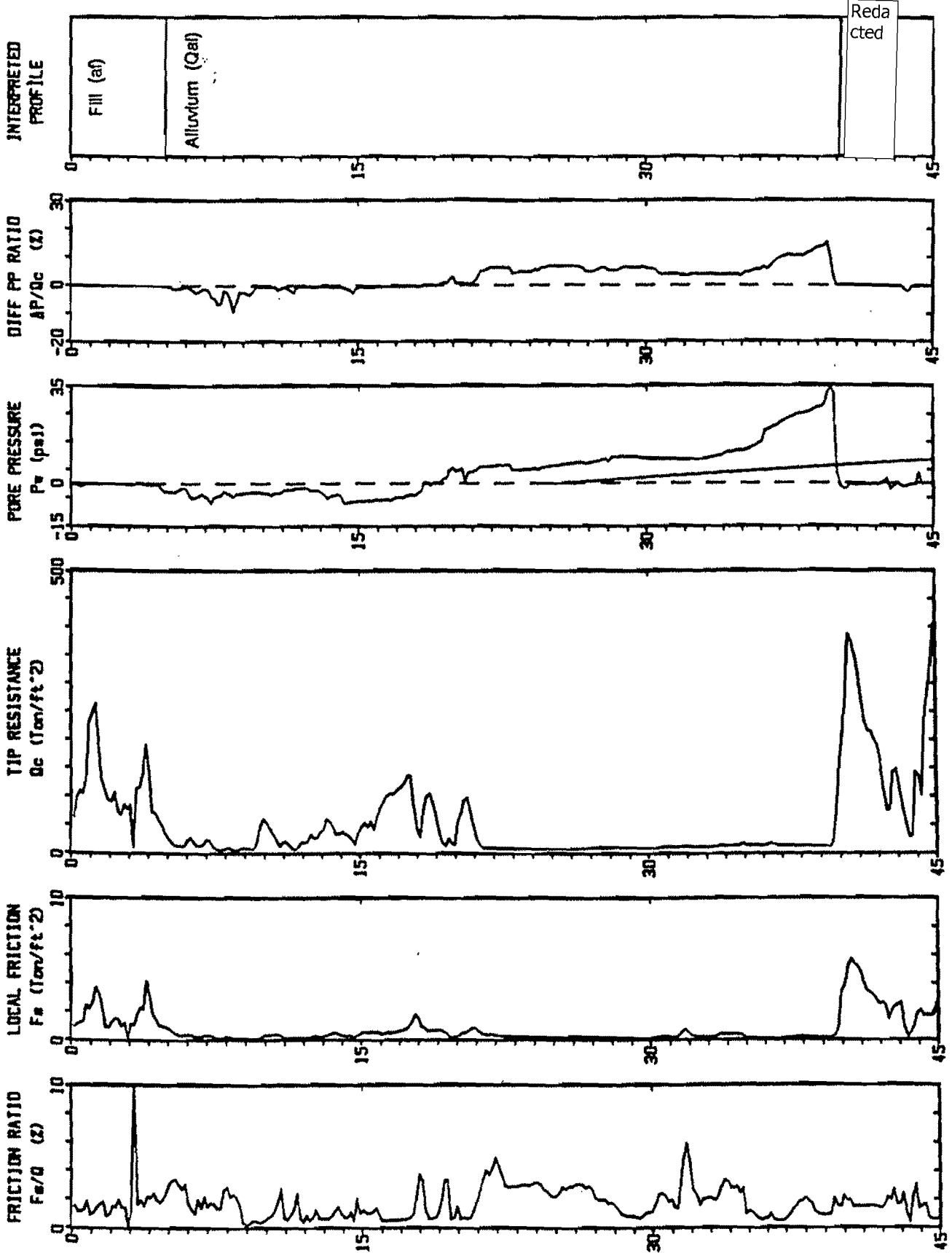
V B I

Operator :
Location : C-32

CPT Date : 05-31-84 12.43
Cone Used : HD 322 TC -U2

Sounding : 94Z180 Pg 1 / 2
Job No. : SF94011

Redacted



Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-32

Elevation:	44.31
Redacted	

PLATE B-32

SB_GT&S_0037426

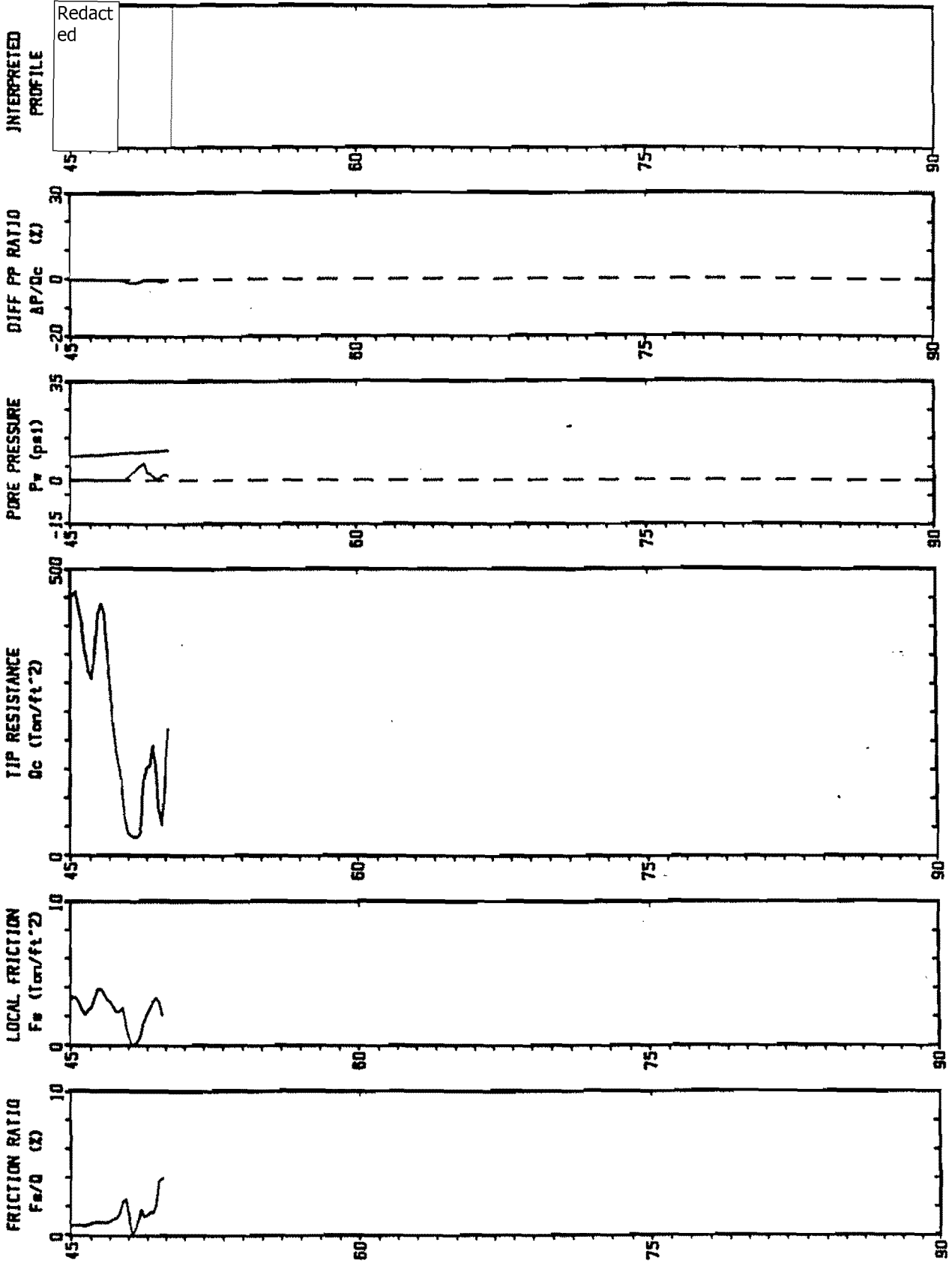
V B I

Operator :
Location : C-32

CPT Date : 05-31-84 12:43
Cone Used : HO 322 TC -U2

Redacted

Sounding : 94Z160 Pg 2 / 2
Job No. : SF94011



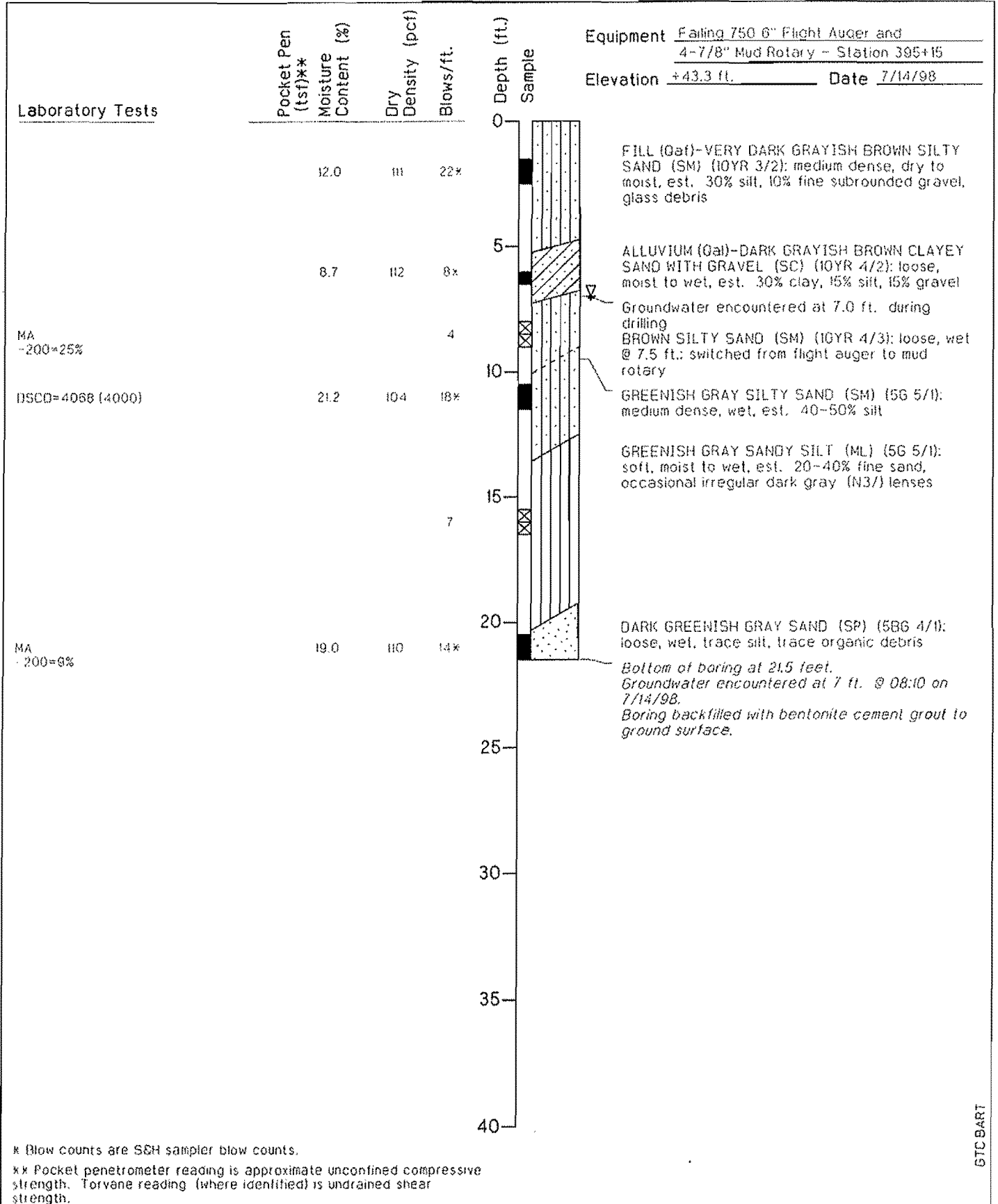
Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-32 (Cont.)

PLATE B-32



GTC BART

Figure

* Blow counts are S&H sampler blow counts.
 ** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.



Harding Lawson Associates
 Engineering and Environmental Services

Log of Boring B-201
 Module 2 - BART Extension to SFO
 San Mateo County, California

A-1

DRAWN CEG	JOB NUMBER 40646 4E	APPROVED Redact	DATE 8/98	REVISED DATE
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LOG OF DRILL HOLE

SanBrunoG.T-LineRuptureInvestigation_DR_CPUC_213-Q03A4ch01

LOGGED BY: Redacted

DRILL HOLE NO.: B-26

CHECKED BY: Redacted

DRILLING DATE: May 18, 1994

ELEVATION: 43.50 feet

DATE: NGVD

JOB NO.: SF04011

PROJECT: BART SFO Airport Extension

LOCATION: Redacted

DRILLING METHOD: 4 7/8" diameter Rotary Wash with calhead

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
4							"ALLUVIUM (Gai)" SILTY SAND (SM) brown, damp to moist, loose.						GS
10		9					"ALLUVIUM (Gai)" SANDY SILT (ML) brown, moist, loose, fine grained sand, 52% fines.						GS
15		10					"ALLUVIUM (Gai)" POORLY GRADED SAND (SP) dark gray, moist to wet, loose, 2X fines.	100	22				Cor GS
20		15					"ALLUVIUM (Gai)" SANDY SILT (ML) dark gray, moist to wet, loose to medium dense, 61% fines.						GS
30		12					"ALLUVIUM (Gai)" POORLY GRADED SAND with silt (SP-SM) gray, moist to wet, medium dense, medium to fine grained sand, 11% fines.						GS
40		56					"ALLUVIUM (Gai)" FAT CLAY (CH) black, moist, soft to medium stiff, organic content 14%.	39	55	22			OR
45		75/10"					"ALLUVIUM (Gai)" CLAYEY SAND TO SILTY SAND (SC/SM) light blue-gray, moist, medium dense, root fragments.						
50		13					Redacted POORLY GRADED SAND with silt (SP-SM) dark blue-gray, moist, very dense, with black staining and a layer of black clayey sand (SC) at 35 feet, some roots, weakly cemented.						
55		80/1"					Redacted SILT (ML) blue-gray, moist, very dense, 6-inch layer of clay (CL-ML) at 40 1/2 feet, occasional layers of fine grained sand.						
60							Redacted LEAN CLAY (CL) light blue-gray, moist, stiff to very stiff, with brown organic bands at 1 to 2-inch spacing.						
65							Redacted SILTY SAND (SM) light blue-gray, moist, very dense, fine grained sand.	122	14	31	13		
70							Redacted LEAN CLAY (CL) light orange-brown, moist, very stiff.						

SHEET 1 of 2

LEGEND TO LOGS ON PLATE A-10

PLATE A-2.26

LOG OF DRILL HOLE

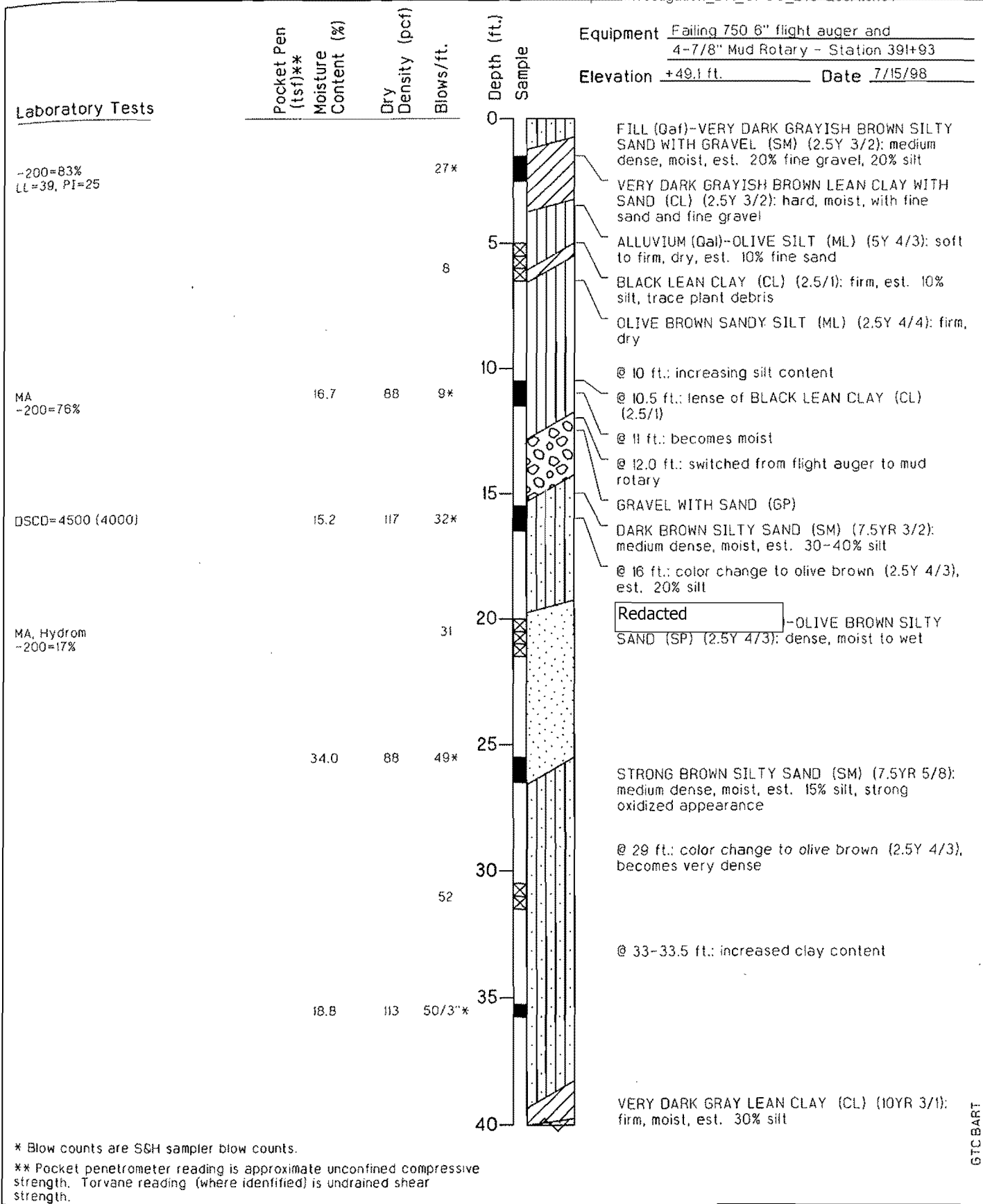
San Bruno CT Line Rupture Investigation_DR_CPUC_213-Q03Atch01

WELL NO.: SF0401
 PROJECT: BART SEA Airport Extension
 LOCATION: Redacted
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: Redacted
 CHECKED BY: Redacted

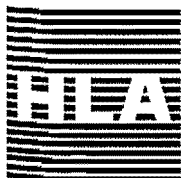
DRILL HOLE NO.: B-26
 DRILLING DATE: May 18, 1994
 ELEVATION: 43.50 feet
 DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPH)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
62 7/8"				3.5			Redacted						
50 5"							SILTY SAND (SM) light orange, moist, very dense, with light gray and dark orange banding, fine grained sand, some fine gravel in layers. Some coarse to fine sand in layers and also some fine gravel 1/2 to 1-inch layers.						
50 5"							Light gray-brown, medium to fine grained sand.						
75							Driller reports hard lense at 78 feet, clay in sand at 79 feet.						
75							80 feet: Clay lenses (stiff) light gray, in cuttings. 80.5 feet: 7-inch layer of silty sand (SM) gray, fine grained sand.						
85							Redacted LEAN CLAY (CL) gray, mottled with brown, moist, stiff, appears to be organic (sulfur odor), layer of fine sand.						
							Bottom of drill hole at 81 1/2 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.						
85													
105													



* Blow counts are S&H sampler blow counts.
 ** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.

GTC.BART



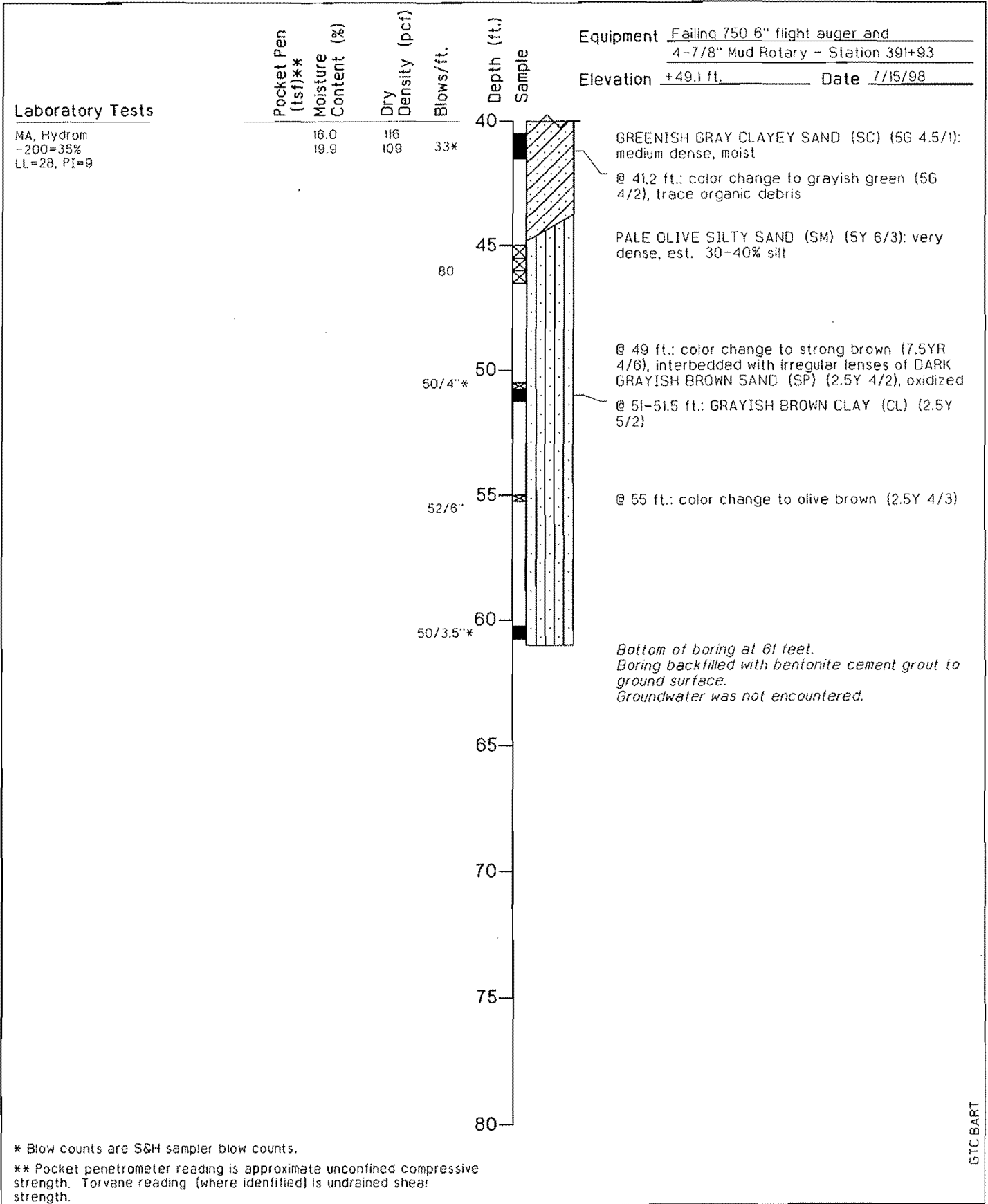
Harding Lawson Associates
 Engineering and Environmental Services

Log of Boring B-202
 Module 2 - BART Extension to SFO
 San Mateo County, California

Figure

A-2

DRAWN CEG	JOB NUMBER 40646 4E	APPROVED Redacte	DATE 8/98	REVISED DATE
--------------	------------------------	---------------------	--------------	--------------



* Blow counts are S&H sampler blow counts.

** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.

GTCBART

Figure



Harding Lawson Associates
Engineering and Environmental Services

Log of Boring B-202
Module 2 - BART Extension to SFO
San Mateo County, California

A-2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CEG	40646 4E	Redacted	8/98	

Operator : Redacted
Location : C-33

CPT Date : 05-28-84 15:29
Cone Used : HD 322 TC -U2

Sounding : 84Z145 Pg 1 / 1
Job No. : SF94011

INTERPRETED PROFILE

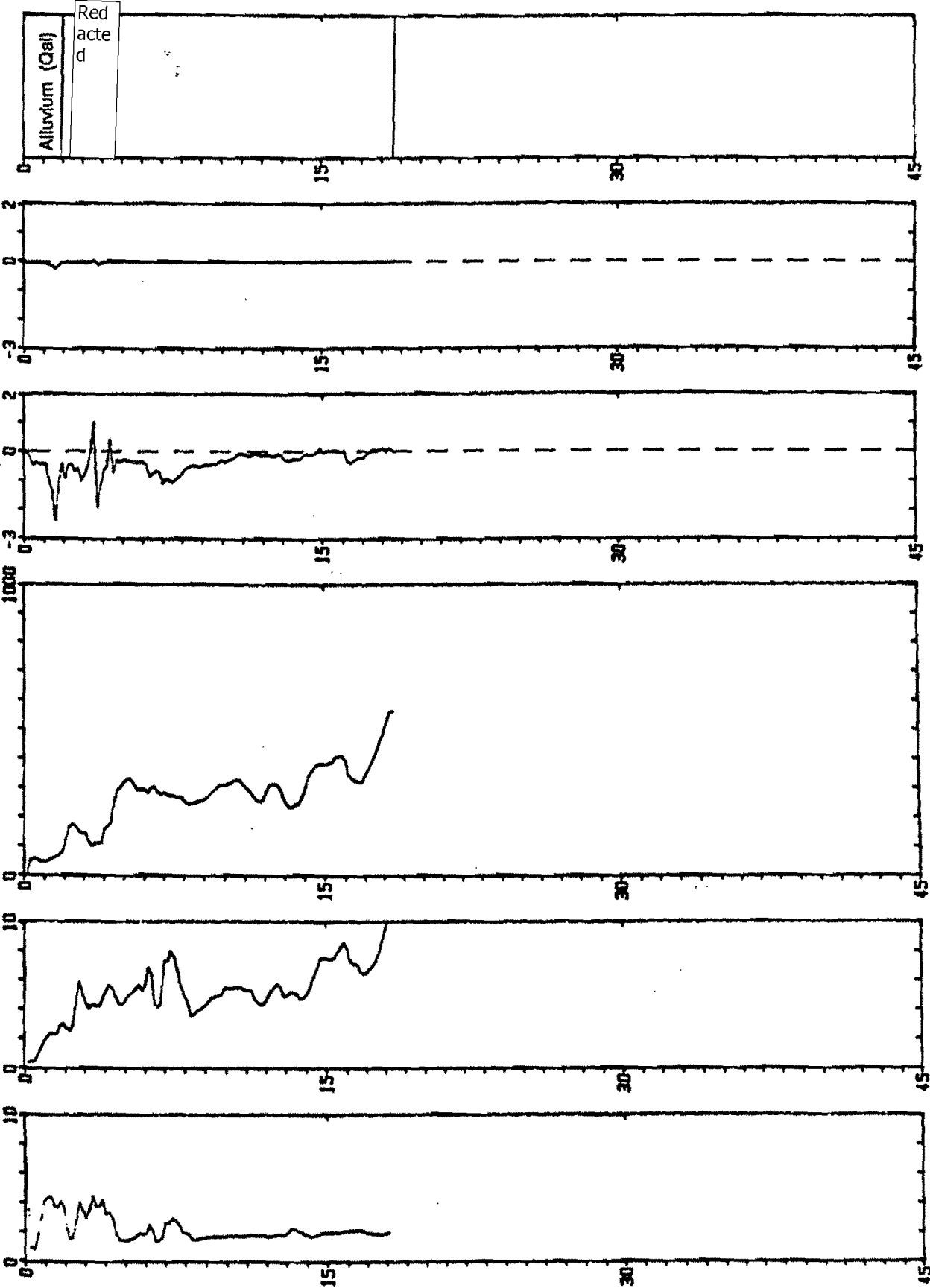
DIFF PP RATIO $\Delta P/Dc$ (%)

PURE PRESSURE P_v (psf)

TIP RESISTANCE Q_c (Ton/ft²)

LOCAL FRICTION F_s (Ton/ft²)

FRICTION RATIO F_s/Q (%)



Max Depth : 18.54 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-33

Elevation:	43.76
Redacted	

LOG OF DRILL HOLE

Investigation_DR_CPUC_213-Q03Atch01

JOB NO.: SF94011
 PROJECT: BART SFO Airport Extension
 LOCATION: Redacted
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: Redacted
 CHECKED BY: Redacted

DRILL HOLE NO.: B-27
 DRILLING DATE: May 18, 1994
 ELEVATION: 44.32 feet
 DATUM: NGVD

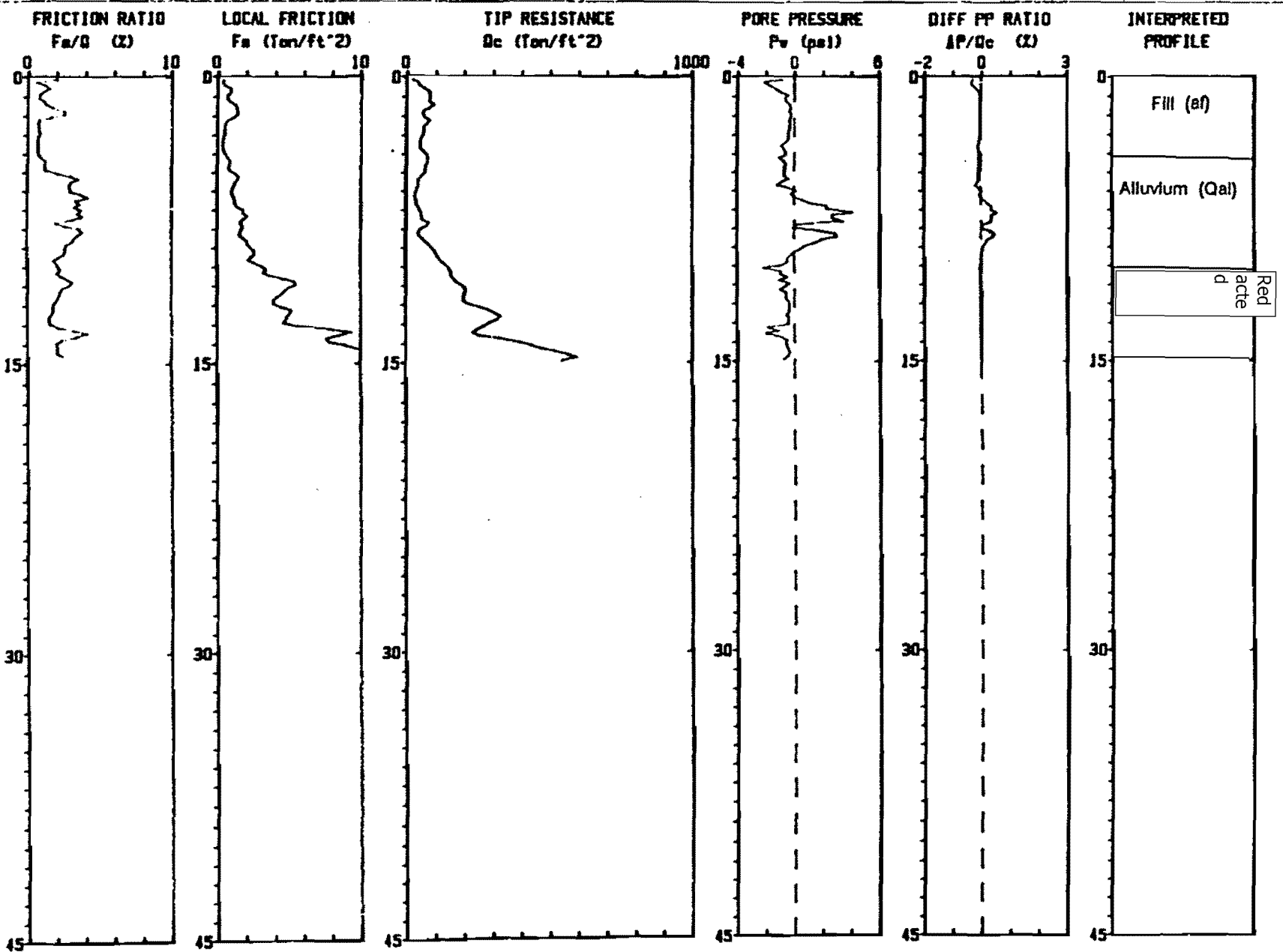
DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVAINE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPH)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
							"ARTIFICIAL FILL (af)" SILTY SAND with gravel (SM) brown, damp, medium dense.						
		48					"ALLUVIUM (Oa1)" SILTY SAND with gravel (SM) brown, damp, dense. Redacted						
10		82/11"					POORLY GRADED SAND with silt (SP-SM) light orange-brown with orange bands, damp, dense, fine grained sand. Silt in bands, very dense, 11% fines.						GS
		83/11"					15 to 15 1/2 feet: Light gray-brown, wet. 15 1/2 feet: Light gray-brown with thin black stripes, moist, fine grained sand.						
20		83/10"					Light brown, moist, with orange bands, fine grained sand.						
		78/11"					Dark orange bands, moist to wet.						
30		50/4"					Dark gray-brown with frequent thin layers of organics, no orange coloring.						
		50/3"					Redacted POORLY GRADED SAND with silt (SP-SM) gray-brown, moist, very dense, fine grained sand and some fine gravel, 11% fines.						GS
40		50/4"					Redacted						
		79					SILTY SAND (SM) gray-brown, moist, very dense.						
50		77					Redacted SILTY SAND/SANDY SILT (SM/ML) gray-brown, moist, very dense, fine grained sand, bands of coarse and coarse to fine grained sand spaced 3 to 4-inches.						
							Bottom of drill hole at 51 feet.						

V B I

Operator : Redacted
 Location : C-34

CPT Date : 05-26-84 15:07
 Cone Used : HO 322 TC -U2

Sounding : 942144 Pg 1 / 1
 Job No. : SF94011



Depth Increment : .05 m

Max Depth : 14.93 ft

(top) H1P30
 CPT-34

Elevation: 43.85
 Redacted

PLATE B-34

LOG OF DRILL HOLE

San Bruno Gas Line Rupture Investigation_DR_CPUC_213-Q03Atch01

WELL NO.: SF94011

LOGGED BY: Redacted

DRILL HOLE NO.: B-28

PROJECT: BART SFO Airport Extension

CHECKED BY: Redacted

DRILLING DATE: May 18, 1994

LOCATION: Redacted

ELEVATION: 41.37 feet

DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

DATUM: NGVD

SAMPLE	BLOW COUNT	TORVAKE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPH)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
									LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
						"ARTIFICIAL FILL (af)" SAND (SP) with cement tailings and gravel.						
						"ALLUVIUM (Qal)" SILTY SAND (SM) brown, damp, loose.						
	47					Redacted SILTY SAND (SM) light brown, moist, dense, with orange banding, 35% fines.						GS
	73					light gray-brown, some orange speckles, very dense, fine grained sand, no apparent cementation, 13% fines.						GS
	88					Dark orange bands at 15 1/2 feet, less silty.						
	80/8"					Redacted SILTY SAND (SM) light gray-brown, moist, very dense, orange and red speckles, some orange mottling in areas, fine grained sand.						
	84											
	78					Less silt, bands of orange.						
	50/5"					Redacted POORLY GRADED SAND (SP) brown with some black staining, moist, very dense.						
	86					Redacted SILTY SAND (SM) gray-brown, moist, very dense, 1-inch thick layer of silty clay at 41 feet.						
	84					Redacted WELL GRADED SAND with silt (SW-SM) light gray, moist, very dense, white mottling, medium to coarse grained sand, some fine gravel.						
	82					Blue-gray at 50 feet.						
						Redacted SILT (ML) blue-gray, moist, very dense.						
						Bottom of drill hole at 51 feet. No water measured to a depth of 41 feet on 8/13/94. Piezometer installed.						

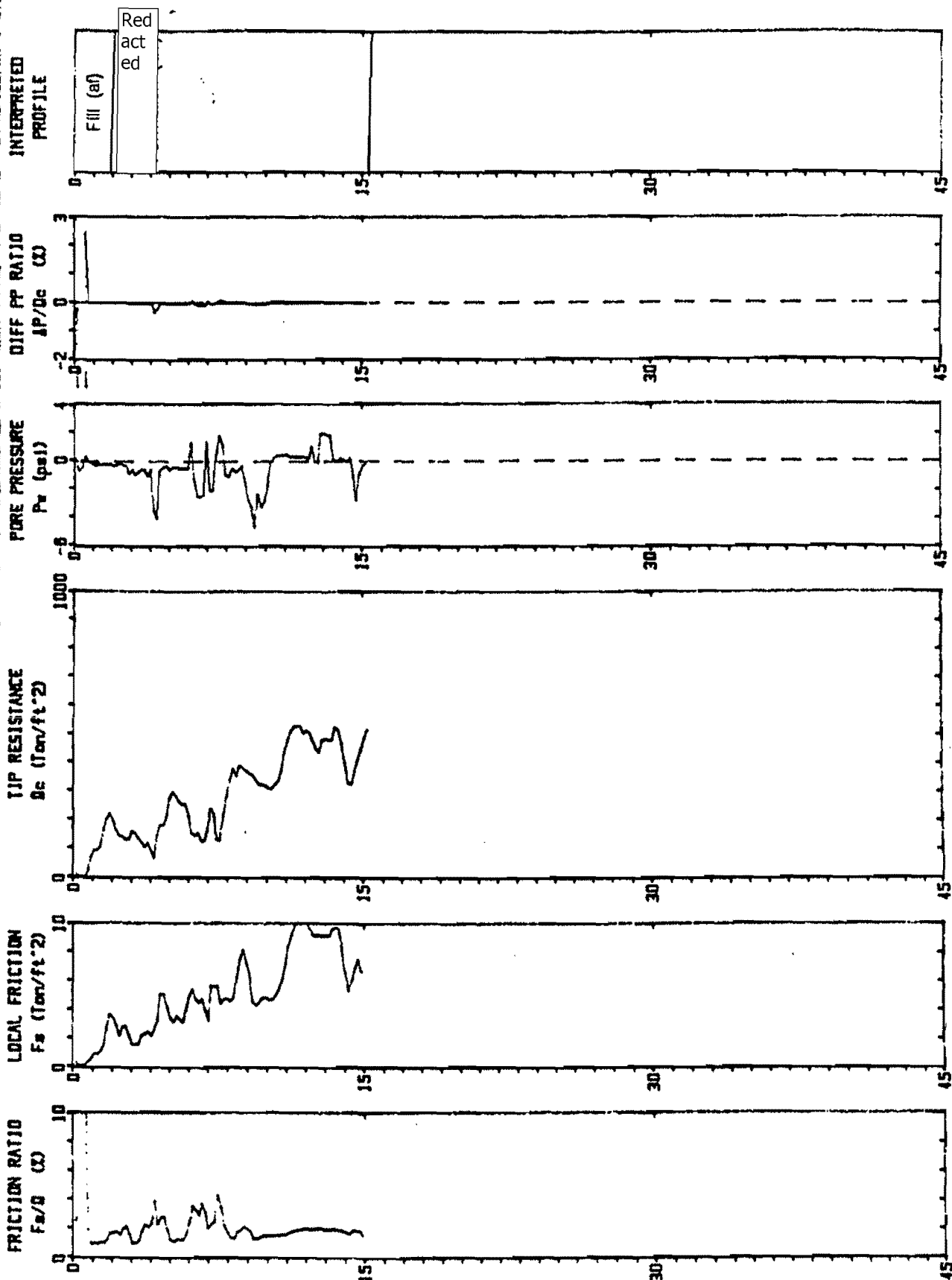
V B I

Operator :
Location : C-35

CPT Date : 05-28-94 14:24
Cone Used : HO 322 TC -U2

Sounding : 94Z143 Pg 1 / 1
Job No. : SF94011

Redacted



Redacted
Fill (af)

Max Depth : 15.26 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-35

Elevation: 41.26
Redacted

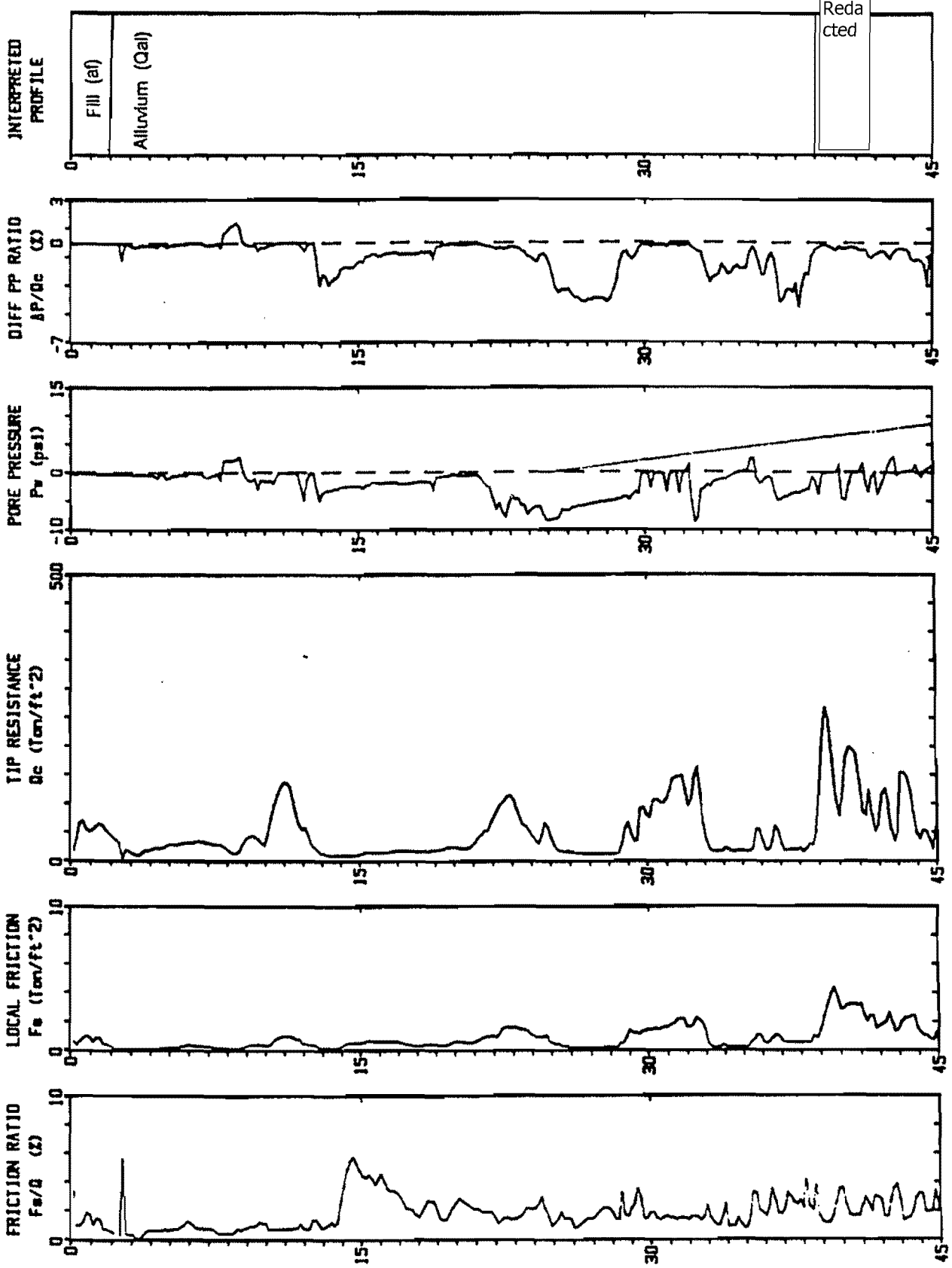
PLATE B-35

V B I

Operator : Redacted
 Location : C-38

CPT Date : 05-26-94 13:00
 Cone Used : HO 322 TC -U2

Sounding : 842141 Pg 1 / 2
 Job No. : SF94011



Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-36

Elevation: 35.89
Redacted

PLATE B-36

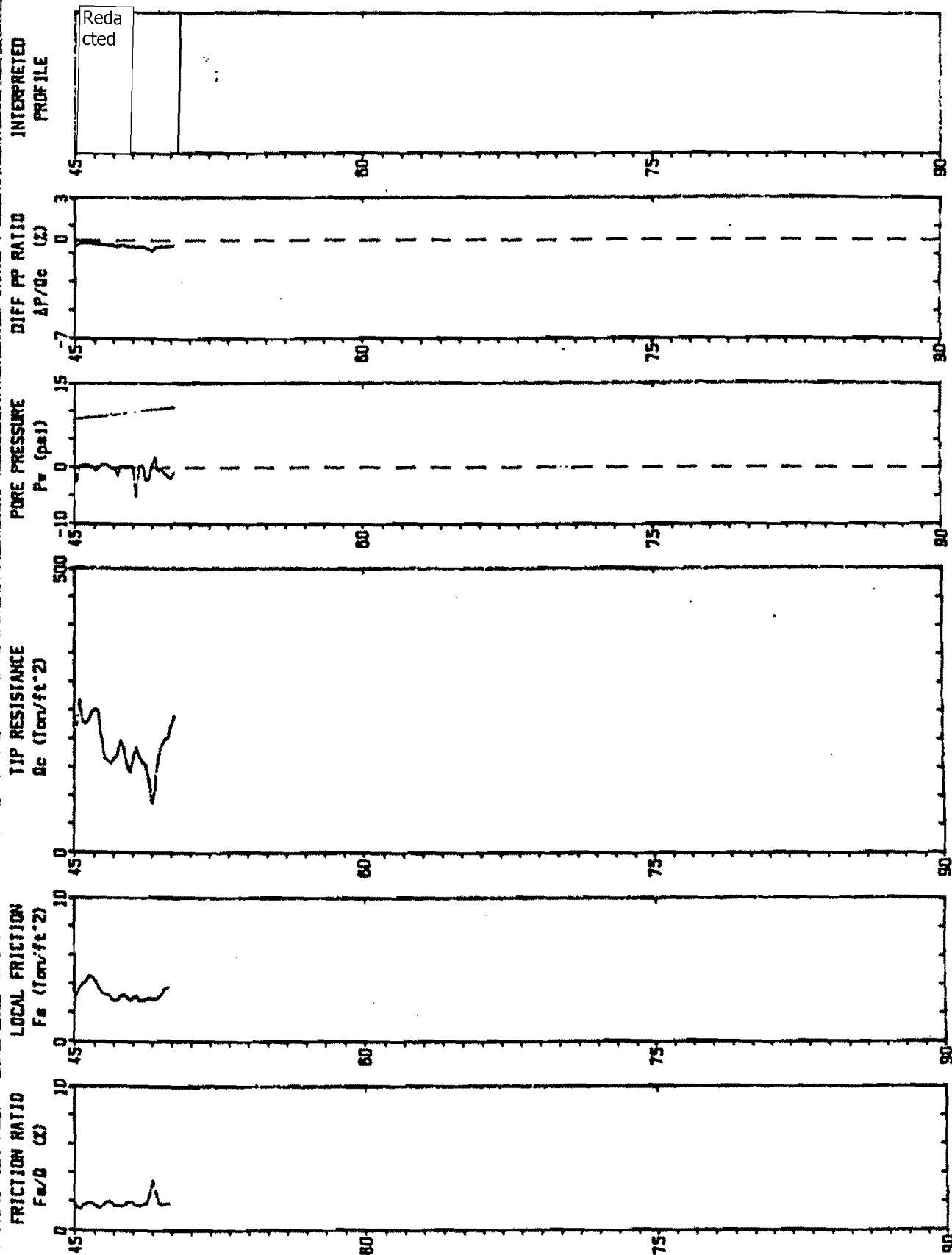
V B I

Operator : Redacted
Sounding : 84Z141 Pg 2 / 2
Job No. : SF94011

CPT Date : 05-26-94 13:00
Cone Used : HO 322 TC -U2

Redacted

Location : C-36



Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)
CPT-36 (Cont.)

PLATE B-36

LOG OF DRILL HOLE

Case: RuptureInvestigation_DR_CPUC_213-Q03Atch01

WELL NO: SF94011

LOGGED BY: Redacted

DRILL HOLE NO.: B-29

PROJECT: BART SEA Airport Extension

CHECKED BY: Redacted

DRILLING DATE: May 25, 1994

LOCATION: Redacted

ELEVATION: 31.74 feet

DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPH)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
							"ARTIFICIAL FILL (af)" POORLY GRADED SAND with gravel (SP) dark brown, dry to damp.						
		6					"ARTIFICIAL FILL (af)" SILTY SAND (SM) brown, damp, loose. Piece of glass at 5.2 feet.						
							"ALLUVIUM (Gal)" POORLY GRADED SAND with silt (SP-SM) light brown, damp, loose, fine to medium grained sand, some roots.						
10		15					"ALLUVIUM (Gal)" SILTY SAND (SM) dark brown, moist, banded with black and orange, medium dense. Wet, 14% fines.						Corr
		15											GS
20		20	1.5				"ALLUVIUM (Gal)" LEAN CLAY (CL) black, moist, stiff, moderately plastic. Marbled blue-green and gray, very stiff.	98	23	48	18	1570	C
		32	2.5					108	21	36	17	2120	
30		7					"ALLUVIUM (Gal)" SANDY SILT (ML) gray, moist, loose, organic odor, 64% fines.						GS
		16	0.7				"ALLUVIUM (Gal)" FAT CLAY (CH) with interbedded silt (ML), gray-brown, moist, medium stiff clay to medium dense silt. Light blue-green gray, heavy organic odor.	90	32	60	28	600	
40		12						87	34			820	
		23					"ALLUVIUM (Gal)" SANDY SILT (ML) gray, moist, medium dense, 66% fines.	64	54				GS
50		12					"ALLUVIUM (Gal)" LEAN CLAY (CL) alternating with layers of silt (ML) dark brown, moist, very stiff clay to medium dense sat. Organic content 1.4%.		30	40	33		OR

LOG OF DRILL HOLE

San Bruno CF-Line Rupture Investigation_DR_CPUC_213-Q03Atch01

PROJECT: PART SEO Airport Extension
 LOCATION: Redacted
 METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: Redacted
 CHECKED BY: Redacted

DRILL HOLE NO.: B-29
 DRILLING DATE: May 25, 1994
 ELEVATION: 31.74 feet
 DATUM: NGVD

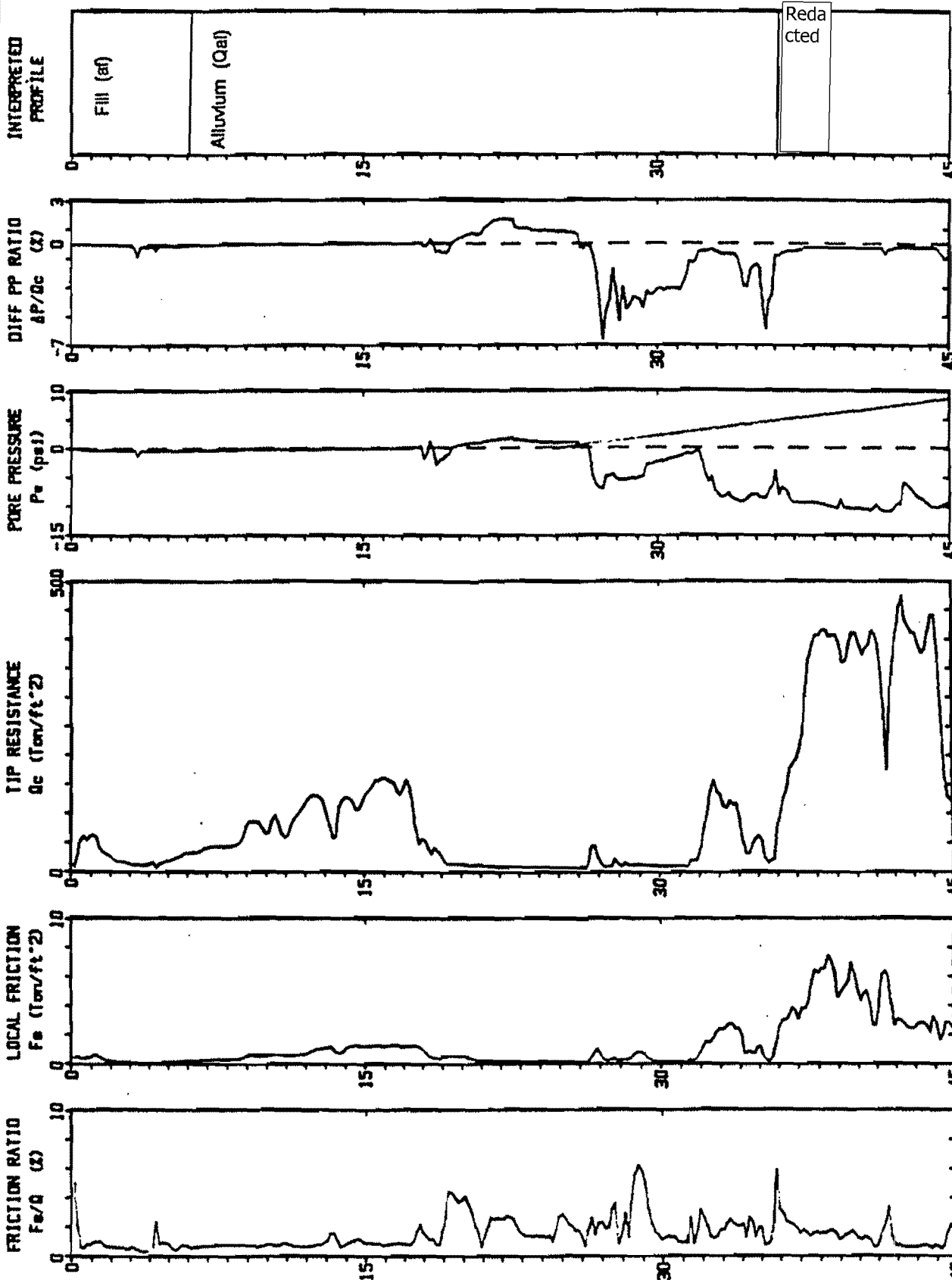
DEPTH (FEET)	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPH)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
									LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
44						Redacted SILTY (ML) green veins, black banding throughout, moist, dense.						
30						Light gray with dark orange speckles at 60 feet.						
60						Redacted SILTY SAND (SM) light gray-brown, moist, very dense, orange speckles.						
50/6"						Redacted WELL GRADED SAND (SW) red-brown to orange, moist, very dense.						
						Redacted SILTY SAND (SM) light gray-brown, moist, very dense. Bottom of drill hole at 70 1/2 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.						

V B I

Sounding : 842139 Pg 1 / 2
Job No. : SF94011

CPT Date : 05-28-94 10:36
Cone Used : HD 322 TC -U2

Operator :
Location : C-37



Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-37

Elevation:	29.45
Redacted	

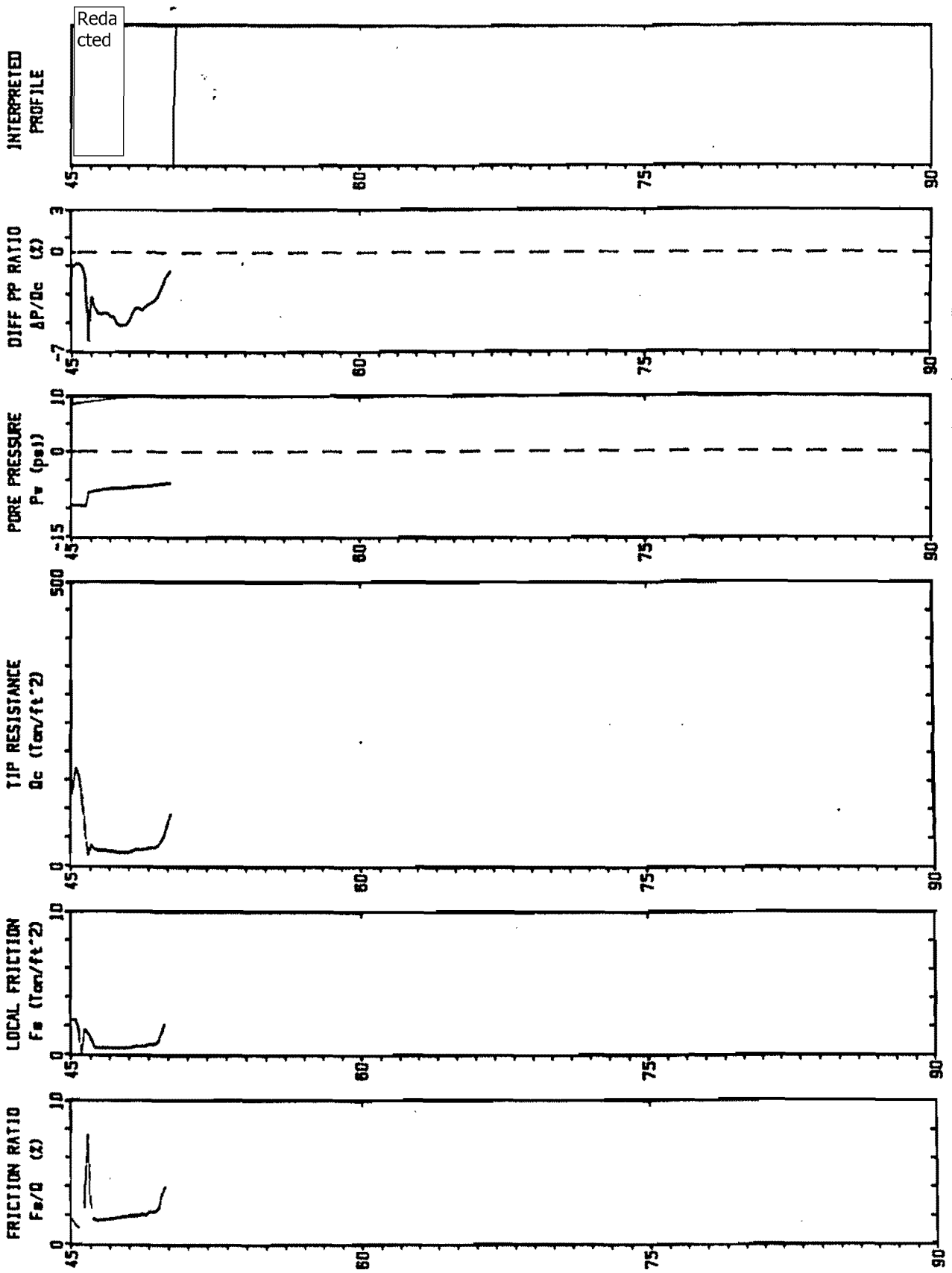
PLATE B-37

V B I

Operator : Redacted
Location : C-37

CPT Date : 05-28-84 10:36
Cone Used : MD 322 TC -U2

Sounding : 94Z139 Pg 2 / 2
Job No. : SF94011



Max Depth : 50.20 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-37 (Cont.)

PLATE B-37

LOG OF DRILL HOLE

RuptureInvestigation_DR_CPUC_213-Q03Atch01

JOB NO.: SF94011

LOGGED BY: Redacted
 CHECKED BY: Redacted

DRILL HOLE NO.: B-30

DRILLING DATE: May 25, 1994

PROJECT: BART SFO Airport Extension

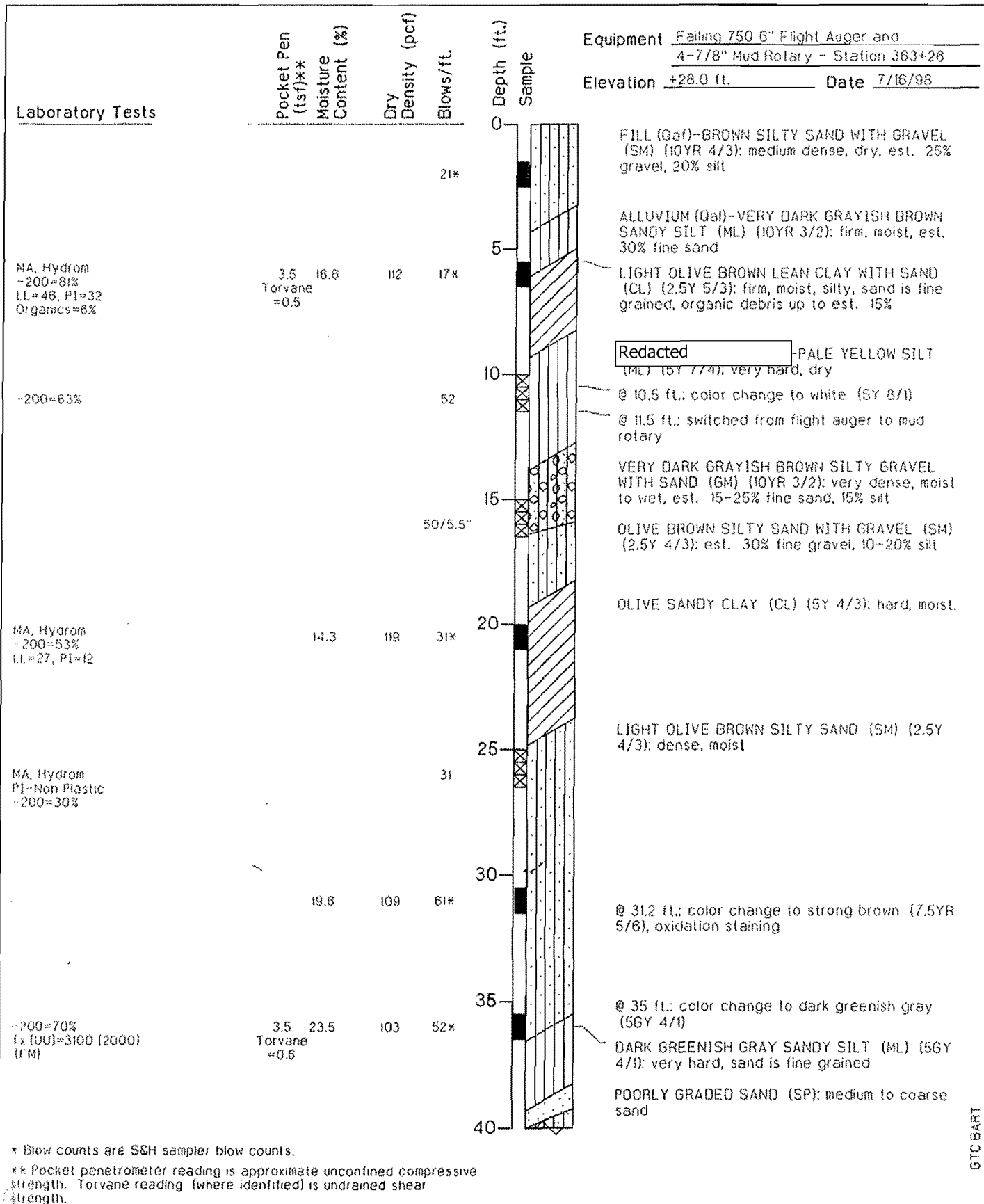
ELEVATION: 27.48 feet

LOCATION: Redacted

DATUM: NGVD

DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
0		9					"ARTIFICIAL FILL (af)" SILTY SAND with gravel (SM) light brown, dry to damp, loose, roots, angular gravel to 1 1/2-inch diameter.						
5		18					5 feet: Treated wood timber, old railroad tie? Debris interfering with drilling to 13 feet.						
10													
15		32					"ARTIFICIAL FILL (af)" LEAN CLAY (CL) brown, moist.						
20		77					"ALUVIUM (al)" SILT (ML) marbled light brown and gray, damp to moist, dense, bands of fine grained sand.						
25							Redacted SILTY SAND (SM) brown, dry, very dense, pink-white mottling, carbonate veins, some fine gravel, weakly cemented.	115	10				
30		30					Marbled light gray-brown and orange-brown, moist, very fine sand, weakly cemented. Gray-brown, friable, moist to wet, dense, 30% fines.						GS
35							Redacted SANDY SILT (ML) light blue-gray, moist, dense, with black and brown lenses, fine grained sand.						
40		54					Very dense, 53% fines.						GS
45		27	2.5				Redacted LEAN CLAY (CL) dark brown, moist, very stiff, some silt and fine grained sand.	108	21			2730	
50		24					Redacted SILT (ML) light blue-gray, moist, medium dense.						
51 1/2							Bottom of drill hole at 51 1/2 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.						



GTC/BART

* Blow counts are S&H sampler blow counts.
 ** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.



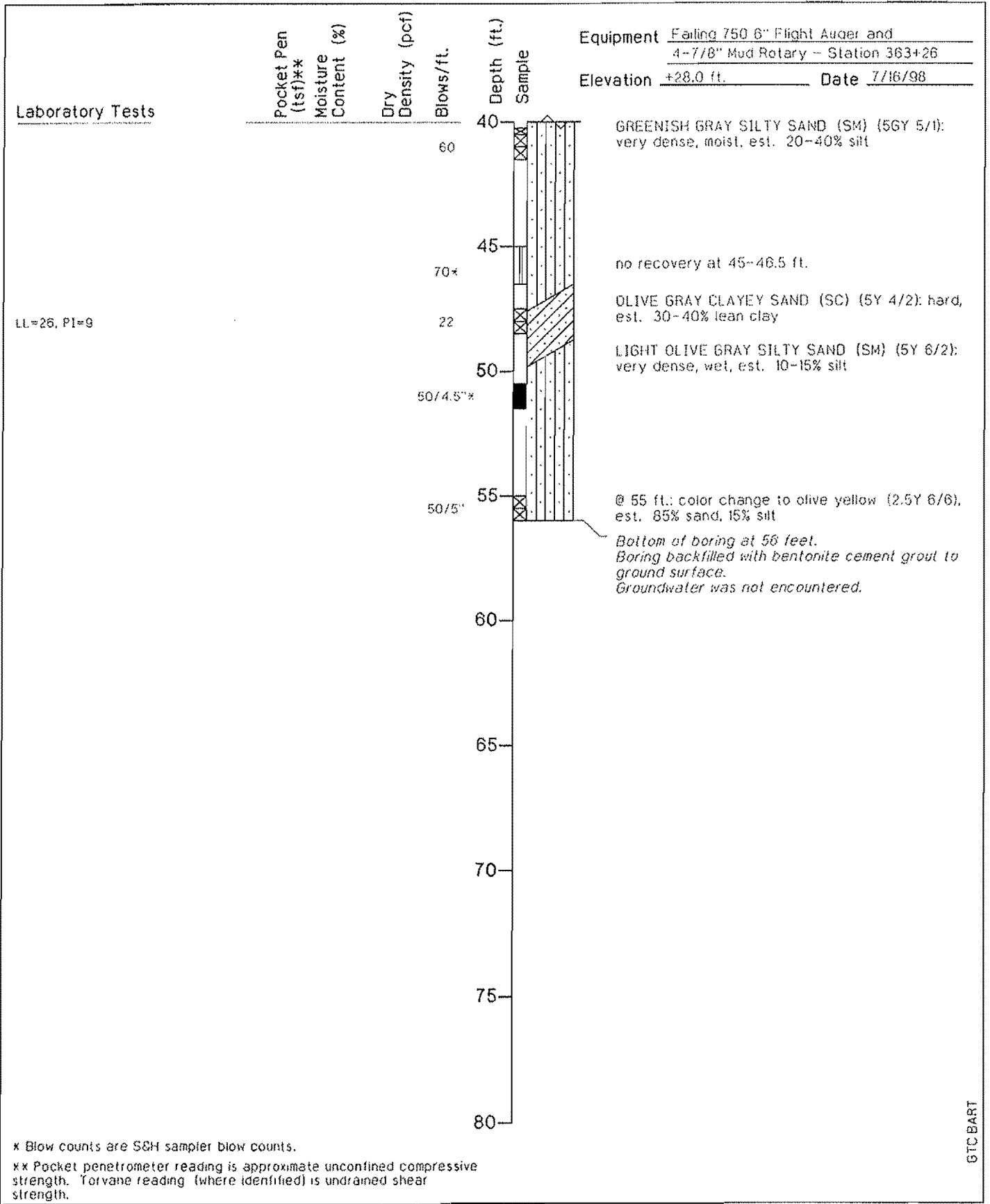
Harding Lawson Associates
 Engineering and Environmental Services

Log of Boring B-203
 Module 2 - BART Extension to SFO
 San Mateo County, California

A-3

Figure

DRAWN CEG	JOB NUMBER 40646 4E	APPROVED Redacted	DATE 9/98	REVISED DATE
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Figure



Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring B-203
Module 2 - BART Extension to SFO
San Mateo County, California

A-3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CEG	40646 4E	Redact	9/98	

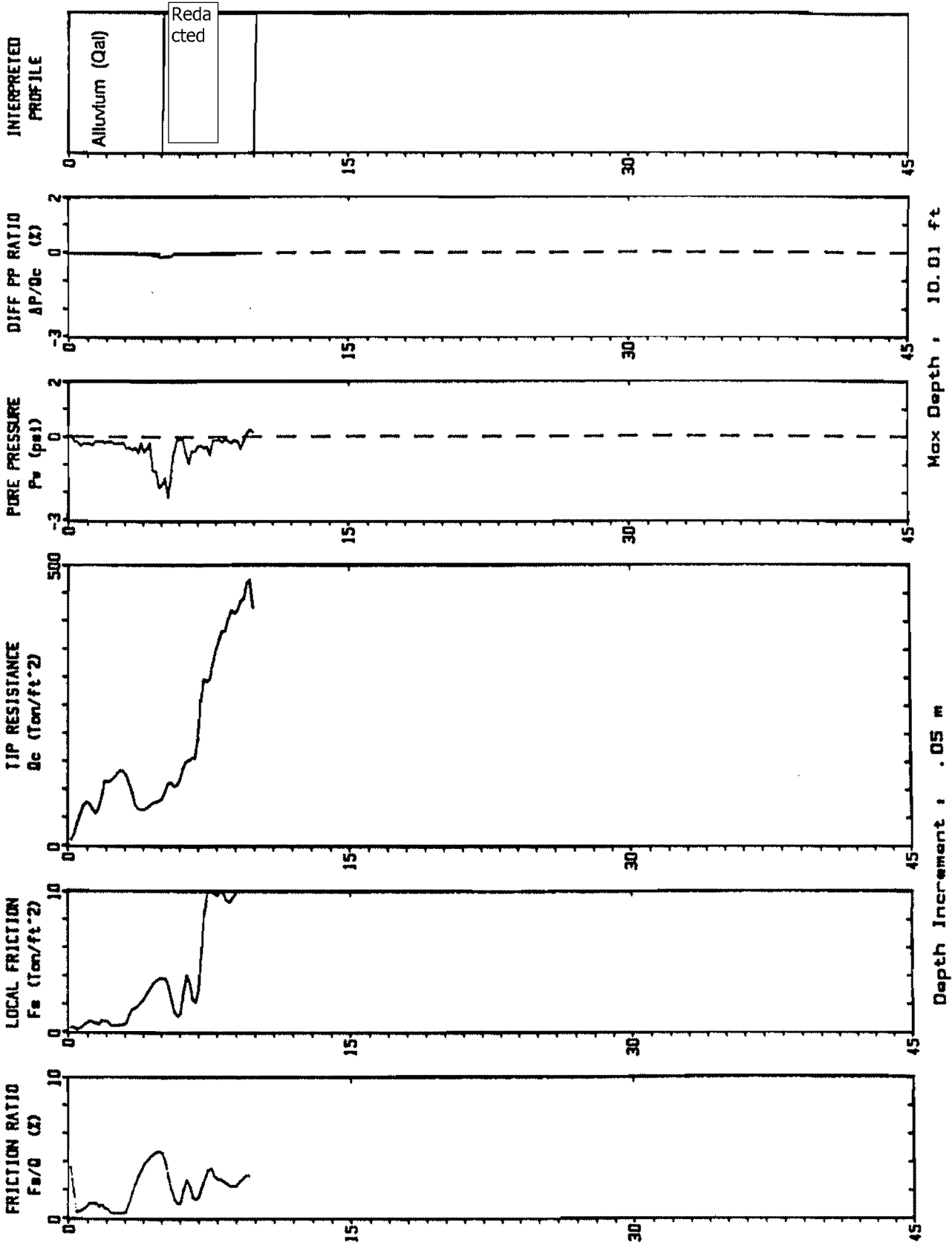
V B I

Sounding : 94Z138 Pg 1 / 1
Job No. : SF94011

CPT Date : 05-26-94 10:02
Cone Used : HD 322 TC -U2

Operator : Redacted

Location : C-38



Max Depth : 10.01 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-38

Elevation:	24.45
Redacted	

PLATE B-38

LOG OF DRILL HOLE

San Bruno Pipeline Rupture Investigation_DR_CPUC_213-Q03A1ch01

WELL NO: SF9401
 PROJECT: BART SFO Airport Extension
 LOCATION: Redacted
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: Redacted
 CHECKED BY: Redacted

DRILL HOLE NO.: B-31
 DRILLING DATE: May 24, 1994
 ELEVATION: 24.40 feet
 DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVADE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPM)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
						[Hatched Pattern]	"ARTIFICIAL FILL (af)" GRAVELLY SAND (SP) brown, dry to damp, medium dense.						
						[Hatched Pattern]	"ALUVIUM (Qal)" SANDY CLAY (CL) brown, moist, stiff. 2 feet: Roots, some coarse gravel.						
30		30		3.0		[Hatched Pattern]	Redacted LEAN CLAY (CL) light brown, moist to damp, very stiff, with red and black speckles.	112	17	41	22	2780	C
10		69				[Vertical Lines]	Redacted SANDY SILT (ML) light brown, damp, very dense, some orange mottled veins, 40% sand.						GS
						[Vertical Lines]	Redacted SILTY SAND (SM) light brown, damp, very dense, layers of poorly and well graded sand in veins, orange to dark orange, 38% fines.						GS
20		55				[Vertical Lines]	Redacted SILTY SAND with gravel (SM) marbled orange and red-brown, moist, very dense, fine gravel in layers, well rounded, medium to coarse grained sand.						
						[Vertical Lines]	Thin layer of silt at 25 feet, 28% fines, no gravel.	108	14				GS DS
30		57				[Vertical Lines]	Redacted SILTY SAND (SM) gray-brown, moist, very dense, layers of silt and veins with fine to coarse grained sand, red-brown.						
						[Vertical Lines]	Driller notes sandy gravel.						
						[Vertical Lines]	2-inch thick dense layer of silt (ML) and medium to fine grained sand.						
40		58				[Vertical Lines]	Moist to wet, very dense, interbedded with layers of fine gravel and fine grained sand.						
						[Vertical Lines]	Redacted CLAYEY SAND (SC) light greenish to yellow-brown with orange banding, moist, medium dense, fine grained sand, 27% fines.						GS
						[Vertical Lines]	Redacted SILTY SAND (SM) light orange-brown, moist, dense, fine grained sand.						
50		81				[Vertical Lines]	Banded orange and tan, very dense. Redacted						
				4.5		[Vertical Lines]	Redacted LEAN CLAY with sand (CL) light gray-brown, moist, hard, fine grained sand.						

Bottom of drill hole at 51 1/2 feet.
 Groundwater measured at 34 feet depth on 6/13/94.
 Piezometer installed. SEND TO LOGS ON PLATE A-1.0

V B I

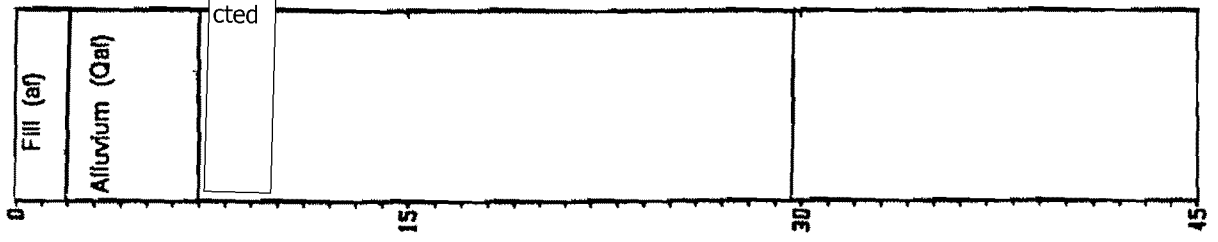
Sounding : 94Z137 Pg 1 / 1
Job No. : SF94011

CPT Date : 05-28-94 09:22
Cone Used : HQ 322 TC -U2

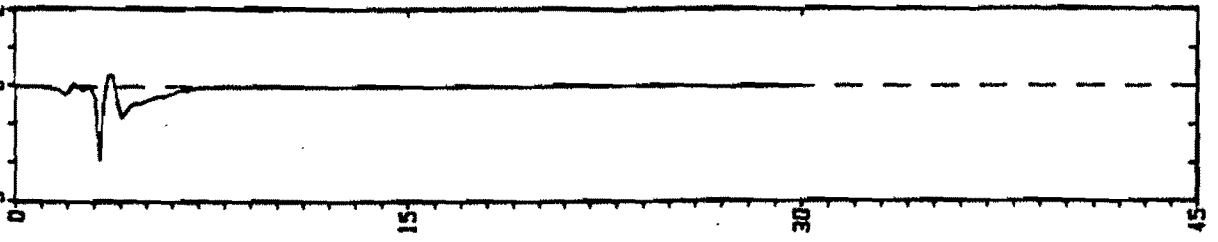
Operator :
Location : C-39

Redacted

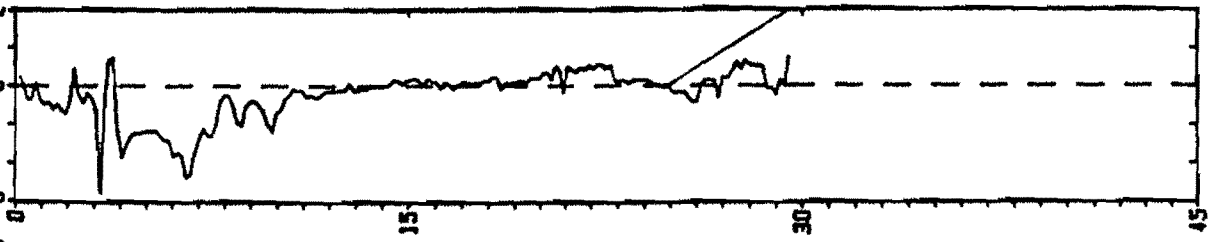
INTERPRETED PROFILE



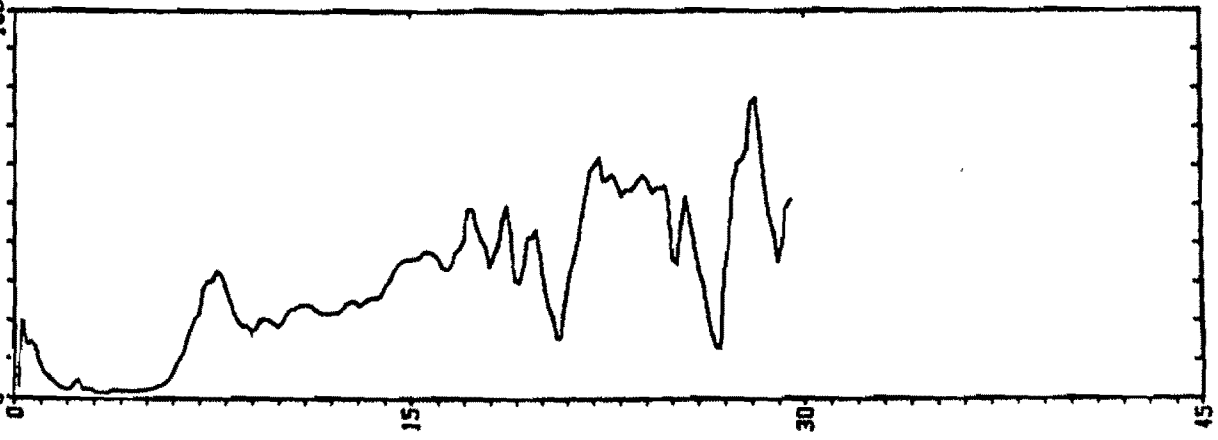
DIFF PP RATIO
 $\Delta P/Q_c$ (X)



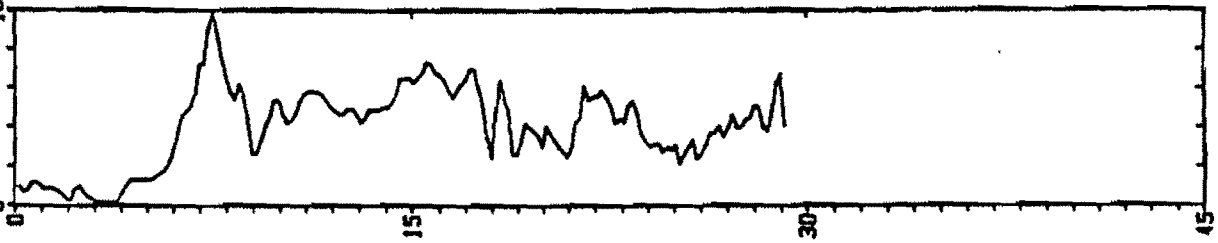
PORE PRESSURE
 P_v (psf)



TIP RESISTANCE
 Q_c (ton/ft²)



LOCAL FRICTION
 F_s (ton/ft²)



FRICTION RATIO
 F_s/Q_c (X)



Max Depth : 29.53 ft

Depth Increment : .05 m

DEPTH (feet)

CPT-39

Elevation: 24.37
Redacted

PLATE B-39

SB_GT&S_0037449

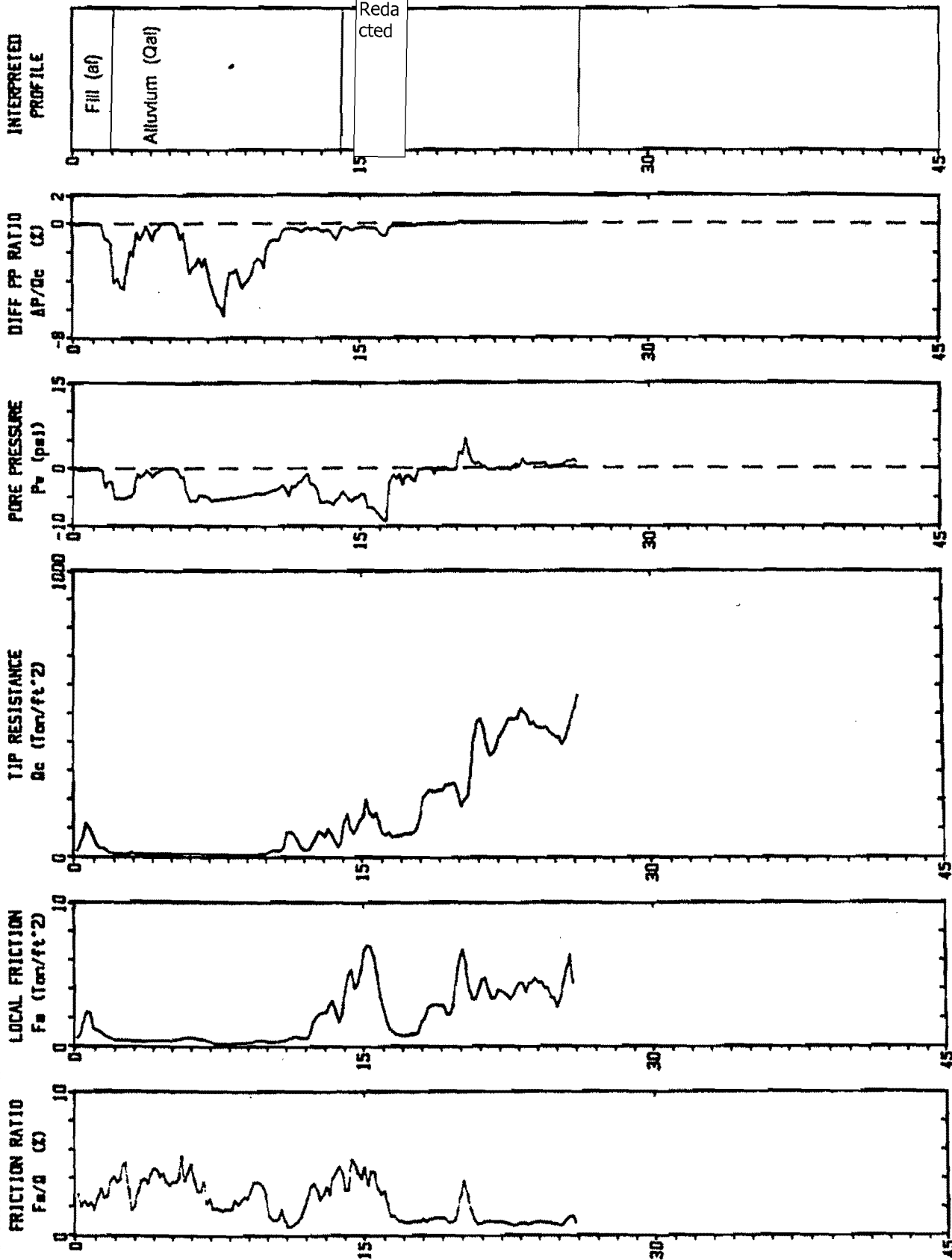
V B I

Sounding : 94Z140 Pg 1 / 1
Job No. : SF94011

CPT Date : 05-28-94 12:17
Cone Used : HD 322 TC -U2

Operator :
Location : C-40

Redacted



Max Depth : 26.25 ft

Depth Increment : .05 m

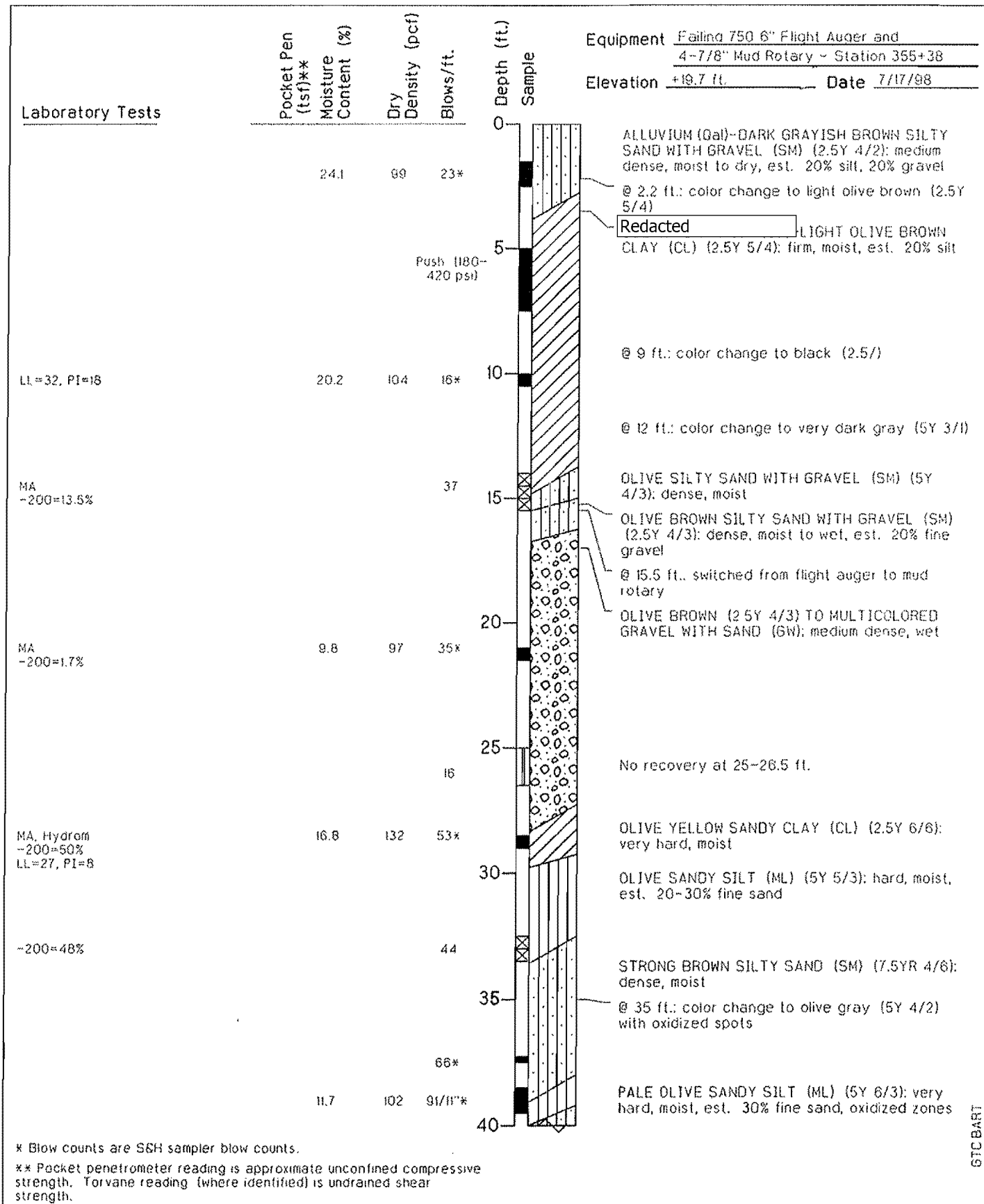
DEPTH (feet)

CPT-40

Elevation: 20.62

Redacted

PLATE B-40



GTC/BART



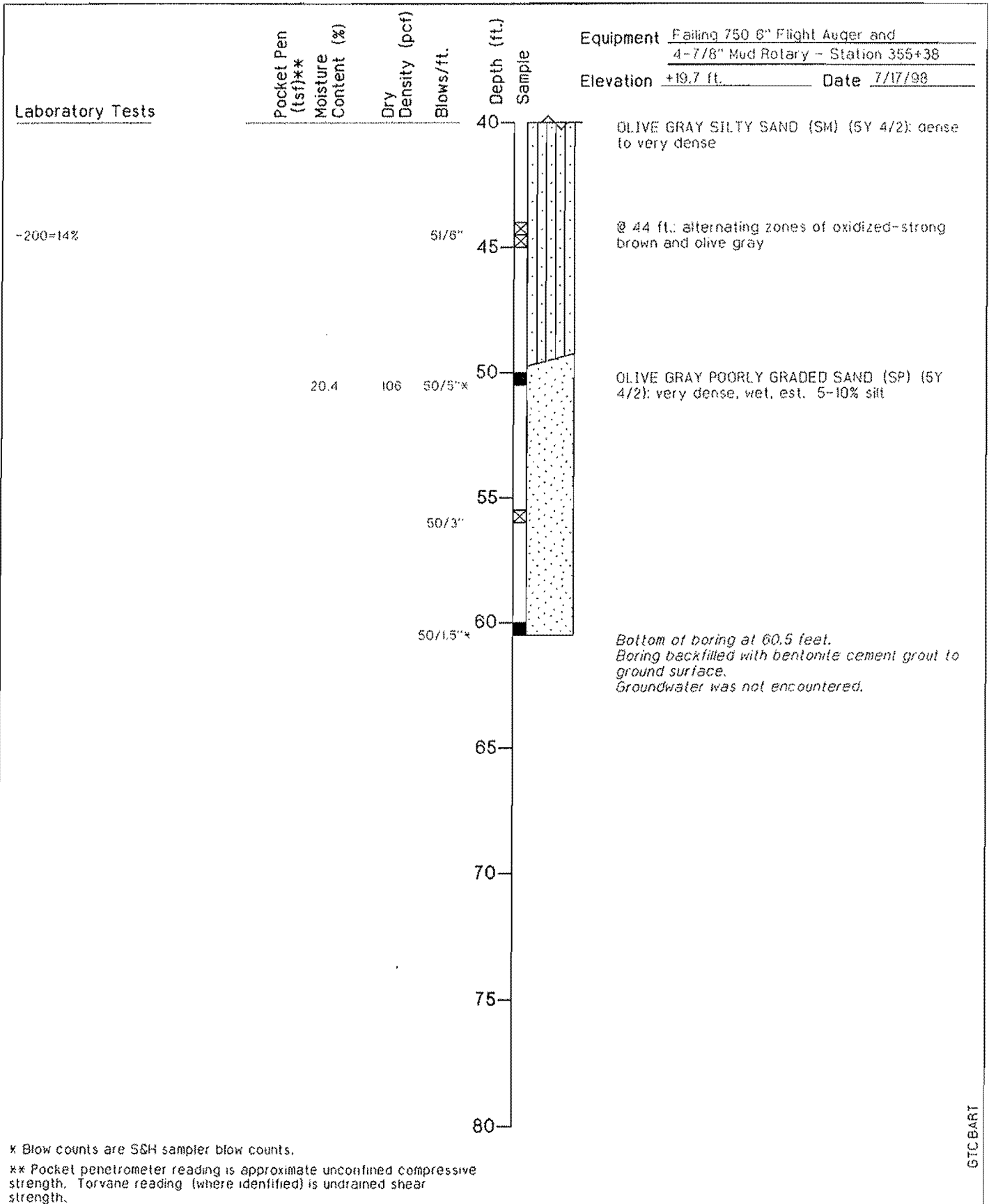
Herding Lawson Associates
 Engineering and Environmental Services

Log of Boring B-204
 Module 2 - BART Extension to SFO
 San Mateo County, California

A-4

DRAWN CEG	JOB NUMBER 40646 4E	APPROVED Redacted	DATE 8/98	REVISED DATE
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Figure



* Blow counts are SSH sampler blow counts.

** Pocket penetrometer reading is approximate unconfined compressive strength. Torvane reading (where identified) is undrained shear strength.



Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring B-204
Module 2 - BART Extension to SFO
San Mateo County, California

A-4

Figure

DRAWN CEG	JOB NUMBER 40646 4E	APPROVED Redacted	DATE 8/98	REVISED DATE
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LOG OF DRILL HOLE

(Attachment) RuptureInvestigation_DR_CPUC_213-Q03Atch01

ID NO: SF94011
 PROJECT: BART SEO Airport Extension
 LOCATION: [Redacted]
 DRILLING METHOD: 4 7/8" diameter Rotary Wash with cathead

LOGGED BY: [Redacted]
 CHECKED BY: [Redacted]

DRILL HOLE NO.: B-32
 DRILLING DATE: May 24, 1994
 ELEVATION: 32.99 feet
 DATUM: NGVD

DEPTH (FEET)	SAMPLE	BLOW COUNT	TORVANE SHEAR STRENGTH (PSF)	POCKET PENETROMETER COMP. STRENGTH (TSF)	PHOTOVAC TIP READING (PPH)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	ATTERBERG LIMITS		UNCONFINED SHEAR STRENGTH (PSF)	ADDITIONAL TESTS
										LIQUID LIMIT (%)	PLASTIC LIMIT (%)		
						[Redacted]	[Redacted] LEAN CLAY (CL) light orange-brown, moist, hard, some sand.		12	38	18		
38						[Redacted]	5 feet: 2-inch thick layer of orange mottling with medium grained sand.						
10		11				[Redacted]	SILT (ML) light brown with orange stains, moist, dense. 9 feet: Fine to coarse grained sand with fine gravel in cuttings. 10 feet: Medium dense, layers of sand [SP/SW] dark red-brown and orange, 1 to 3-inches thick.						
20		20		1.5		[Redacted]	LEAN CLAY with sand (CL) light brown, with orange bands and mottling, moist, stiff to very stiff, fine grained sand.						
20		57				[Redacted]	SILTY SAND (SM) light gray-brown, with light orange banding, moist to wet, very dense, fine grained sand.						
42		42				[Redacted]	SANDY SILT (ML) light gray-brown, moist to wet, dense, 52% fines. 26 1/2 feet: Fine to medium grained sand.	111	18			GS DS	
30		17				[Redacted]	SILTY SAND (SM) blue-gray, moist, medium dense, fine grained sand, some thin lean clay layers, 38% fines.					GS	
82		82				[Redacted]	Very dense. Light gray-brown with gray banding, fine grained sand, 13% fines.	102	20			DS	
40		70				[Redacted]		106	22			GS	
32		32		3.5		[Redacted]	LEAN CLAY with sand (CL) light brown with light orange marbling, moist, very stiff, fine grained sand.						
50		49				[Redacted]	SILTY SAND (SM) light brown to orange, moist, dense, fine grained sand.						
						[Redacted]	SILTY SAND/SANDY SILT (SM/ML) light brown, moist, dense, fine to coarse grained sand, 50% fines. Bottom of drill hole at 51 1/2 feet. Backfilled hole with soil cuttings and grouted uppermost 5 feet.					GS	

Operator :

Redacted

CPT Date : 05-25-94 15:53

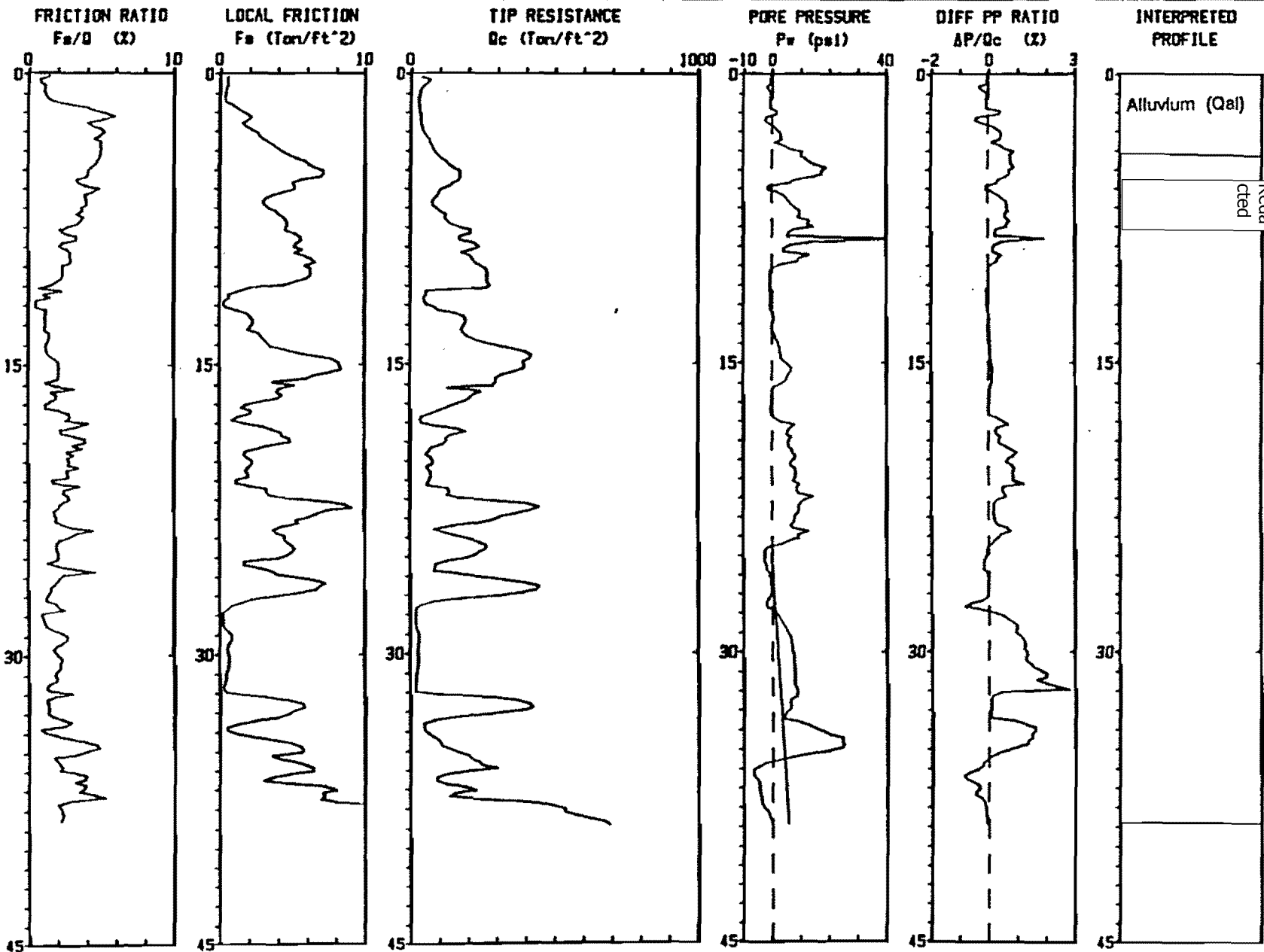
Sounding : 942136 Pg 1 / 1

Location : C-41

Cone Used : 347TC U2

Job No. : SF94011

V B I



Depth Increment : .05 m

Max Depth : 38.88 ft

(feet) H1P3C

CPT-41

Elevation: 35.86

Redacted

PLATE B-41