APPENDIX A
Procedure for Soil Sampling with Methanol Preservation

CORE SAMPLING FOR RESIDUAL NAPL SATURATION
Collection, Presentation, and Analysis Procedures

SOP-CORSAMP-1
March 1, 1998
Revision 4

PURPOSE: Measure total concentration of organic compounds in core samples. Use data to estimate residual NAPL saturation, composition, and component phase distribution.

1.0 SAMPLE CONTAINER PREPARATION

1.1 Materials

1.1.1 For samples of sediments without gravel or cobbles:

a. 40 mL amber glass vials with teflon-septa
b. purge and trap grade methanol below 8^0C
c. *25* mL graduated cylinder
d. balance with at least 0.1 gm accuracy and 100 gm capacity

1.1.2 For samples of sediments containing gravel or cobbles:

a. 4 oz. amber wide mouth jars with teflon-lined caps
b. purge and trap grade methanol below 8^0C
c. 50 mL graduated cylinder
d. balance with at least 0.1 gm accuracy and 400 gm capacity

1.2 Procedure

1.2.1 For samples of sediments without gravel or cobbles (maybe done in the lab):

a. Add 15.0 mL methanol to each vial. Seal vial with cap.
b. Mark each vial with a unique number. CAUTION: some kinds of ink can be dissolved by methanol!
c. Weigh each vial and record.
d. Prepare extra vials for QA samples, spillage, and uncertainty of core depths to sample.

1.2.2 For samples of sediments containing gravel or cobbles (may be done in the lab):

a. Add 50.0 mL methanol to each jar. Seal jar with cap.
b. Mark each jar with a unique number. CAUTION: some kinds of ink can be dissolved by methanol!
c. Weigh each jar and record.
d. Prepare extra jars for QA samples, spillage, and uncertainty of core depths to sample.

2.0 SAMPLE COLLECTION

2.1 Materials

2.1.1 For all samples

a. soap (e.g., Alconox)
b. wipes (e.g., Kimwipes)
c. vial or jar labels
d. field book
e. ball-point pens
f. chain-of-custody forms
g. transparent packing tape (to cover vial labels and wrap packages)
h. lab address, phone number, and contact person
I. cooler and packing material
j. plastic bags for samples and COCs

k. FedEx package forms and sleeves
1. custody seals
m. box of protective gloves
n. vials or jars prepared in step l
o. balance listed in step I

2.1.2 For samples of sediments without gravel or cobbles:
a. modified 10 cc plastic syringes (VWR Cat No. BD305462) for use as subcorers (tips cut off at 0 cc mark (by knife) and rubber tip removed from plungers)
b. bottle brush for pro-cleaning subcorers

2.1.3 For samples of sediments containing gravel or cobbles:
a. stainless steel scoops or spoons

2.2 Procedure

2.2.1 For all samples:
a. Clean subcorers, scoops, or spoons with soap and water and dry.
b. Immediately after the split spoon core sampler or sample core liner is opened, use a subcorer, scoop, or spoon to collect about 8 mL (for 40 mL vials) or 25 mL (for 4 oz. jars) of undisturbed core and deliver it to the vial or jar. Do not add sample at a methanol: soil sample volume ratio greater than 1 to ensure that all DNAPL will be extracted into the methanol. Take care not to remove any of the methanol in the vial or jar by splashing or contacting the methanol with the subcorer, scoop, or spoon. Wipe cap threads with Kimwipe to remove grit. Cap.
c. Wipe dry the outside of the vials.
d. Weigh vials to determine sample masses delivered.
e. Complete labels or add labels to vials or jars. Cover with transparent tape to protect labels from methanol.
f. Reweigh and record. The lab will be asked to reweigh to check for sample loss.
g. Seal each sample container in a separate Zip-lock bag and store cold (below 8^0C).

3.0 EXTRACTION ANALYSIS

3.1 Analyze contaminant concentrations in methanol extract by GC.
a. For volatile chlorinated hydrocarbons use SW-846 GC-PID/ELCD Method 802lB (formerly 8010B) or GC-MS Method 8260B (Star Analytical, 1-800-8874179, will do the GO-MS method for $78/sample). Request analysis for the target analytes only, or if necessary, request all halogenated compounds listed in EPA 8010B. Request reporting limits of no lower than 1.0 mg/L.
b. For volatile components of coal tar or petroleum products use SW-846 GC-PID/ELCD Method 8021B or GC-MS Method 8260B.
c. For semi-volatile components of coal tar or petroleum products use SW-846 GC-MS Method 8270C.
d. For PCBs use SW-846 GC Method 8082 or, with PAHs, GC-MS Method 8275A.

3.2 Request that the lab weigh the sample jar and contents to check for sample loss.
3.3 Request that clods be broken up and samples agitated 24 hours before analysis.
3.4 Ask the lab to report the concentrations as concentrations in methanol (mg/L).
3.5 Request that field-collected QC blanks be analyzed at the beginning of a batch.
3.6 For water content analysis, the Karl-Fisher titration method (approx. $30/sample) is best. A cheaper method is to measure the density of the extract, but this has not worked in the past, likely because methanol vaporizes so quickly. Densities could probably be measured more precisely by taring a syringe or pycnometer and working in a cold room. This method could provide a cheap way to determine sample water content, which is valuable information for NAPLANAL calculations.

4.0 CALCULATIONS

4.1 Use the measurements and Mathcad file CORWATO.MCD to estimate the total mass of contaminants and water in the sample.

4.2 Enter the results into NAPLANAL to calculate NAFL residual saturation, composition, and component phase distribution.

Calculating Sample Concentrations from Methanol Extract Concentrations
Core Samples from the Saturated Zone

Measurements:

Wet mass of sample: $Msamp := 226.5 \cdot gm$

Volume methanol added: $Vmeth := 96.2 \cdot mL$

Number of contaminants: $N := 2$

Estimated water content (vol. water/vol. sample): $fwat := 0.25$

TCE Conc in extract: $Cecont_1 := 1100 \cdot \frac{mg}{liter}$

PCE Conc in extract $Cecont_2 := 200 \cdot \frac{mg}{liter}$

Constants:

Rock density: $ps := 2.6 \cdot \frac{kg}{liter}$

Water density (at 22-23'C): $pwat 0.998 \cdot \frac{kg}{liter}$

Calculations:

Estimated sample water volume: $Vw := \frac{fwat \cdot Msamp}{(fwat\text{-}pwat + (I - fwat) \cdot \rho s)}$ $Vw = 25.744 \cdot mL$

Total masses of contaminants in sample:

TCE: $Mcont_1 := Cecont_1 \cdot (Vw + Vmeth)$ $Mcont_1 := 134.139 \cdot mg$

PCE: $Mcont_2 := Cecont_2 \cdot (Vw + Vineth)$ $Mcont_2 := 24.389 \cdot mg$

Total sample concentrations:

TCE: $Ccont := \frac{Mcont_1}{Msamp}$ $Ccont_1 = 592.225 \cdot \frac{mg}{kg}$

PCE: $Ccont_2 := \frac{Mcont_2}{Msamp}$ $Ccont_2 = 107.677 \cdot \frac{mg}{kg}$

APPENDIX B
Geologic Logs and
Well Construction Details

Location Coordinates of Wells, soil borings, CPT borings and MLS samplers

Location	Northing	Easting	Elevation Ground	TOC
IN01	339435.8315	2496487.07	25.54	25.71
IN02	339444.8916	2496489.85	25.52	25.27
IN03	339453.1307	2496492.71	25.8	25.34
HC01	339427.527	2496483.9	26.85	26.42
HC02	339461.6546	2496495.7	26.17	25.87
EX01	339440.8058	2496472.62	25.63	25.59
EX02	339450.5296	2496475.9	25.66	25.56
EX03	339459.3573	2496479.4	25.98	25.64
EX04	339430.571	2496500.34	25.59	25.65
EX04R	339432.88	2496502.62	25.6	
EX05	339439.9732	2496504.05	25.42	25.22
EX06	339447.4862	2496506.44	25.73	25.45
RW01	339447.2038	2496475.77	25.49	25.24
RW02	339441.6861	2496489.87	25.54	25.35
RW03	339429.4074	2496466.98	26.84	26.49
RW04	339427.0241	2496511.78	26.07	25.78
RW06	339417.9552	2496507.8	26.86	26.46
IW01	339439.3594	2496496.52	25.61	25.24
MW10IW	339451.5	2496487.02	25.8*	NA
WP01AQT	339448.32	2496485	25.6*	NA
WP02AQT	339449.61	2496485.72	25.6*	NA
MLS-1	339439.23	2496477.66	25.6*	
MLS-2	339448.96	2496480.72	25.6*	
MLS-3	339457.37	2496487.02	25.8*	
CPT01	339429.1547	2496573.55	25.79	
CPT02	339442.6893	2496537.93	28.83	
CPT04	339469.7012	2496499.49	25.8	
CPT05	339496.3537	2496424.99	25	
CPT06	339467.986	2496437.42	25.54	
CPT07	339450.2707	2496410.37	25.99	
CPT08	339382.1602	2496399.19	25.73	
CPT09	339361.3396	2496464.64	26.28	
CPT10	339342.0089	2496515.72	26.33	
CPT11	339372.7974	2496436.73	26.13	
CPT12	339454.1104	2496483.59	25.69	
IS01	339435.6666	2496505.83	25.45	
IS02	339434.5729	2496511.08	25.57	
IS03	339429.3495	2496514.01	25.98	
IS04	339379.83	2496471.4		
IS05	339405.9933	2496486.14	26.87	
IS06	339390.05	2496486.31		
IS07	339454.0657	2496469.83	25.74	
IS09	339391.1085	2496486.19	26.8	
IS10	339441.94	2496486.31		
IS11	339447.94	2496484.99		
IS12	339451.8148	2496452.56	26.11	
IS13	339447.94	2496483.18		
IS14	339439.95	2496511.93		
IS15	339457.02	2496492.37		
IS16	339428.05	2496516.91		
IS17	339454.25	2496470		
IS18	339466.8791	2496462.76	25.24	
IS19	339440.57	2496502.33		
IS20	339461.2	2496484.19		
IS21	339431.59	2496501.06		
IS22	339434.43	2496491.13		
IS23	339445.37	2494993.26		
IS24	339441.66	2496499.46		
IS25	339445.43	246485.45		
IS26	339443.58	2496496.18		
IS27	339453.36	2496505.63		
IS28	339401.2763	2496543.85	26.86	
IS29	339428.27	2496476.53		
IS30	339414.46	2496498.38		
IS31	339407.2556	2496533.24	26.83	
IS32	339432.88	2496498.38		

* Estimated from nearby well elevations

Table 3.1 Well Construction Details

Well ID	Casing Diameter (in)	Elevation (ft amsl)		Well Depth (ft BGS)	Screen Intervals (ft amsl)		Bentonite Seal Interval (ft amsl)	Sand Pack Interval (ft amsl)
		Ground	TOC		Lower	Upper		
EX01	4	25.63	25.59	19.96	6.1-10.6	NA	16.8-12.8	12.8-5.6
EX02	4	25.56	25.66	21.20	4.9-9.5	NA	14.7-11.8	11.8-4.2
EX03	4	25.64	25.98	19.94	6.5-11.0	NA	15.9-12.9	12.9-6.0
EX04	4	25.65	25.59	21.09	4.9-9.5	NA	14.1-11.8	11.8-4.6
EX04R	4	25.65	25.59	19.70	6.3-10.9	NA	16.9-13.1	13.1-5.6
EX05	4	25.22	25.42	21.75	4.1-8.7	NA	13.9-11.2	11.2-4.4
EX06	4	25.45	25.73	20.41	5.7-10.3	NA	15.5-12.5	12.5-5.2
HC01	2	26.42	26.85	22.71	4.5-9.1	5.9-15	13.9-11.9	11.9-4.9
HC02	2	25.87	26.17	20.40	6.1-10.8	13.9-18.4	12.8-11.8	11.8-6.1
IN01	4	25.71	25.54	22.58	3.5-8.0	14.0-18.0	12.1-10.1	10.1-3.0
IN02	4	25.27	25.52	19.65	6.5-11.0	14.5-18.5	12.6-11.6	11.6-5.5
IN03	4	25.34	25.8	19.96	6.4-10.9	14.4-18.4	12.9-11.9	11.9-5.8
RW01	4	25.49	25.24	20.00	6.2-10.4	NA	16.2-13.2	13.2-5.2
RW02	4	25.54	25.35	20.00	6.4-10.9	NA	16.4-13.4	13.4-5.4
RW03	2	26.49	26.84	21.97	5.2-9.9	15.8-19.7	14.0-12.0	12.0-5.0
RW04	4	25.78	26.07	23.39	3.3-7.8	13.7-18.2	13.2-11.2	11.2-4.1
RW06	2	26.46	26.86	21.07	6.1-10.8	14.2-18.7	13.9-12.4	12.4-6.4
IW01	2	25.61	25.24	18.50	6.9-11.4	NA	20.7-17.7	17.7-6.2
MW10IW	¼" tube	25.8*	25.0*	39.00	-12.9 - -8.4	NA	8.2- -6.1	-6.1 - -13.34
WP01AQT	¼" tube	25.6*	NA	23.0	2.6-3.6	NA	10.6-4.0	4.0-2.2
WP02AQT	2	25.6*	NA	25.0	0.6-1.6	NA	10.6-2.6	2.6-0.2

*Estimated from nearby wells

ft amsl = feet above mean sea level

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25: DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): Bldg 25: UST T25-2 Area
3. DRILLING AGENCY: Geo Environmental
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS01
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 19 ft
10. SIZE AND TYPE OF BIT: Direct push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 1 | UNDISTURBED 5
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~9 ft bgs
16. DATE HOLE: STARTED 7/25/97 @ 1025 | COMPLETED 7/25/97 @
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Holzmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		TANK Removal | Backfill: clean f. SAND, tan, moist, loose			Geoprobe cont tube 1 1/16 in ID
				85%		HNu 0.5' = 1.6 1.0 = 4.2 1.5 = 3.9 2.0 = 3.5
	2					
	3					3.5 = 2.9
	4					4.0 = 2.6 4.5 = 2.1
			4.5 Contact @ native sed's: f. SAND w silt/clay, wet, cohesive, low plast, mottled lt/med gray	75%		5.0 = 56 (Sample IS01-1) HS 5.2 = 796 5.5 = 98 strong chemical odor: smells like petrol distillates (Varsol?) Sample 01-1 @ 5.4-5.5
	6					
	7					7.0 = 196 7.5 = 511
	8			85%		8.0 = 780 (Sample IS01-2) HS @ " = 1950 8.5 = 1024 (Sample IS01-2) HS @ " = 1640 9.0 = 331 Strong chem odor
	10		med gray, wet, loose		10	10 = 311 (Sample IS01-4) HS 10.0 = 1436 10.5 = 96
			11.0 f. SAND, w decreased silt/clay, wet, cohesive, slight plast, lt gray	100%		11 = 177 11.5 = 121 12 = 34 12.5 = 25 mild chem odor
	12					
	13		f. SAND w minor fines, wet, cohesive, no plast, lt gray		13	13 = 17; resistant probing layer ~14-16' Sample tube split lengthwise 14 = 44
	14		Core samples from ~14-19 may be borehole backfilling	60%		trace chem. odor 15 = 13 HS 15.5 = 32 HS 16.0 = 72
	16		Samples from 16-19 of unknown depth (borehole backfilling?)		16	Core samples clogged in sampler, extruded, not represent. samples
			Flowing sands, borehole not staying open between core runs	?		
	18		TD = 19'; descriptions to ~14' bgs.		19	

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Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): N of Bldg 25: T25-1 Area
3. DRILLING AGENCY: GeoEnvironmental
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS02
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 9 ft bgs
16. DATE HOLE: STARTED 7/25/97 @ 1430 | COMPLETED 7/25/97 @ 1510
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Hoffner INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Tank Removal | Backfill: f. SAND, clean, moist, loose			Cont tube Samples 1¼/6 in ID
						HNu 1.5' = 3.1
						2.0 3.1
						2.5 2.6
	2			80%		3.0 2.8
						3.5 2.3
	4				4	
						4.5' = 120
						5 97
			4.9 Contact Native sed's f. SAND w some silt/clay, moist, cohesive, slt to low plast, minor peat, organic decay smell, med-dk gray	100%		5.5 61
	6					6. 33
						6.5 158
			6.1 f. SAND w minor silt/clay, wet, cohesive, lt gray, org decay & hydrocarb smell			
			6.8 CLAY seam, w some silt, wet, med plast, lt to greenish gray w yellow-orange mottling		7	
		NR				
	8		7.5 f. SAND (w intermitant silt & clay, decreasing w depth) wet, cohesive, lt to med gray strong hydrocarb smell	70%		8' = 394 strong hydrocarb smell (Sample ISO2-1)
						HS 8.3 = 1616
						8.5 = 1032
						HS 8.8 = 1180 (Sample ISO2-2, ISO2-3)
			9.0 f. SAND, trace silt, wet, loose, lt tannish gray, strong hydrocarb smell			9 = 909
						9.5 115 open to atm
	10				10	
			10.5 si-f. SAND, wet, loose, tan to lt gray			11 = 146
				90%		11.5 68
						12 27
	12		11.9 f. SAND w minor silt, lt to med gray			12.5 12
					13	Muck sample; will use discrete sampler
					NS	
	14		14 si-f. SAND		14	Discrete sampler (2'x 1" ID)
						HNu 14.5' = 2.8
			f. SAND, minor silt			15 2.8
						15.5 2.7
	16		16 si-cl-f. SAND grading to		16	16.3 — (Sample ISO2-4)
						16.5 = 2.0
			16.6 si-CLAY, wet, soft, med plast, olive gray	100%		17 2.0
			17.4 grading to si-cl-f. SAND, low plast.			17.3 2.3
	18				18	
			18.4 CLAY w peat, med plast, olive to charcoal brn @ 20'	80%		HNu 18.5 = 1.6
						19 1.6
					20	

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DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings

2. LOCATION (Coordinates or Station): N-side Bldg 25 @ former AST/PCE (5 ft west of Air Comp)

3. DRILLING AGENCY: GeoEnvironmental

4. HOLE NO. (As shown on drawing title and file number): IR88-IS03

5. NAME OF DRILLER: Rich Melton

6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN

8. DEPTH DRILLED INTO ROCK

9. TOTAL DEPTH OF HOLE: 16'

10. SIZE AND TYPE OF BIT: Direct Push

11. DATUM FOR ELEVATION SHOWN (GM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 4

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER: ~9 ft bgs

16. DATE HOLE: STARTED 7-25-97 @ 1654 COMPLETED 7-25-97 @ 1725

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING %

19. SIGNATURE OF INSPECTOR: Geologist: Fred Holzmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		Soil Zone/orig bldg constr backfill, f. SAND w minor silt, color alternating lt brn to dk brn to charcoal brn (3.2-3.5)	100%		HNu 1' = 92 ppm 1.5 66 2 210 mild sweet smell 2.5 400 (Sample IS03-1) HS 2.8 = 191 3 309
	2		2.8 Native sed contact f. SAND w some silt/clay, moist, cohesive, friable to slt plast, lt brn-gray			3.5 10
	4		5.4 Si-CLAY, moist, firm, low plast, lt gray	100%		4.5 = 153 mild sweet smell 5 40 5.5 51 (Sample IS03-2) HS 5.7 26 6 82
	6		6.0 f. SAND, minor fines, moist, friable, mottled yel-orange in tan matrix			HS 6.1 6.5 12 14
	8			TOT.		7.5 = 211 mild sweet smell HS 7.6 108 8 23 (Sample IS03-3) 8.5 11 9 14
	10		11.5 grading to med gray (texture as above	100%		10 = 6 10.5 2.8 11 2.4 11.5 3.0 12 2.41 12.5 2.6
	12					
	14					14 = 2.2 14.5 = 1.6 15 1.9 15.5 2.1
	16		as above to TD @ 16.0			
	18					

PROJECT

HOLE NO.

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DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): ~6' W of TW04 (S-side Bldg 25)
3. DRILLING AGENCY: GeoEnvironmental
4. HOLE NO. (As shown on drawing title and file number): IR88-IS04
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 13 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 4
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~9.5 ft bgs
16. DATE HOLE: STARTED 7-26-97 @ 0740 | COMPLETED 7-26-97 @ 0815
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Holzmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Grass, soil zone, f. SAND w silt, moist, cohesive, friable, gray brn			HNa Backgrnd = 1.5
	2		si-v.f. SAND	95%		1.0' = 1.5 ppm 1.5 = 1.5 2 = 1.7 2.5 = 1.7 3 = 1.6 3.5 = 1.6
	4				4	
			5.1 Sediments sat'd to ~7.0 ft bgs, then unsat'd (recharge pulse from recent rains)	90%		5 = 1.5 5.5 = 1.5 6 = 1.5 6.5 = 1.5
	6		6.1 si-CLAY w f. sand, moist cohesive, low plast, lt brn			
			6.5 si-v.f. SAND, moist firm, cohesive, friable, tan w yel-orange mottling		7	
	8			80%		8.5 = 2.7 9 = 1.9 9.5 = 2.7
			9.1 sat'd 7-24-97 WL = 9.36 btoc @ MW02 (~20 ft from boring)			
	10				10	11 = 9.2 11.25 = 34 11.5 = 11
			11.0 grading to f. to v.f. SAND, clean, wet, stiff, cohesive, tan	80%		12 = 107 12-12.2 = Sample IS04-1 12.5 = 22
	12		TD = 13			
					13	
	14					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

DRILLING LOG	DIVISION	INSTALLATION	SHEET / OF / SHEETS
		MCB Camp Lejeune	1 of 1

1. PROJECT	Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station)	Inside Bldg 25, ~ 13' from S of N-wall
3. DRILLING AGENCY	Geoprobe
4. HOLE NO. (As shown on drawing title and file number)	IRBB-IS05
5. NAME OF DRILLER	Rich Melton
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	20 ft
10. SIZE AND TYPE OF BIT	Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
12. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: / UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	~ 9-9.5 ft bgs
16. DATE HOLE	STARTED 7.26.97 @ 0915 / COMPLETED 7.26.97 @ 1026
17. ELEVATION TOP OF HOLE	
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Geologist: Fred Holzmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			0-.35 Conc	.4		Cont tubr samples 1 1/16 ID (43 mm) HNu
			.35 construction backfill; f. SAND, moist, loose, tan to lt brn			1.0 = 240 ppm
				70%		1.5 445 strong hydrocarb smell
	2		2.1 Native soil/zone contact f. SAND w/ minor silt/clay, lt brn w/ charcoal mottling, loose			2 609
						2.5 861
			as above, grading to buff color			HS 2.8 1005 Sample IS05-1
	4			4		3 760
			4.5 cl-SILT, moist, cohesive, friable mottled lt gray-brn & yellow-orange			4.5 = 308
						5 844 strong hydrocarb smell
			w/ ↑ f. sand fraction	95%		5.5 945
						HS 5.8 1179 sample IS05-2
	6		6.1 si-CLAY, moist, firm, low-med plast, lt gray/brn & yel-org grading @ 6.5 cl-SILT, slt plast			6 1051
						6.5 653
		NR		7		
			7.0 SILT/v.f. SAND, moist cohesive, friable, some clay clasts, buff color			7.5 = 947 strong hydrocarb smell
	8					8 887
						HS 8.4 1225
			increasing v.f. sand content	100%		8.5 945 Sample IS05-3
			v.f. SAND/SILT, clean (no clay)			
	10			10		HS 10.2 938 Sample IS05-4
			darker (lt gray) w/ depth			10.5 = 621
						11 371
				90%		11.5 154
						12 100
	12					12.5 101
				13		
			as above			13.5 = 39
						14 89
	14			90		14.5 60
						15 49
						15.5 36
				16	1" dia discrete sampler	16.5 = 73
	16					17 = 52
				100		17.5 = 45
				18	as above	18.5 = 30
	18		18.2 grading to cl-SILT wet, cohesive, med-gray			19 11
				100		19.5 9.3
			19.3 grading to si-CLAY, wet cohesive, low-med plast, med-gray TD = 20' bgs			20 9.9

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT HOLE NO.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): SW Corner Bldg 25 (outside ~5' S of Bldg)
3. DRILLING AGENCY: GeoEnvironmental
4. HOLE NO. (As shown on drawing title and file number): IRBB-ISO6
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 14 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 5
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 9.5 ft bgs
16. DATE HOLE: STARTED 7-26-97 @ 1412 | COMPLETED 7-26-97 @
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Holzmer / INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		Soil horizon: v.f. SAND, moist, cohesive, friable, dk brn			Geoprobe cont tube 1 1/16" ID HNu 1.0 = 3.6 1.5 = 3.3
	2			100%		2 3 2.5 3 3 2.8 3.5 2.7
			2.6 grading to unweathered seds. Si - v.f. SAND, moist, cohesive friable, tan w mottled yel-orange		4	
	4					4.5 = 2.9
				100		5 2.5 5.5 2.4
	6					6 2.5 6.5 2.5
			as above		7	
						7.5 = 100 8 130 8.5 5.4
	8			80% Resampled; Seds dropped out of tube on 1st try		9 12.6 strong hydrocarbon smell HS 9.3 — 9.5 405 / 61 (Sample ISO6-1)
			wet			
	10		as above		10	Sampled dropped out; moved rig ~1' & used 2'x1"d scrate sampler 10.1' = 3.6 (bkgrnd) 10.5 " 11 " 11.5 "
				100%		12 " 12.1 = 7.5
	12		11.6 grading to f. SAND, minor fines, wet, cohesive, yel-orange		12	12.5 6.6 (Bkgrnd)
			13.0 grading to f. to v.f. SAND, minor fines, wet, cohesive, med gray (to TD = 14' bgs)	100%		13 6.4 13.5 6.5
	14				14	TD = 14' bgs
	16					
	18					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL
2. LOCATION (Coordinates or Station): N-side Bldg 25 @ Tank T25-4
3. DRILLING AGENCY: Geo Environmental
4. HOLE NO. (As shown on drawing title and file number): IR88-IS07
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 7-26-97 @ 1555 | COMPLETED 7-26-97 @
17. ELEVATION TOP OF HOLE: ~ 9-9.5 ft bgs
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Holzmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			0.0 Tank yank backfill f-v.f. SAND, clean, moist, loose tan.	75%		Geoprobe Cont tube 1 1/16" ID HNu 1.0' = 4.0 (bkgrd) 1.5 3.6 2 3.4 2.5 3.5 3 3.3 3.5 3.6
	4		4.7 Contact w native sed's: SILT w clay & f. sand, moist cohesive, friable, med-gray			4.5' = 3.1 5 138 Sample IS07-1 HS 5.3 — 83 5.5 20
	6	NR	5.5 grading to cl-SILT, trace f. sand, minor peat, moist, cohesive, slt plast, organic decay odor, dk gray	70%		6 112
	8		cl-SILT / cl-f. SAND moist, cohesive, friable, slt plast, occassional plant fibers & clay clasts, med-dk gray w mottled yel-orange	90%		7.5' = 4 8 29 strong hyd-carb smell 8.5 171 HS 8.8 — 477 Sample IS07-2 9 53 9.5 79
	10		9.2 f.-v.f. SAND. w silt, 9.8 si-f. SAND, wet, firm, cohesive, olive gray	100%		10' = 47 10.5 37 Sample IS07-3 HS 10.8 — 195 11 44 11.5 32 12 11 12.5 9 13 13 13 113(?) probably backfill from above 13.5 153(?) 14 90(?)
	12					
	14			50%(?)		
	16			100%	1" ID Sampler	14.5 14 15 14 15.5 10 16.5' = 12 17 13 17.5 16 18 77
	18		17.8 grading to SILT w clay & v.f. sand, wet, firm	50% likely bottom foot drained oil	1" ID sample	18 81 Sample IS07-4 18.5 701
			19 si-sa-CLAY w plant matter, soft, olive-gray TD push = 20'; TD recovery ~ 19'			19 219

ENG FORM 1836 | PROJECT | HOLE NO.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): N-side of Bldg 25, ~ 20' west of tank T25-4
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): IR88-IS08
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: | UNDISTURBED: 9
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER: ~ 9-9.5 ft bgs
16. DATE HOLE: STARTED 7-27-97 @ 0728 | COMPLETED 7-27-97 @
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Hoffman / INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			0.0 Backfill f. SAND, tan			Geoprobe cont. tube sampler 1 1/16" ID
			.8 Native soil contact si-cl-f. SAND, wet, soft, minor peat matter, dk gray-brn low plast	80%		HNu 0.5' = 54 ppm; 1 = 33; 1.5 = 48; 2 = 23; 2.5 = 280; 3 = 234
	2		2.6 grading to f. SAND w fines, moist, cohesive, firm friable, lt brn			
	4			4		Sample IS08-6 Hydrocarb Sample; Sample IS08-4 4.5 = 604 strong hydrocarb smell; 5 = 523
				95%		5.5 = 350; 6 = 516; 6.5 = 381
	6		6.4 grading to cl-f. SAND, wet, cohesive, low plast, med gray-brn			
			7.2 grading to f. SAND w fines, moist to wet, cohesive, lt gray, soft to med firm	7		7 = 340 Sample IS08-5
				100	8-10 dropped out	7.5 = 442; 8 = 166 Sample IS08-6 Hydro Carb Sample
	8		8-10 Sample interval uncertain	8		
		?		50%	1" ID discrete sampler (collected ~1' N of orig boring)	Looks like 7-8' interval = 440; Bottom ½ dropped out of sample tube = 340; = 83
	10		si-f. SAND, wet, cohesive firm, lt gray	10		10' = 56; 10.5 = 41
			10.8 grading to f. SAND, minor fines, lt gray brn	100		11 = 32; 11.5 = 28
	12		grading to med gray some clay content, slt plast			12 = 23; 12.5 = 24
			f. SAND w silt, minor clay	13		13 = 81.
	14			100		13.5 = 13; 14 = 15
				14.5		15 = 52; 15.5 = 13
				95%		16 = 12
	16			16.5		
			17.0 ~~grading to si-cl-f. SAND~~	17	NS	
			17.0 grading to si-cl-f. SAND			HS 17.5 = 829 strong solvent (sweet) smell; 17.5 = 870 Sample IS08-1; 18 = 534
	18		grading to si-cl-v.f. SAND slt plast			HS 18.5 = 875; 18.5 = 683 Sample IS08-2 DNAPL(?) fluid inclusion
				19		19 = 871; 2 54 (Bkgrd 200); 19.5 = 871 (" 165) Sample IS08-3 (Bkgrd 58)
			19.0 grading to si-CLAY, wet, soft med plast, med gray, to TD = 21' bgs		HS 19.5 = 925	20 = 230 (" 220); 20.5 = 174; 21 = 156

PROJECT | HOLE NO. (170) (148)

ENG FORM 1836 MAR 71 | PREVIOUS EDITIONS ARE OBSOLETE.

HOLE NO.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): Inside Bldg 25: ~ 25ft S of N-wall
3. DRILLING AGENCY: GeoEnvironmental
4. HOLE NO. (As shown on drawing title and file number): IR88-IS09
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 8
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 9-9.5 ft bgs
16. DATE HOLE: STARTED 7-27-97 @ 1040 | COMPLETED 7-27-97 @
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Hahmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			0. - .4 Conc floor		Conc.	
			.4 Construction backfill f. SAND, moist, loose, tan to lt brn			HNu .5' = 134
						1 151
						1.5 174
	2			70%		2 220
			2.3 Contact with native sed si-f. SAND, firm, cohesive friable, lt gray-brn			2.5 15
	4				4	4.5' = 176
						5 81
				95%		5.5 206
	6					6 160
			6.4 si-v.f. SAND, moist, cohesive, mottled lt gray & yel-orange			6.5 15
					7	7' = 518 strong hydrocarbon smell
						7.5 367
	8			100%		8 370
						8.5 470
		NR				
	10		as above, lt gray, wet		10	10' = 44
						10.5 181 (Sample 1509-1)
						11 21
				70%		11.5 29
	12					12 36
			13.5 as above, grading to yel-orange		13	13' = 62
						13.5 33
	14			90%		14 9 (Sample 1509-2)
						14.5 41 moderate solvent smell
					15	15 105
	16				1" ID discretr Sampler	15 55
						15.5 6 after HNu malfcn & repair
						16' = 6
			increasing fines, slt plast		17	16.5 2.5
					as above	17 10
						17 7
	18		as above, grading to med gray	50%		17.5 2
		NR			bottom	18
			as above			
			19.1 si-CLAY w minor v.f. sand, wet, med plast, med gray (to TD = 21' bgs)		19	19' = 3
						19.5 1.3
						20 1.5
						20.5 3.4
						21 1.7

PROJECT | HOLE NO.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): N-side Bldg 25: ~10' W-SW of Tank T25-4
3. DRILLING AGENCY: GeoEnvironmental
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS10
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 21
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 8
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~9-9.5 ft bgs
16. DATE HOLE: STARTED 7.27.97 @ 1454 | COMPLETED 7.27.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Hoffmeister INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Tank yank backfill f.-v.f. SAND, clean, tan			Geoprobe cont tube sampler 1 11/16" ID
						HNu – DL 101
						0.5 = .8 (Bkgrnd)
						1 .8
	2			75%		1.5 1
						2 .9
						2.5 1
			3-4' interval dropped out of tube upon retrieval			
		NR				
	4		si-v.f. SAND, moist, cohesive soft, lt tan-gray	4		4.5' = 3.1
						5 .4
						5.5 1.1
				85%		6 2.3
	6		6.1 si-CLAY, moist, med plast, lt gray			6.5 .7
		NR				
			si-v.f. SAND, moist, cohesive, buff color w/ yel-orange	7		7' = 4.1
						7.5 18
	8			100%		8 34
			8.7 as above, grading to lt gray & wet			8.5 19
						9 0.6
						9.5 .7
	10			10		10' = 4
			as above			10.5 217
			11.1-13: sampled dropped out out of tube upon retrieval.	35%		11 73
		NR				
	12					
			as above, lt gray & bright yellow-orange pockets, wet	13		13' = 3.3
						13.5 1.0 HNu ?!
	14		13.8 grading to med-gray	100		14 1.0
						14.5 1.0 mod solvent smell
				15		15 → 15.4 Sample IS10-1
			v.f. SAND, minor silt		1" 2D discrete sampler	HNu out of order
	16			90%		Sample tubes noticably cool upon retrieval, with strong solvent smell
						16.1-16.4 Sample IS10-2
				17	as above	Sample tube noted cool. Fluid inclusions of DNAPL(?) associated with sporadic peat (plant fibers) @ 17.2-17.4, & trapped droplets @ 17.6-17.8'
			increasing fines, w/ coarse plant fibers			17.2 Sample IS10-3
	18		17.7 grading to cl-SILT, low plast med gray			17.75 Sample IS10-4
		NR	Sample dropped out upon retrieval			
				19	as above	Strong solvent smell @ 19.0, decreasing to none @ ~19.5
			si-CLAY, decreasing silt w/ depth, soft, med plast, med-dk gray			
			20.3 organic CLAY (fine peat layers) with no solvent smell, only organic decay / H_2S smell, to TD = 21' bgs			

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. — PROJECT — HOLE NO.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg 25 DNAPL Source Zone Borings
2. LOCATION (Coordinates or Station): N-side Bldg 25; ~16' W of Tank T25-4
3. DRILLING AGENCY: GeoEnvironmental
4. HOLE NO. (As shown on drawing title and file number): IR88-IS11
5. NAME OF DRILLER: Rich Melton
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 18 ft
10. SIZE AND TYPE OF BIT: Direct Push
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 6
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~9-9.5 ft bgs
16. DATE HOLE: STARTED 7.27.97 @ 1728 | COMPLETED 7.27.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Geologist: Fred Hohmer INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0–2		Mixed tank yank backfill & native sediments, disturbed thru-out f. to v.f. SAND	75%	0–4	HNu 0.5' = 7.7 (bkgrnd) 1 7.2 1.5 6.4 2 6.8 2.5 6.4
	2–4	NR	See below			
	4–6	NR	Core sample dropped out upon retrieval (Geoprobe needs to develop catcher baskets to prevent this)	0%	4–7	
	6–8		cl- f. to v.f. SAND, wet, soft, low plast, occassional gray clay clasts in dk-gray brn matrix	70%	7–10	7.5' = 6.4 8 8.7 moderate 8.5 70 hydrocarb & organic 9 27 decay smell
	8–10		Core tube stuck in barrel due to flowing sands; had to destroy tube: misc disturbed core described: f. to v.f. SAND, wet, cohesive, lt to med gray	30%	10–13	strong hydrocarb smell
	10–12		No sample collected		13 NS	
	12–14		si- f.- v.f. SAND, wet, cohesive, med gray	100%	14 1" ID discrete sampler	14' = 5 14.5 4 (bkgrnd) 15 4 no solvent smell 15.5 4 16 4
	14–16		16.0 grading to cl-SILT, wet soft, low plast, med gray		16 as above	16.5 43 mild solvent smell 17 18 17.5 17 organic decay smell
	16–18		16.4 grading to si-CLAY, wet, soft low-med plast, med gray (to TD = 18' bgs) sparse plant fibers	70%	18	

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: Camp Lejeune, NC | SHEET 01 OF 1 SHEETS

1. PROJECT: Bldg. HP25 DNAPL Source Zone Borings
LOCATION (Coordinates or Station)

3. DRILLING AGENCY: PARRATT-WOLFE INC
4. HOLE NO. (As shown on drawing title and file number): IR88-IS12
5. NAME OF DRILLER: ARNOLD CHAPEL
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: NA
8. DEPTH DRILLED INTO ROCK: NA
9. TOTAL DEPTH OF HOLE: 19 feet

10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 adapted for hollow stem augers
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 8/19/97 | COMPLETED 8/19/97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: 78 %
19. SIGNATURE OF INSPECTOR: John T. Londergan, INVERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDY LOAM, brown, dry			HNU (ppm)
	2		clay content increases			
				3		1.8
						16.0
	4					39.0 RECOVERED 3' out of a 4' push
						49.8
						77.0
						45.0
	6					
			fine sand, moist, lt. brown			1.0
						0.8
	8					4.8 RECOVERED 3' out of 4' push
						1.6
						1.0
						1.2
	10					
			very fine sand, wet lt. gray/brown color	11		7.4
						3.6
						1.1
	12					0.8 RECOVERED 3' out of a 4' push
						0.7
						0.7
	14					
				15		6.7 IS12-03 PCE 15.5'
						5.3
						21.7 IS12-01 PCE 16-16.2' RECOVERED 3.5' out of FOG a 4' push
	16		silty clay, gray, soft wet			1.2
						1.3
						0.8
	18					0.7 IR88-IS12-08 16.2-16.5'
			silty clay, gray, soft wet	19		IS12-02 PCE 17-17.2'
	20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG | DIVISION: . | INSTALLATION: Camp Lejeune, NC | SHEET 01 OF 1 SHEETS

1. PROJECT: Bldg HP25 DNAPL Source Zone Borings
LOCATION (Coordinates or Station):
3. DRILLING AGENCY: PARRATT-WOLFF INC.
4. HOLE NO. (As shown on drawing title and file number): IR88-I513
5. NAME OF DRILLER: ARNOLD CHAPEL
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: NA
8. DEPTH DRILLED INTO ROCK: NA
9. TOTAL DEPTH OF HOLE: 19 FEET
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 adapted for hollow stem augers
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: UNDISTURBED:
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 8/19/97 COMPLETED 8/19/97
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: 75 %
19. SIGNATURE OF INSPECTOR: John T. Londergan - INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			VERY FINE SAND, LT. BROWN, DRY			HNU's (ppm)
	2					
	3			3.5' of recovery out of 4' possible		1.2
						0.8
	4					1.1
						1.5
						5.2
						30.0
	6		Hydrocarbon odor			
	7					
						6.8
	8			3.5' recovery out of 4' possible		19.5
						93.0 — I513-04 TPH 8.5
						71.0
						6.3 — NOT SUBMITTED TO LABORATORY
	10					2.6
	11					7.9
						1.4
	12			3.5' of recovery out of 4' possible		1.5
						1.1
						1.0
						0.7
	14					0.7
						1.0
			VERY FINE SAND, Olt. GRAY WET, HYDROCARBON ODOR 15			4.8
						4.0 — I513-1 PCE 17.0
	16					6.6
						15.9 — I513-2 PCE 17.5
				3.5' of recovery out of 4' possible		148.0 — I513-09 PCE 17.5-17.7
						182.0
	18					106.0 — I513-3 PCE 18.0
						12.0 — I513-08 TPH 18.0-18.5
			Silty clay, soft, dk gray, wet 19			
	20					

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil sampling @ Bldg 25
2. LOCATION (Coordinates or Station): N-side of Bldg 25
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS14
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 22 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11-18-97 @ 0912; COMPLETED 11-18-97 @ 1450
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		0.0 Grass, v.f. SAND, moist, cohesive, loose, tan			4hu
			1.5 si-CLAY, tan-brn, low plast			18
			1.6 SILT w/ v.f. sand, moist, friable, charcoal-brn grading to dk brn			78
	2					74
			2.8 SILT w/ clay & v.f. sand, moist slt plast, gray-brn			24
						20
					3	19
	4					8
						13
						9
			5.1 Si-CLAY, wet, low plast	80%		5
		NR				3
	6		6.0 Cl-SILT w/ v.f. sand, slt plast, moist grading to wet @ ~ 7.0, gray		6	4
						2
			7.7 SILT w/ minor clay, wet, cohesive, tan to buff, trace v.f. sand			1
				100		1
	8					1
			8.4 si-CLAY, wet, low plast, tan-gray			0
			8.5 v.f. SAND, trace fines, wet, cohesive, lt gray w/ tan & yel-org mottling			0
					9	0
	10					1
			10.4 grading to cl-si-v.f. sand, wet, slt plast, med-gray cohesive	85%		2
			10.8 v.f. SAND, wet, loose, gray			1
		NR				1
	12		12.0 si-v.f. SAND, wet, cohesive med-gray		12	12
						0
			13.1 thin cl-si-v.f. SAND seam, slt plast			1
			13.2 f.-v.f. SAND, trace fines, wet cohesive;	70%		0
	14					0
			grading to v.f. SAND			
					15	0
						0
	16					2
				50%		1
		NR				
	18		18.0 CLAY, v. soft, med plast gray		18	3
						0
			20.1 grading to CLAY w/ f.-v.f. SAND, soft, med plast, gray-brn to TD @ 22'	100		0
						0
						0

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT 22

HOLE NO. 0

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe soil sampling Bldg25
2. LOCATION (Coordinates or Station): N-side of Bldg 25
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IRB8-IS15
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 22 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~8 ft BGS
16. DATE HOLE: STARTED 11-18-97@1500 | COMPLETED 11-18-97@1730
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	Hnu
	0		0 Appears to be mixed backfill from tank removal area: clean f. sand w native soil: si-f. sand w clay			Core samples collected in 1-1/16" ID core tubes	0
	2			70%			0
							2
							1
	3						1
	4						0
				50%			0
	6		6.4 CLAY, soft, wet, med plast, yel-org & gray	6			
			6.6 si-v.f. SAND, moist, cohesive buff	85			2
	8						4
							6
						IS15-01 8-9'	13
				9			
			9.5 grading to SILT w v.f. sand, wet, cohesive, gray w intermitant zones of SILT w clay & v.f sand				3
	10			85%			2
							4
							3
							0
	12			12			
				80			1
							5
	14						6
							0
				15			
	16	NR		0			
			18.0 SILT, wet, cohesive, gray	18			8
			19.0 CLAY, wet, v. soft, med plast gray	90%		IS15-02 @ 19' above clay contact	25
			19.9 CLAY w peat, low-med plast gray-brn				0
							0

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. — PROJECT 22 — HOLE NO. 0 0

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil sampling @ Bldg 25
2. LOCATION (Coordinates or Station): 5ft N of Bldg 25
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS16
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 11.19.97 | COMPLETED 11.19.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Hohymer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						IS16 is located 1 ft E of IS03
	8		8.0 si-v.f. SAND, wet, cohesive, tan	8 / 75% / 10		IS16-01 8-9'
	16		16.0 si-v.f. SAND, wet, cohesive, firm, gray to loose	16		
	18		17.5 grading to SILT w/ v.f. sand, wet, soft, cohesive,	100%		Strong solvent smell IS16-02 @ 18.5'
	20		18.6 grading to si-CLAY, wet, v. soft, low plast	20		

4 7 8 7 — 2 3 70 320 500 250 250 500

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO. 25

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS17
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: 1" & 1¾" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: | UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11-19-97 @ 1015 | COMPLETED 11-19-97 @ 1150
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Hohmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 si-v.f. SAND, wet, loose, lt. gray	8		Strong hydrocarb smell IS17-01 8-9'
				80%		Hnu 280 160 70
	10			10		80
	16		17.0 SILT w clay & v.f. sand, firm, wet, cohesive, slt plast, gray	17		Hnu 220 Strong solvent odor IS17-02 @ 18.0' → 400
	18		18.5 grading to si-CLAY w v.f. sand & peat, wet, v. soft, low plast gray	100%		100 190
	20		19.8 CLAY w peat, soft to firm, low plast, peat decreasing w depth			40 80

ENG FORM 1836 | PROJECT 21 | HOLE NO. 20 30

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station): ~12 ft N of well TW-3
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS18
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~8 ft BGS
16. DATE HOLE: STARTED 11.17.97 @ 1400 COMPLETED 11.19.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. to v.f. SAND, wet, loose to cohesive, firm, lt gray	8 / 100% / 10		Hnu: 6, 2, 2, 0
	17		17.0 si- v.f. SAND, wet, firm, cohesive, gray	17		
	18		18.0 grading to cl-SILT w/ f. sand & peat particles, slt plast.	100%	IS18-02 @ 18.4' →	3, 7, 7, 3, 1, 0
			18.8 grading to si-CLAY w/ f sand & peat particles, wet, soft, med gray low plast			
	20		19.6 grading to CLAY w/ peat, minor silt & f. sand, soft-firm, low plast			

ENG FORM 1836

PROJECT 21

HOLE NO. 0

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS19
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: | UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11.19.97 @ 1510 | COMPLETED 11.19.97
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
	2						
	4						
	6						
							Hnu
	8		8.0 si-f. SAND, wet, gray	8			40
			8.7 si-cl-v.f. SAND w peat	80%		Strong hydrocarb smell	280
						IS19-01 @ 8-9'	170
	10			10			250
	12						
	14						
	16						
							Hnu
			17.0 si-f. SAND, wet, firm,	17			12
	18		18.2 grading to cl-SILT w v.f. sand & peat particles, wet, slt plast	100%			3
			18.9 grading to si-CLAY w v.f. sand & peat particles, wet, low plast, soft				.5
			19.5 grading to CLAY w minor silt, peat particles, v. soft, low-med plast				.5
	20						.5

ENG FORM 1836 | PROJECT | HOLE NO. 3

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS20
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: | UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~8 ft BGS
16. DATE HOLE: STARTED 11.19.97 @ 1630 | COMPLETED 11.19.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 si-v.f. SAND, wet, firm, lt gray	8		Hnu 4
			lt brn	100%		11 125
	10		tan-gray	10		25 3
	16					
	18		17.0 si-v.f. SAND, wet, firm,	17		Hnu 38
				100%		slight solvent smell 10 52
			19.0 grading to cl-SILT, wet, slt plast			IS20-02 @ 18.5 20
	20		19.4 grading to CLAY, wet, soft, low plast, w/peat particles			1

ENG FORM 1836 MAR 71 | PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling at Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS22
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 22 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: UNDISTURBED: 3
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~8 ft BGS
16. DATE HOLE: STARTED 11.20.97 @ 1140; COMPLETED 11.20.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. to v.f. SAND, minor silt, wet, cohesive, lt. gray to buff	100%	IS22-01 8-9'	Hnu 400 / 400 / 360 / 360 / 425
	16		16.0 f. to v.f. SAND, wet, firm, lt gray			Hnu Strong solvent odor 420 / 380 / 340
	18		17.5 grading to si-cl-f. SAND, wet firm to slt soft, slt plast	100%	Perm Test Core ↓ Hnu 400	220 / 420
			18.4 grading to cl-SILT w v.f. sand, wet, soft, low plast, med gray			440
			19.2 grading to si-CLAY, wet, soft, low plast, med-dk gray		90	260
	20			20	22	340 / 160
	21		21.0 grading to CLAY w silt & peat particles, peat increasing w depth, low plast, brown, solvent smell			

ENG FORM 1836 | PROJECT | HOLE NO.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88 - IS23
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 21 ft
10. SIZE AND TYPE OF BIT: 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 1
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~8 ft BGS
16. DATE HOLE: STARTED 11-21-97 | COMPLETED 11-21-97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Hohmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	2					
	4					
	6					
	8					
	10					
	12					
	14					
	16					
	18		17.0 v.f. SAND, wet, firm, gray	17		* PA Samples * Hnu
			18.3 grading to SILT w/ v.f. sand & clay, wet, firm, slt plast	95%		IS23-01 @ 17.5' → 40 / 160 VOA
			19.0 grading to si-CLAY w/ peat particles, wet, v.soft, low-med plast med-dk gray			IS23-02 @ 18.25' → 240 / 380 VOA
	20		20.2 as above grading to gray-brn w/ increasing peat fragments, low plast			IS23-03 @ 19.0' 320 VOA; IS23-04: 19.5-19.9 70 Kv/CapP; IS23-05: 20.0-20.4 24 Kv/CapP

ENG FORM 1072 | PROJECT 21 | HOLE NO. 40

21

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS24
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: UNDISTURBED:
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11-20-97 @ 1600 | COMPLETED 11-20-97
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Hohmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	2					No Performance Assessment VOC samples collected here due to difficult sampling & poor recovery
	4					
	6					
	8					
	10					
	12					
	14					
	16			16		Difficulty collecting core: 1st attempt recovered ~25% 2nd " " ~40% → strong solvent smell. Estimate recovered core is from ~ 17.5 - 19.0 ft based on nearby logs IS07 & IW01
	18		~17.5 si-v.f. SAND, wet, firm			Hnu 420 440 360 250
	20		~18.0 grading to cl-SILT	20		17 18 19
			~19.0 grading to si-CLAY, wet, v. soft, w peat fragments v. soft, low-med plast			

PROJECT | HOLE NO.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling @ Bldg 25
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IRB8-IS25
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: | UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11·21·97 @ 0850 | COMPLETED 11·21·97
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Hohmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. to v.f. SAND, wet, firm, lt gray to buff, sparse peat fragments	75%	8	Hnu: 6, 6, 7, 3
	16		16.0 f. SAND, wet, stiff,	85%	16	Hnu: 38, 80, 440, 260, 280, 480, 420 * PA Samples * IS25-01 @ 17' IS25-02 @ 18' IS25-03 @ 19'
	18		17.5 SILT w clay & v.f. sand, sparse peat fragments, slt plast, med-dk gray 18.4 grading to v.f. SAND 18.5 cl-SILT w v.f. SAND, slt-low plast 18.7 si-CLAY, med soft, low plast, minor peat, med gray 19.0 thin si-v.f. SAND seam followed by si-CLAY, minor peat, low-mod plast, gray-brn			
	20				20	

ENG FORM 1836 — PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling at Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS26
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1 3/4" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11.21.97 @ 1000 COMPLETED 11.21.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Hohner DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	16		16.0 f. SAND, wet, firm, sparse peat fragments, gray		16	* PA Samples * Hnu IS26-01 @ 17.0' → 13, 4, 60
	18		17.2 si-v.f. SAND, wet, stiff, sparse peat fragments 17.7 grading to cl-SILT, wet, slt plast, sparse peat fragments, med-soft 18.3 grading to si-CLAY, wet, soft, low plast, sparse peat frags	80%		IS26-02 @ 17.75' → 160, 130 IS26-03 @ 18.5' → 60, 62
	20	NR			20	

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT

HOLE NO.

Hole No.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling at Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS27
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 10 ft
10. SIZE AND TYPE OF BIT: 1" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 1
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11.21.97 @ 1035 | COMPLETED 11.21.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Fred Holzner DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. to v.f. SAND w intermittent si-cl-f. SAND layers, wet, firm, grading from brn to yel-orange to lt gray	65%	IS27-01 @ 8-9' Varsol Sample	Hnu 1 0 1.5
	10	NR				

ENG FORM 1836 — PROJECT — HOLE NO.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling inside Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS28
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20
10. SIZE AND TYPE OF BIT: 1" & 1¾" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11.21.97 @ 1935 COMPLETED 11.22.97 @ 0815
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. to v.f. SAND, wet, firm, tan to buff color	80%	8–10	Hnu 1 1 1 1 No VOC sample collected since no contacts were observed between sand to silt to clay, & no evidence of contam.
	14		cl-SILT, med-firm, gray, low plast. sparse peat	40%	14–18	Poor recovery: 1.5 ft from somewhere between 14-18. ft PID malfunction but no evidence of contamination, only mild organic decay smell
	18		18.0 CLAY, wet, soft, low-med plast, sparse peat, med-gray 18.7 grading to peaty-CLAY, soft-firm, low plast, grayish-brn	100%	18–20	Hnu malfunction, but no evidence of contam; mild organic decay odor only.
	20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT

HOLE NO.

Hole No.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe soil sampling inside Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IRBB-IS29
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1" & 1¾" ID core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER: ~ 8 ft BGS
16. DATE HOLE: STARTED 11-22-97 @ 0825 | COMPLETED 11-22-97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holmer DE & S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. SAND, moist on top then wet, firm, tan, grading to lt gray	8 / 75% / 10		IS29-01 8-9' Strong hydrocarb smell — Hnu: 58, 170, 250, 120
	10	NR				
	16			16 / 50%		* * Due to poor recovery (50%), depth of Hnu readings & geologic descriptions are estimated to be from ~18-19.5 ft but not known w certainty of actual depth — Hnu: 300, 260
	18		~18.0 f. to v.f. SAND, minor silt, wet, firm, gray, sparse peat			IS29-02 ~18.8' * * free-phase DNAPL observed in voids (~⅛") — Hnu: 260, 200
			18.9 grading to CLAY, variable silt content, low-med plast, med-dk gray soft			
	20		TD @ ~ 19.8	20		

ENG FORM 1836 — PREVIOUS EDITIONS ARE OBSOLETE — PROJECT — HOLE NO.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe Soil Sampling inside Bldg 25
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): IR88-IS30
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1" & 1¾" dia core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED: 2
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 11-22-97 @ 1030; COMPLETED 11-22-97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. SAND, wet, firm	60%	8 – 10	IS30-01 8-9' Hnu 250 200 60
	18		~18.5 si-CLAY, soft-firm, low plast, med-gray ~18.8 CLAY w minor silt, soft, low to med plast, med-gray minor peat, grading to brn-gray w increasing peat content	40%	16 – 20	Core sample from 16-20 ft had poor recovery (~40%). Recovered core is estimated to be from a depth interval of ~18.5 - 20 ft * * * Hnu IS30-02 → 200 @ ~18.8'; abundant free-phase DNAPL in core-catcher tracks & 70 in water in core tube 60

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 1 SHEETS

1. PROJECT: Geoprobe soil Sampling inside Bldg 25
2. LOCATION (Coordinates or Station): 7.7 ft
3. DRILLING AGENCY: FUGRO
4. HOLE NO. (As shown on drawing title and file number): IR88-IS31
5. NAME OF DRILLER: Frank Ward
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20 ft
10. SIZE AND TYPE OF BIT: 1" & 1 3/4" dia core barrel
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 11.22.97 @ 1400 COMPLETED 11.22.97
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	8		8.0 f. to v.f. SAND, wet, firm, lt yel-orange w/ lt gray mottling assoc'd w/ clayey areas.	90%	8	IS30-01 8-9 ft
	10				10	
	16		16.0 v.f. SAND, wet, firm, sparse peat frags, gray		16	IS31-02 @ ~16.8 ft →
			17.0 interlayered v.f. SAND & CLAY firm,			
	18		17.5 CLAY, soft, low-med plast, w/ minor v.f. sand seams (¼-½") med-dk gray; sparse peat	95%		
			18.9 grading to peaty-CLAY, low-med plast, soft-firm, gray-brn			
	20				20	

Hnu: 9, 15, 5, 12, 110, 100, 20, 8, 1, 1, 0

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT

HOLE NO.

Hole No.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Site 88: Bldg 25
2. LOCATION (Coordinates or Station): PITT Wellfield: 3ft W of EX04
3. DRILLING AGENCY: Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number): IR88-IS32
5. NAME OF DRILLER: Layne Pech / Parratt-Wolff
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 22 ft BGS
10. SIZE AND TYPE OF BIT: 3¼" ID HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 5
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 3/23/98 @ 1345 | COMPLETED 1515
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	PID Reading
						Geoprobe macrocore Sampler (2" x 48") from 4-20 ft. bgs	
	4.0		v.f. SAND w minor silt & clay, cohesive, friable, moist	4		Split-spoon sample 20-22 ft bgs	250
	5			50%			250
				8			300
			~9 si-cl-f. SAND, moist, slt plast				200
	10		~10 f SAND, minor fines, moist, lt gray	75			280
			11 as above, med-gray, wet, loose				300
							200
	12			12			
			as above				250
				40%			100
	14						150
	16			16			
			as above				250
			grading to si-v.f. SAND, wet, cohesive, friable, solvent odor	30%			300
	18						300
			poor recovery				
			contact between sand & clay not recovered				
	20		20.0 CLAY w minor peat med plast,	20		Spt Spoon sample 1¾" x 24"	9
				100%			4
							4
	22			22			3
							2
							2

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG

DRILLING LOG	DIVISION	INSTALLATION Camp Lejeune, NC	SHEET 01 OF 01 SHEETS

1. PROJECT: Bldg. 1825 DNAPL Source Zone Borings

LOCATION (Coordinates or Station)

3. DRILLING AGENCY: Parratt - Wolff Inc.

4. HOLE NO. (As shown on drawing title and file number): IR88-RW01

5. NAME OF DRILLER: Arnold Chapel

6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: NA

8. DEPTH DRILLED INTO ROCK: NA

9. TOTAL DEPTH OF HOLE: 20.0 FEET

10. SIZE AND TYPE OF BIT

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 Adapted w/ hollow stem AUGERS

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE: STARTED 8/19/97 | COMPLETED 8/19/97

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING: 72 %

19. SIGNATURE OF INSPECTOR: INTERA John T. Londergan

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			8-inch manhole			HNU (ppm)
			very fine sand, dry			
			watertight gripper plug			
	2		grout mixed at 600 lb Portland Cement w/ 40 gal water and 6 lb bentonite			
			3			
	4		4 inch diam. Sch 40 flush threaded joint PVC casing	Only 1.1' recovery from 4' push		9.2
						147
	6					47
			Hydrocarbon odor			121
			7			3.1
	8		bentonite seal	3.5' recovery from 4' push		10.6
▽						9.8
Hw=8.40' 8/26/97 1800hrs			12.25-inch diam. borehole			4.6 — RW01-05 TPH 9.5'
						4.6
	10					3.5
			Very fine sand, wet, lt grey color			
			11			4.7
	12			3.8' recovery 4' push		1.8
			Drilling Service Inc. #1 Filter Sand 704-322-1100 8-50 lb bags			2.4
						1.5
						1.3
	14					1.3
						1.5
			15			22.4
	16		4 inch diam. 304 SS 0.01-inch wire wrap continuous slot screen	3.5' recovery from a 4' push		10.2
						4.3
						10.0 — RW01-1 PCE 17.0'
						165.0
	18					270.0 — RW01-2 PCE 18'
						122.0
			silty clay, lt grey wet, soft			27.0
			19	1 ft recovery 1 ft push		
	20		1' sump 304 SS			RW01-3 PCE 20.0

Hole No.

DRILLING LOG | DIVISION

INSTALLATION: CAMP LEJEUNE, NC | SHEET 1 OF 1 SHEETS

1. PROJECT: Bldg. HP26 DNAPL Source Zone Project
LOCATION (Coordinates or Station)

3. DRILLING AGENCY: Parratt Wolff

4. HOLE NO. (As shown on drawing title and file number): IR88-RW02

5. NAME OF DRILLER: Arnold Chapel

6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: NA

8. DEPTH DRILLED INTO ROCK: NA

9. TOTAL DEPTH OF HOLE: 20.0

10. SIZE AND TYPE OF BIT

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55 Adapted for hollow stem augers

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE | STARTED: 8/19/97 | COMPLETED: 8/19/97

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING: 82 %

19. SIGNATURE OF INSPECTOR: INTERA
MW Lodge JOHN T. LONDERGAN

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			8-inch diameter manhole			HNu (ppm)
			Very fine SAND, dry, lt gray			
			watertight gripper cap			
	2		grout mixed at 600 lbs portland cement w/ 40 gal. water and 6 lbs bentonite			
	3			2.5 ft recovery from 4' push		
	4		4-inch diameter Schedule 40 PVC flush threaded CASING			49.7
						8.8
						22.0
						66.0
	6		12.25-inch diam. borehole			5.6
						11.3
	7					
				3.0 ft recovery from 4' push		5.5
	8					4.6
						2.7
						112.0
			CHANGE TO A TAN color			22.0
8.96' 8/97 1003 hrs	10		bentonite seal			11.0
						4.4
	11					
				3.5 ft recovery from 4' push		97.0
	12		CHANGE BACK TO A lt. grey color			72.0
						6.7
						3.3
						11.2
	14		4-inch diameter 304 STAINLESS STEEL			14.7
						36.0
			0.01-inch wire wrap continuous slot screen w/ flush threaded joints			12.8
	15					16.7
				4.0 ft recovery on 4.0 ft push		16.0
	16		Drillers Service Inc. #1 Fifth Sand 704-322-1100 8-50 lb bags filled			4.0
						5.6
						19.0
	18					13.1
						94.0
			silty clay, grey, soft wet	1.0 ft recovery 18' push	SS	20.0
	20					

RW02-4 TPH 2.0-8.5'
RW02-1 PCE 17.0'
RW02-2 PCE 18.0'
RW02-09 PCE 18.0-18.5
RW02-3 PCE 18.5'

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG

DIVISION

INSTALLATION: CAMP LEJEUNE, NC

SHEET 01 OF 01 SHEETS

1. PROJECT: Bldg. HP25 DNAPL Source Zone Borings
LOCATION (Coordinates or Station)

3. DRILLING AGENCY: TARRATT-WOLFF INC.

4. HOLE NO. (As shown on drawing title and file number): IR88-IW01

5. NAME OF DRILLER: ARNOLD CHAPEL

6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: NA

8. DEPTH DRILLED INTO ROCK: NA

9. TOTAL DEPTH OF HOLE: 19.0 FEET

10. SIZE AND TYPE OF BIT

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL: EMESS Adapted for hollow stem auger

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE | STARTED 8/24/97 | COMPLETED 8/25/97

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING: 75 %

19. SIGNATURE OF INSPECTOR: JOHN T. LONDERGAN, INTERA

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			8-inch diam. MANhole			HNu (ppm)
			fine SAND, lt brown, dry			
			water tight griffen cap			NOTE: 2-inch diam. well installed inside 8-inch ID Augers because drillers had no other augers available over 3.25 in.
	2					
			2-inch diameter SCHEDULE 40 PVC CASING w/ flush threaded joints	3.5 ft recovery on a 4' push		
	4					15.9
			clayey fine SAND, dk grey, moist			227.0 IW01-04 TPH 4[illegible]
			grout mixed at 400 lbs Portland cement w/ 1 lb BENTONITE and 5.0 gal water			268.0
	6					31.0 IW01-05 PCE 4.5'
			12.25-inch diam. BOREHOLE			42.0
						48.0
	8		decrease in clay content becomes fine SAND dk grey wet	2.5 ft recovery on a 4' push		19.8
						55.0
						61.0 IW01-05 TPH 9.0-9.5' Not SUBMITTED TO LAB
	10		BENTONITE SEAL			5.7
						3.3
						17.0
			becomes darker grey in color	3.0 ft recovery on a 4.0 ft push		13.0
	12					13.6
			Drillers Service Inc. #1 filter sand			4.9
			704-322-1100			1.2
	14		12-50 lb bags of SAND			2.0
						2.1
						2.3
			2-inch diameter 15, 304 STAINLESS STEEL 0.01-inch wire wrap CONTINUOUS SLOT SCREEN w/ flush threaded joints	4.0 ft recovery on a 4.0 ft push		22.0 IW01-1 PCE 17.0
	16					6.1 IW01-7 TCE 18.0
						1.5
						6.2
						20.1 IW01-09 FOC 18.0-18.5'
	18		silty clay, soft, grey, wet			140.0
						613.0 IW01-3 TCE 18.5'
						22.0 IW01-09 TPH 18.5-19.0
	19					
	20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

INTERA | -TON304 | SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4 HSA

SAMPLING METHOD: 2' x 1 3/8" SPLIT SPOON

BORING NO. SB-EX01

SHEET 1 OF 1

					DRILLING START	DRILLING FINISH
WATER LEVEL (BLS)					TIME 1119	TIME 1350
TIME						
DATE					DATE 12/3	DATE 12/3
CASING DEPTH (BLS)						

DATUM ELEVATION

DRILLER:

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

PID (PPM)

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
					0-16' A-H (Auger-No Sample)						
16.5							EX01-01	260	16.5'		VOA
		75			VF SAND, some silt, trace clay; gray; wet; solvent odor		EX01-02	320	17.5'		(VOA)
18				18.7			EX01-03	300	18.5'		(VOA)
		80						150			
								150			
20				20.0	CLAY, little silt, trace sand; dark gray; wet to moist			160			
		90			and peat			300			
22					CLAY, trace silt; dark gray; moist			250			
								200			
								100			

LOGGED BY: M. DeJohn (BAKER)

INTERA ~~TRG304~~ TDN304 · SOIL BORING LOG

SITE NAME AND LOCATION	DRILLING METHOD: 3 1/4" HSA				BORING NO. 88-EX02	
					SHEET 1 OF 1	
	SAMPLING METHOD: 2' x 1 3/8" SPLIT SPOON				DRILLING	
					START	FINISH
	WATER LEVEL (BLS)				TIME 1534	TIME 1625
	TIME					
	DATE				DATE 12/3	DATE 12/3
DATUM ELEVATION	CASING DEPTH (BLS)					

DRILLER:

DRILL RIG	SURFACE CONDITIONS
ANGLE BEARING	
SAMPLE HAMMER TORQUE FT.-LBS.	

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
13					0-13' A-N						
14		90			13.0 VF SAND, little silt, trace clay; dark gray; wet						
15											
16		100			VF SAND, some silt, trace clay; dark gray; wet						
17											
18		100			VF SAND, some silt, trace clay; dark gray; wet						
19				19.3	19.3 SILT, trace fine sand; clay; gray; wet						SOLVENT ODOR
20		100		20.0	20.0 CLAY, little silt, trace fine sand and peat; brown (dark); moist						
21	30	4@	21.0'		PER JTL, NO SOIL SAMPLES COLLECTED FOR VOA.						

LOGGED BY:

INTERA | ~~IRG304~~ TDN304 | SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: 2' x 1 3/8" SPLIT SPOON

BORING NO. 88-EX03

SHEET OF

DRILLING START 0720 FINISH 0900

DRILLER:

					START	FINISH
WATER LEVEL (BLS)					TIME 0720	TIME 0900
TIME						
DATE					DATE 12/4	DATE 12/4
CASING DEPTH (BLS)						

DATUM ELEVATION

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
16	2 2 3	100			0-16' A-N						
17	2 2 8				VF SAND, some silt, trace M sand; dark gray; wet	=	EX03-01	@16.0'			VOA
18	2 8 40	90		19.0		=	EX03-02	@17.5'			VOA
19	18 12			19.4	SILT, little clay, trace f sand; dark gray; wet 19.4'	=	EX03-03	@19.0			VOA SL. SOLVENT ODOR
20		Ball @ 20.0'			CLAY, little silt, trace f sand, dark gray; wet						
21											
22											
23											
24											

LOGGED BY:

INTERA - TON304

SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: GEOPROBE MACROCORE

BORING NO. 88-EX04

SHEET 1 OF 1

					DRILLING START	DRILLING FINISH
WATER LEVEL (BLS)						
TIME					TIME 1154	TIME 1853
DATE					DATE 12/4	DATE 12/4
CASING DEPTH (BLS)						

DATUM ELEVATION

DRILLER:

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
16					VF SAND, some silt, little clay; dark brown; wet		EX04-01	(17.0') VOA			
17	19 4 0	80%					EX04-02	(18.5) VOA			
18	3 5				VF SAND, some silt, trace clay; dark gray; wet		EX04-03	(19.5) VOA			
19	15 18										
20	40			20.0	SILT, some clay; dark gray; wet			SL. SOLVENT ODOR			
21	35 20			21.0	CLAY, some silt; dark gray; moist						
22	4 0	80%		21.5	CLAY, little silt, peaty; dark brown; damp to moist						
23	4										
24		BOHE	24.0'								

LOGGED BY:

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Site 88: Replacement Well
2. LOCATION (Coordinates or Station): PITT Wellfield: 3ft N of EX04
3. DRILLING AGENCY: Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number): EX04R
5. NAME OF DRILLER: Layne Pech
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 4
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 3/23/98 @ 1545 | COMPLETED 3/23/98 @ 1
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						1¾" x 24" split spoon sampler
	5		Grout			
8.7						
	10		Bentonite			
	12		f. to v.f. SAND, trace fines, wet, loose, gray	12 / 60%		PID: 20, 280, 50, 70
12.5						
	14		as above	14 / 75%		
14.6						
	16		as above; solvent odor	16 / 90%		35, 12, 10, 10, 30
	18		18.0 cl-sa-SILT, wet, slt plast grading to cl-SILT, low plast, soft grading to si-CLAY, soft, med plast.	18 / 100%		solvent odor; 200, 20, 10, 3, 3
19.3						
19.7	20			20		

4" Sch 40 PVC Riser

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

INTERA - TON304

SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: GEOPROBE MACRO CORE

BORING NO. 88-EX05

SHEET 1 OF 1

DRILLING START: TIME 1430 DATE 12/4

DRILLING FINISH: TIME ____ DATE ____

WATER LEVEL (BLS)					
TIME					
DATE					
CASING DEPTH (BLS)					

DATUM ELEVATION

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DRILLER:

LOGGED BY:

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
17					0-17' A-N						
18		75	N.R.		F SAND, little silt; tan; wet		EX05-01	(18') VOC			
19	6 15 1			19.0	VF SAND, some silt, trace clay; dark brown; wet		EX05-02	(19') VOC			
20	38 20 20			20.5	SILT, trace clay; f sand; dark brown; wet		EX05-03	(20') VOC			
21	0		DOH@21.0		CLAY, trace silt; dark brown; moist						
22											
23											
24											

INTERA - TDN304

SOIL BORING LOG

SITE NAME AND LOCATION	DRILLING METHOD: 3 1/4" HSA		BORING NO. 88-EX06
			SHEET 1 OF 1
	SAMPLING METHOD: GEOPROBE MACRO CORE		DRILLING START / FINISH
	WATER LEVEL (BLS)		TIME 0758 / TIME 0840
	TIME		
	DATE		DATE 12/5 / DATE 12/5
DATUM ELEVATION	CASING DEPTH (BLS)		

DRILLER:

DRILL RIG	SURFACE CONDITIONS
ANGLE BEARING	
SAMPLE HAMMER TORQUE FT.-LBS.	

PID

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
					0-16' A-N						
16					F SAND, some silt; dark brown; gray; wet						
17											
18		100			VF SAND, some silt, trace clay; dark gray; wet						
19				19.0	SILT, little clay; dark gray; wet						
20				19.6	CLAY, little silt; dark gray; moist						
		Bore @ 20.0'									

LOGGED BY:

INTERA | - TDN 304 | SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: GEOPROBE MACRO CORE

BORING NO. 88-IN01

SHEET 1 OF 1

DRILLING START / FINISH

					TIME	TIME
WATER LEVEL (BLS)						
TIME					0740	0830
DATE					DATE	DATE
CASING DEPTH (BLS)					12/8	12/8

DATUM ELEVATION

DRILLER:

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
15					0-15' A-N						
240											
360											
16					VF SAND, some silt & clay; dark brown; wet						STRONG SOLVENT ODOR THROUGHOUT SAMPLE CORES
340											
340		90									
17											
190											
300					VF SAND, little silt; dark gray; wet		IN01-01 (18') VOA				
18											
300											
330					VF SAND, trace silt; dark gray; wet						
19											
FREE PHASE DNAPL				19.5			IN01-02 (19.5') VOA				FREE PHASE DNAPL
20					CLAY, some silt, trace f sand; dark gray; wet						
80		100					IN01-03 (20.5') VOA				
130											
21											
70											
111					CLAY, trace silt & peat; dark brown moist						
22											
		Bott @ 22.0'									

LOGGED BY:

INTERA - TAN 304

SOIL BORING LOG

SITE NAME AND LOCATION	DRILLING METHOD:	BORING NO.	88-IN02
		SHEET	1 OF 1
	SAMPLING METHOD:	DRILLING START	FINISH
	WATER LEVEL (BLS)	TIME	TIME
	TIME		
	DATE	DATE	DATE
DATUM ELEVATION	CASING DEPTH (BLS)	12/8	12/8

DRILLER:

DRILL RIG	SURFACE CONDITIONS
ANGLE BEARING	
SAMPLE HAMMER TORQUE FT.-LBS.	

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
16	104				VF SAND, trace silt; gray; wet						
17	28				VF SAND, some silt; gray; wet			70			
18	280	100		18.0	SILT, little clay, trace vf sand; dark gray; wet			140			
19	350			18.7	CLAY, some silt; dark gray; wet			150			
20	82				CLAY, trace silt; dark gray; moist						
					Bottom 20'						

LOGGED BY:

INTERA · TDN 304

SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: GEOPROBE MACRO CORE

BORING NO. 88-IN03

SHEET 1 OF 1

DRILLING START / FINISH

					TIME	TIME
WATER LEVEL (BLS)					1508	1535
TIME						
DATE					DATE 12/8	DATE 12/8
CASING DEPTH (BLS)						

DATUM ELEVATION

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DRILLER:

LOGGED BY:

PID

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
14	13 13 15	90			0-14' A-N VF SAND, little silt; clay; dark brown; wet						
15	2 9 2				VF SAND, little to some silt (inc. w/ depth) gray; wet		88-IN03-01 (16.0') VOA				
16							88-IN03-02 (17.5') VOA				
17											
18	41			18.0	SILT, some vf sand; dark gray; wet		88-IN03-03 (19') VOA				
19	2 5	80		19.0							
20	3 2				CLAY, little silt, trace vf sand; dark gray; moist						
21					BOH @ 21'						
22											

INTERA | TDN 304

SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 6" CASING DRIVE

BORING NO. BB-HC01

SHEET 1 OF 1

SAMPLING METHOD: GEOPROBE MACRO CORE

DRILLING START / FINISH

					DRILLING START TIME	DRILLING FINISH TIME
WATER LEVEL (BLS)						
TIME						
DATE					DATE	DATE
CASING DEPTH (BLS)						

DRILLER:

DATUM ELEVATION

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
16											
17											
18											
19		19			VF SAND, some silt; dark gray; wet		BB-HC01-01 (18.5') VOA				STRONG SOLVENT ODOR
20											FREE PHASE DNAPL
21		100		20.3 ?	SILT, little clay (increase amt w/depth to some); dark gray; wet		BB-HC01-02 (20') VOA				
22				21.5	CLAY, trace silt; dark gray; moist		BB-HC01-03 (21') VOA				
		BOH @ 22.0									

LOGGED BY:

INTERA - TDN304

SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: GEOPROBE MACRO CORE

BORING NO. 88-HC02

SHEET 1 OF 1

DRILLING START 0800 FINISH 0830

DRILLER:

WATER LEVEL (BLS)					TIME	TIME
TIME					0800	0830
DATE					DATE 12/9	DATE 12/9
CASING DEPTH (BLS)						

DATUM ELEVATION

DRILL RIG SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
14	5 5	14									
15	1 1	80%			VF SAND, some silt, trace clay; dark brown; wet		88-HC02-01 (16.0')	VOA			
16	4 14										
17	19 50	18			VF SAND, some silt; gray; wet		88-HC02-02 (17.5')	VOA			SL. SOLVENT ODOR
18	65 7	100		18.7			88-HC02-03 (18.5')	VOA			
A	3			19.2	SILT, trace clay; dark gray; wet						
20		20.5			CLAY, some to trace silt (decreasing w/ depth); dark gray; wet						
21					BOHE 20.5'						

LOGGED BY:

INTERA | - TON304 | SOIL BORING LOG

SITE NAME AND LOCATION

DRILLING METHOD: 3 1/4" HSA

SAMPLING METHOD: GEOPROBE MACROCORE

BORING NO. 88-RW04

SHEET 1 OF 1

DRILLING START / FINISH

					TIME	TIME
WATER LEVEL (BLS)						
TIME					1200	
DATE					DATE 12/9	DATE 12/9
CASING DEPTH (BLS)						

DRILLER:

DATUM ELEVATION

DRILL RIG

SURFACE CONDITIONS

ANGLE BEARING

SAMPLE HAMMER TORQUE FT.-LBS.

PID

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
14	26 4 30										
15	10 10 3	100		14.8	VF SAND, some silt, trace clay; dark brown; wet						
16	20 200 9			15.2	CLAY, some silt; gray; wet						
17	300 340 340				VF SAND, little silt; gray; wet to some						
18	200 360	100			VF SAND, some silt, trace clay; dark brown; wet		88-RW04-01 (18') VOA				STRONG SOLVENT ODOR
19				18.7	VF SAND, some silt; dark gray; wet						
20					SILT, little clay; dark gray; wet		88-RW04-02 (19.5') VOA				FREE PHASE DNAPL
21				20.3	CLAY, trace silt; dark gray; moist		88-RW04-03 (20.5') VOA				
22					BOH @ 21'						

LOGGED BY:

INTERA | - TON304 | SOIL BORING LOG

SITE NAME AND LOCATION	DRILLING METHOD:					BORING NO. RW06	
						SHEET 1 OF 1	
	SAMPLING METHOD:					DRILLING	
						START	FINISH
	WATER LEVEL (BLS)					TIME	TIME
	TIME						
	DATE					DATE	DATE
DATUM ELEVATION	CASING DEPTH (BLS)						

DRILLER:

DRILL RIG	SURFACE CONDITIONS
ANGLE BEARING	
SAMPLE HAMMER TORQUE FT.-LBS.	

DEPTH IN FEET (BLS)	BLOWS / 6 IN. ON SAMPLER	% RECOVERY	SOIL GRAPH	MATERIAL CHANGE DEPTH (BLS)(FT)	DESCRIPTION OF MATERIAL	SAMPLED INTERVAL	SAMPLE No.	FIELD SCREENING OR HEAD SPACE ANALYSIS OVM/HNU (ppm)	DEPTH IN FEET FROM	DEPTH IN FEET TO	DESCRIPTION OF OPERATION AND REMARKS
14											
15											
60 16											
24					VF SAND, some silt; dark brown; wet						
30 17											
20					VF SAND, little silt; gray; wet						
18											
19											
20		50									
160 21											
200											
22											

LOGGED BY:

Hole No.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Site 88 : Replacement Well
2. LOCATION (Coordinates or Station): PITT Wellfield : 3ft N of EX04
3. DRILLING AGENCY: Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number): EX04R
5. NAME OF DRILLER: Layne Pech
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED: 4
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED: 3/23/98 @ 1545 | COMPLETED: 3/23/98 @
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						1¾" x 24" split spoon sampler
	5					
	10					
	12		f. to v.f. SAND, trace fines, wet, loose, gray	12 / 60%		PID 20 280 50 70
	14		as above	14 / 75%		
	16		as above; solvent odor	16 / 90%		35 12 10 10 30
	18		18.0 cl-sa-SILT, wet, slt plast grading to cl-SILT, low plast, soft grading to si-CLAY, soft, med plast.	18 / 100%		solvent odor 200 20 10 3 3
	20			20		

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG | DIVISION

1. PROJECT	Site 88 : Bldg 25 Aquitard Well Point Installation
2. LOCATION (Coordinates or Station)	PITT Wellfield
3. DRILLING AGENCY	Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number)	WP01AQT
5. NAME OF DRILLER	Lee
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	23.5 ft BGS

INSTALLATION	MCB Camp Lejeune
SHEET / OF / SHEETS	1 of 1
10. SIZE AND TYPE OF BIT	6¼" ID HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
12. MANUFACTURER'S DESIGNATION OF DRILL	CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: / UNDISTURBED: 3
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 6-25-98 @ 0800 / COMPLETED 6-26-98
17. ELEVATION TOP OF HOLE	
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Fred Holzmer DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	5					No core samples from 0-13' bgs Continuous tube sampling from 13-21' bgs w/ 2" ID x 4 ft long geoprobe Macrosampler
	10					
	15		13.0 f. SAND w/ minor fines, wet, cohesive, lt gray	13 70%		PID Reading 14 — 25 ppm 14.5 — 20 15 — 3 15.5 — 0
	16		as above	16		
	18			65%		17.5 — 0 18 — 0 18.5 — 12
	20		19.0 Cl-SILT w/ f. sand, wet low plast, lt gray, soft 19.5 grading to si-CLAY, wet, low plast, med gray, v. soft. 19.8 grading to CLAY w/ silt & minor peat, wet, soft, mod plast, gray-brn. as above to 21 ft bgs	19 100%		19.5 — 110 20 — 20 20.5 — 12 No PCE odor at 21.0
	22			21		- Drilled to 19.5' bgs to set surface casing. (3" ID x 21.1' steel pipe) - Pushed casing from 19.5-21.0' bgs - Grout
	24					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT | HOLE NO.

Hole No.

DRILLING LOG | DIVISION

INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Site 88 : Bldg 25 Aquitard Well Point Installation
2. LOCATION (Coordinates or Station): PITT Wellfield
3. DRILLING AGENCY: Parratt Wolfe
4. HOLE NO. (As shown on drawing title and file number): WP02AQT
5. NAME OF DRILLER: Lee
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 25.5 ft BGS
10. SIZE AND TYPE OF BIT: 6 1/4" ID HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 3
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6-25-98 @ 1015 | COMPLETED 6-26-98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzner DE&S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	5					No core samples collected from 0-15 ft Continuous tube sampling from 15-21' bgs w/ 2" ID x 4 ft long geoprobe Macrosampler
	10					
	15		15.0 f - v.f SAND, wet, cohesive, lt gray	15		PID Reading 15.5 — 55 ppm
	16			100%		16 — 12 16.5 — 3
	17		17-19 grading to si-v.f SAND, wet, cohesive, lt gray	17		
	18			50%		18 — 110
			19.0 grading si-CLAY, wet, soft, low plast, lt to med gray.	19		19 — 120 19.5 — 20
	20		20.0 as above, w/ minor peat grading to gray brn to TD @ 21' bgs	100%		20 — 8 20.5 — 8 21 — 0
				21		TD drilling = 19.0' bgs Set Surface Casing from 19.0-21.0' bgs (3" ID x 21' steel pipe) Grout outside casing from 19' to surface
	22					
	24					
	26					

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 1 OF 1 SHEETS

1. PROJECT: Site 88 : Bldg 25 Aquitard Well Point Installation
2. LOCATION (Coordinates or Station): PITT Wellfield
3. DRILLING AGENCY: Parratt Wolfe
4. HOLE NO. (As shown on drawing title and file number): WP02AQT
5. NAME OF DRILLER: Lee
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 25.5 ft BGS
10. SIZE AND TYPE OF BIT: 6¼" ID HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 3
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6-25-98 @ 1015 | COMPLETED 6-26-98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Fred Holzmer DE & S Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			3" dia. steel casing			No core samples collected from 0-15 ft
			Grout			
	5		2" dia. hollow drive rod (removed)			Continuous tube sampling from 15-21' bgs w/ 2" ID x 4 ft long geoprobe Macrosampler
			Sample collection Tubing (¼" OD)			
	10					
	15		15.0 f-v.f SAND, wet, cohesive, lt gray	15		PID Reading
			Bentonite Seal			15.5 55 ppm
	16			100%		16 12
						16.5 3
	17		17-19 grading to si-v.f SAND, wet, cohesive, lt gray	17		
	18			50%		18 110
			19.0 grading si-CLAY, wet, soft, low plast, lt to med gray.	19		19 120
						19.5 20
	20		20.0 as above, w/ minor peat grading to gray brn to TD @ 21' bgs	100%		20 8
						20.5 8
						21 0
				21		TD drilling = 19.0' bgs
	22		WP02AQT Specs.			Set Surface Casing from 19.0-21.0' bgs (3" ID x 21' steel pipe)
			Drive Point @ 25.5' bgs			Grout outside casing from 19' to surface
			Sand Pack to 23.0' bgs			
			Bentonite to 15.0' bgs			
			Screen @ 24 to 25' bgs			
	24		Tubing Stickup 2.8' ags			
			3" dia steel casing @ 21' bgs			
			Surface completion includes 1' of 3" dia. PVC pipe and a press on cap with a ¼" hole.			
	26					

Screen
Drive Point

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG | DIVISION

1. PROJECT: Site 88 : Bldg 25 Aquifer Well Point Installation	INSTALLATION: MCB Camp Lejeune
2. LOCATION (Coordinates or Station): PITT Wellfield	10. SIZE AND TYPE OF BIT: 6 1/4" ID HSA
3. DRILLING AGENCY: Parratt-Wolfe	11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
4. HOLE NO. (As shown on drawing title and file number): WP01AQT	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
5. NAME OF DRILLER: Lee	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED: 3
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	14. TOTAL NUMBER CORE BOXES
7. THICKNESS OF OVERBURDEN	15. ELEVATION GROUND WATER
8. DEPTH DRILLED INTO ROCK	16. DATE HOLE: STARTED 6-25-98@0800 / COMPLETED 6-26-98
9. TOTAL DEPTH OF HOLE: 23.5 ft BGS	17. ELEVATION TOP OF HOLE
	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: Fred Holzmer DE&S Geologist

SHEET 1 OF 1 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			3" dia. steel casing			No core samples from 0-13' bgs
			grout			
			2" dia. hollow drive rod (removed)			Continuous tube sampling from 13-21' bgs w/ 2" ID x 4 ft long geoprobe Macrosampler
	5		Sample Collection Tubing 1/4" OD			
	10					PID Reading
			13.0 f. SAND w/ minor fines, wet, cohesive, lt gray	13		
	15			70%		14 25 ppm; 14.5 20; 15 3; 15.5 0
	16		as above	16		
				65%		17.5 0; 18 0; 18.5 12
			Bentonite seal			
	18					
			19.0 cl-SILT w/ f. sand, wet low plast, lt gray, soft	19		
	20		19.5 grading to si-CLAY, wet, low plast, med gray, v. soft.	100%		19.5 110; 20 20; 20.5 12
			19.8 grading to CLAY w/ minor silt & minor peat, wet, soft, med plast, gray-brn.			No PCE odor at 21.0
	22		as above to 21 ft bgs	21		- Drilled to 19.5' bgs to set surface casing. (3" ID x 21.1' steel pipe)
			WP01AQT specs.			- Pushed casing from 19.5-21.0' bgs
			Drive point @ 23.5' bgs			- Grout
			Sand Pack to 21.7' bgs			
			Bentonite to 15.0 bgs			
			Screen @ 22-23' bgs			
	24		Tubing Stickup 1.6' ags			
			3" dia. steel casing @ 21' bgs			
			Surface completion includes 1 foot of 3" dia. PVC pipe and a press on cap with a 1/4" hole.			
			Screen			
			Drive Point			

Hole No.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 1 OF 2 SHEETS

1. PROJECT: Site 88: Bldg 25; Upper Castle Hayne monitor well
2. LOCATION (Coordinates or Station): PITT Wellfield
3. DRILLING AGENCY: Parratt Wolfe
4. HOLE NO. (As shown on drawing title and file number): MW 10 IW
5. NAME OF DRILLER: Lee
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 39'
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6/26/98 COMPLETED 6/26/98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			6" dia. steel casing			No core samples collected from 0-15ft
			Grout			
			2" dia. Sch. 40 PVC Riser			Continuous tube sampling from 15-38' logs 2" ID x 4ft geoprobe macro sampler
	5					
	10					
	15		fine SAND w minor fines, wet, cohesive, lt gray (poor recovery)	25%		PID Reading
	16					0 ppm
	17		as above			
	18		grading to si-cl-v.f. SAND, wet, cohesive, slt plast, med gray	65%		5 ppm
	19		grading to si-CLAY w minor f. sand, wet, soft, low plast. med gray			180 ppm
	20		20.2 grading to si-CLAY w peat, soft. low-med plast, gray-brown to 21'	100%		180 ppm 100 ppm 100 ppm 20 ppm
			Bentonite			
	22		22.0 CLAY w minor peat, wet, low-med plast, med stiff, gray w brn in peat fraction			0
			23.5 peaty-CLAY, wet, low plast, gray-brn			0
	24			100%		0
						0
	26		26 CLAY, wet, high plast, med-stiff to stiff, med gray			0
						0
	28		as above	100%		0

6" dia. Sch. 40 PVC Riser

Hole No.

DRILLING LOG

DIVISION

INSTALLATION: MCB Camp Lejeune

SHEET 2 OF 2 SHEETS

1. PROJECT: Site 88: Bldg. 25 Upper Castle Hayne Monitor Well
2. LOCATION (Coordinates or Station): PITT Wellfield
3. DRILLING AGENCY: Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number): MW10IW
5. NAME OF DRILLER: Lee
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 39'
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6/26/98 COMPLETED 6/26/98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30		Bentonite 30.5 peaty - CLAY, wet, friable to slt plast, med stiff, gray-brn.			PID Reading 0 ppm
	32		2" dia. Sch. 40 PVC Riser 32.5 CLAY w peat, wet, stiff low - med plast, gray	100%		0
	34		33.7 grading to f. SAND (no recovery 34 - 35' bgs)			0
	36		35 si-sa-peaty CLAY, friable, wet gray-brn, wood chips to 2" dia. 35.5 si-cl-f. SAND, wet friable gray 36 sa - CLAY, wet, low plast gray	100%		0 0
	38		36.3 f. SAND wet, non-cohesive, lt. gray, clean well sorted sand to end of sample			0
	40		2" dia. well MW10IW Specs Well Length: 39' bgs 2" Riser ground surface to 34' bgs 2" PVC wire wrap screen 0.010 from 34 - 38.5 Sand Pack 31.8 - 39' bgs Bentonite 17.5 - 31.8 bgs Grout 0.5 - 17.5' bgs			

Sand Pack
Screw on Cap
0.010 Wire Wrap Screen

Hole No.

DRILLING LOG | DIVISION | INSTALLATION: MCB Camp Lejeune | SHEET 2 OF 2 SHEETS

1. PROJECT: Site 88: Bldg. 25 Upper Castle Hayne Monitor Well
2. LOCATION (Coordinates or Station): PITT Wellfield
3. DRILLING AGENCY: Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number): MW10IW
5. NAME OF DRILLER: Lee
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 39'
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6/26/98 | COMPLETED 6/26/98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30		Bentonite 30.5 peaty - CLAY, wet, friable to slt plast, med stiff, gray-brn.			PID Reading 0 ppm
			2" dia. Sch. 40 PVC Riser			
	32		32.5 CLAY w peat, wet, stiff low - med plast, gray	100%		0
			33.7 grading to f. SAND (no recovery 34 - 35' bgs)			0
	34		35 si-sa-peaty CLAY, friable, wet gray-brn, wood chips to 2" dia.			0
	36		35.5 si-cl-f. SAND, wet friable gray 36 sa - CLAY, wet, low plast gray	100%		0
	38		36.3 f. SAND wet, non-cohesive, lt. gray, clean well sorted sand to end of sample			0
	40		2" dia. well MW10IW Specs Well Length: 39' bgs 2" Riser groundsurface to 34' bgs 2" PVC wire wrap screen 0.010 from 34 - 38.5 Sand Pack 31.8 - 39' bgs Bentonite 17.5 - 31.8 bgs Grout 0.5 - 17.5' bgs			

Sand Pack
Screw on Cap
0.010 Wire wrap Screen

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

Hole No.

DRILLING LOG | DIVISION

1. PROJECT	Site 88: Bldg. 25 Upper Castle Hayne Monitor Well
2. LOCATION (Coordinates or Station)	PITT Wellfield
3. DRILLING AGENCY	Parratt-Wolfe
4. HOLE NO. (As shown on drawing title and file number)	MW10IW
5. NAME OF DRILLER	Lee
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	39'

INSTALLATION	MCB Camp Lejeune
SHEET	2 OF 2 SHEETS
10. SIZE AND TYPE OF BIT	
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
12. MANUFACTURER'S DESIGNATION OF DRILL	CME 55
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: UNDISTURBED: 7
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 6/26/98 COMPLETED 6/26/98
17. ELEVATION TOP OF HOLE	
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	

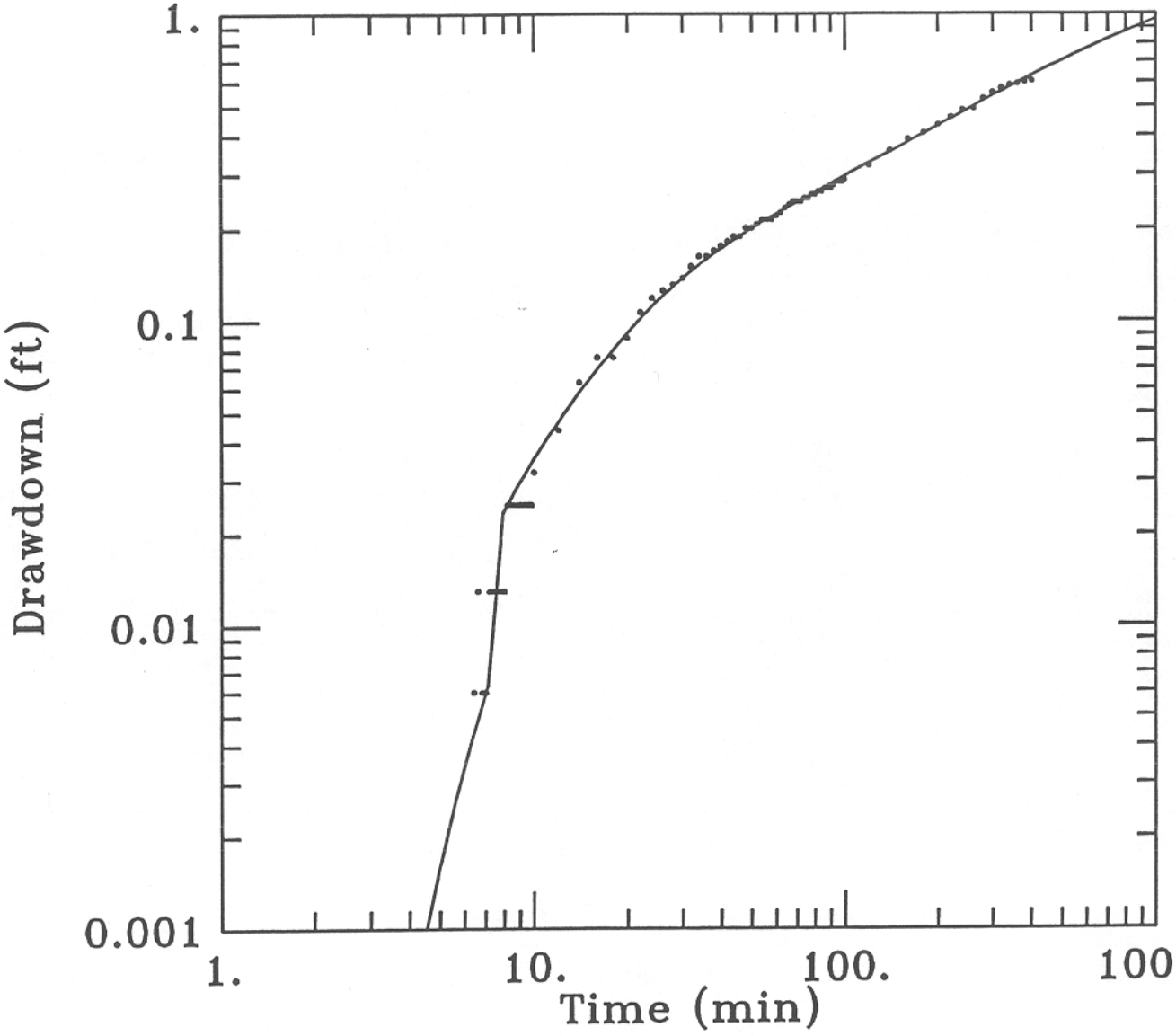
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30		Bentonite			PID Reading
			30.5 peaty-CLAY, wet, friable to slt plast, med stiff, gray-brn.			0 ppm
			2" dia. Sch. 40 PVC Riser			0
	32			100%		0
			32.5 CLAY w peat, wet, stiff low-med plast, gray			0
			33.7 grading to f. SAND (no recovery 34-35' bgs)			0
	34					0
			35 si-sa-peaty CLAY, friable, wet gray-brn, wood chips to 2" dia.			0
	36		35.5 si-cl-f. SAND, wet friable gray	100%		0
			36 sa-CLAY, wet, low plast gray			0
	38		36.3 f. SAND wet, non-cohesive, lt. gray, clean well sorted sand to end of sample			
			2" dia. well			
	40		MW10IW Specs			
			Well Length: 39' bgs			
			2" Riser ground surface to 34' bgs			
			2" PVC wire wrap screen 0.010 from 34-38.5			
			Sand Pack 31.8-39' bgs			
			Bentonite 17.5-31.8 bgs			
			Grout 0.5-17.5' bgs			

Sand Pack
Screw on Cap
0.010 Wire Wrap Screen

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT | HOLE NO.

APPENDIX C
Aquifer Test Data, Drawdown and Curve Match Plots



DATA SET:
TW02-PT.AQT
09/28/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Neuman (approx.)

PROJECT DATA:
test date: Sept 22, 1997
test well: RW-02
obs. well: TW-02

TEST DATA:
Q = 0.067 ft^3/min
r = 18.8 ft
r_c = 0.17 ft
r_w = 0.5 ft
b = 11. ft
Pumping Well Screen Depth:
top = 6. ft
bot.= 11. ft
Obs. Well Screen Depth:
top = 0. ft
bot.= 7. ft

PARAMETER ESTIMATES:
T = 0.01278 ft^2/min K= 6E-4 $\frac{cm}{s}$
S = 0.002564
Sy = 0.008588
β = 1.049

AQTESOLV

Water Level Drawdown at Observation Well TW02 During Pump Test

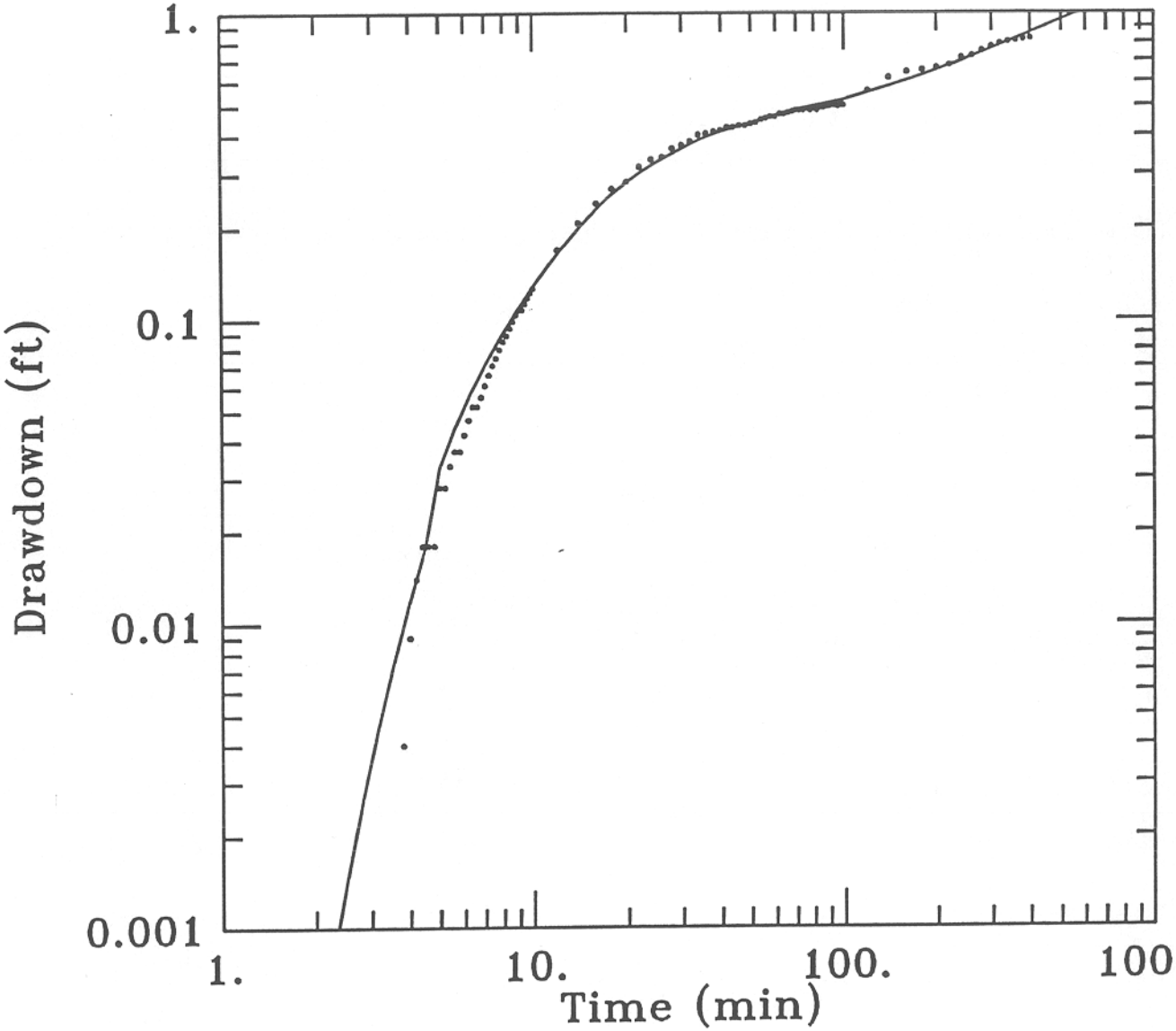
SE2000
Environmental Logger
08/23 20:17

Unit# 373 Test 1
Setups: INPUT 2
---------- ---------
Type Level (F)
Mode TOC
I.D. TW:02

Reference 8.550
PSI at Ref. 2.325
SG 1.000
Linearity 0.020
Scale factor 19.901
Offset -0.064
Delay mSEC 50.000

Step 0 08/22 11:59:35
Elapsed Time INPUT 2

Elapsed Time (min)	Water Level (ft)
0.0000	8.474
0.0083	8.474
0.0166	8.474
0.0250	8.468
0.0333	8.474
0.0416	8.474
0.0500	8.474
0.0583	8.474
0.0666	8.474
0.0750	8.474
0.0833	8.474
0.0916	8.474
0.1000	8.468
0.1083	8.474
0.1166	8.468
0.1250	8.474
0.1333	8.474
0.1416	8.474
0.1500	8.474
0.1583	8.468
0.1666	8.474
0.1750	8.468
0.1833	8.474
0.1916	8.468
0.2000	8.474
0.2083	8.474
0.2166	8.474
0.2250	8.474
0.2333	8.468
0.2416	8.474
0.2500	8.474
0.2583	8.474
0.2666	8.474
0.2750	8.474
0.2833	8.474
0.2916	8.468
0.3000	8.474
0.3083	8.474
0.3166	8.474
0.3250	8.468
0.3333	8.468
0.3500	8.468
0.3666	8.474
0.3833	8.474
0.4000	8.474
0.4166	8.474
0.4333	8.474
0.4500	8.474
0.4666	8.468
0.4833	8.468
0.5000	8.474
0.5166	8.474
0.5333	8.474
0.5500	8.468
0.5666	8.474
0.5833	8.474
0.6000	8.468
0.6166	8.474
0.6333	8.474
0.6500	8.474
0.6666	8.474
0.6833	8.474
0.7000	8.468
0.7166	8.474
0.7333	8.474
0.7500	8.474
0.7666	8.474
0.7833	8.474
0.8000	8.474
0.8166	8.474
0.8333	8.474
0.8500	8.474
0.8666	8.468
0.8833	8.468
0.9000	8.474
0.9166	8.474
0.9333	8.474
0.9500	8.474
0.9666	8.474
0.9833	8.474
1.0000	8.474
1.2000	8.474
1.4000	8.474
1.6000	8.474
1.8000	8.474
2.0000	8.474
2.2000	8.474
2.4000	8.468
2.6000	8.468
2.8000	8.474
3.0000	8.468
3.2000	8.468
3.4000	8.468
3.6000	8.474
3.8000	8.474
4.0000	8.474
4.2000	8.480
4.4000	8.474
4.6000	8.474
4.8000	8.474
5.0000	8.474
5.2000	8.480
5.4000	8.474
5.6000	8.480
5.8000	8.474
6.0000	8.480
6.2000	8.480
6.4000	8.480
6.6000	8.487
6.8000	8.480
7.0000	8.480
7.2000	8.487
7.4000	8.487
7.6000	8.487
7.8000	8.487
8.0000	8.487
8.2000	8.499
8.4000	8.499
8.6000	8.499
8.8000	8.499
9.0000	8.499
9.2000	8.499
9.4000	8.499
9.6000	8.499
9.8000	8.499
10.0000	8.506
12.0000	8.518
14.0000	8.537
16.0000	8.550
18.0000	8.550
20.0000	8.562
22.0000	8.581
24.0000	8.593
26.0000	8.600
28.0000	8.606
30.0000	8.612
32.0000	8.625
34.0000	8.637
36.0000	8.637
38.0000	8.644
40.0000	8.650
42.0000	8.656
44.0000	8.663
46.0000	8.663
48.0000	8.675
50.0000	8.675
52.0000	8.681
54.0000	8.688
56.0000	8.688
58.0000	8.688
60.0000	8.694
62.0000	8.700
64.0000	8.707
66.0000	8.713
68.0000	8.719
70.0000	8.719
72.0000	8.719
74.0000	8.725
76.0000	8.725
78.0000	8.732
80.0000	8.732
82.0000	8.738
84.0000	8.738
86.0000	8.744
88.0000	8.744
90.0000	8.744
92.0000	8.750
94.0000	8.757
96.0000	8.757
98.0000	8.757
100.000	8.763
120.000	8.794
140.000	8.832
160.000	8.864
180.000	8.882
200.000	8.908
220.000	8.933
240.000	8.958
260.000	8.964
280.000	9.002
300.000	9.027
320.000	9.046
340.000	9.058
360.000	9.065
380.000	9.071
400.000	9.077



DATA SET:
RW01-PT.OUT
09/28/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Neuman (approx.)

PROJECT DATA:
test date: Sept 22, 1997
test well: RW-02
obs. well: RW-01

TEST DATA:
Q = 0.067 ft^3/min
r = 15. ft
r_c = 0.17 ft
r_w = 0.5 ft
b = 11. ft
Pumping Well Screen Depth:
top = 6. ft
bot.= 11. ft
Obs. Well Screen Depth:
top = 6. ft
bot.= 11. ft

PARAMETER ESTIMATES:
T = 0.008504 ft^2/min K=4E-4 cm/s
S = 0.001814
Sy = 0.01433
β = 1.104

AQTESOLV

Water Level Drawdown at Observation Well RW01 During Pump Test

SE2000
Environmental Logger
08/23 16:44

Unit# 328 Test 1
Setups: INPUT 4
---------- ---------
Type Level (F)
Mode TOC
I.D. RW01

Reference 8.130
PSI at Ref. 4.329
SG 1.000
Linearity 0.112
Scale factor 14.921
Offset -0.011
Delay mSEC 50.000

Step 0 08/22 08:59:55
Elapsed Time INPUT 4

Elapsed Time (min)	Water Level (ft)
0.0000	8.059
0.0083	8.059
0.0166	8.059
0.0250	8.059
0.0333	8.059
0.0416	8.059
0.0500	8.059
0.0583	8.059
0.0666	8.059
0.0750	8.059
0.0833	8.059
0.0916	8.059
0.1000	8.059
0.1083	8.059
0.1166	8.059
0.1250	8.059
0.1333	8.059
0.1416	8.059
0.1500	8.059
0.1583	8.059
0.1666	8.059
0.1750	8.059
0.1833	8.059
0.1916	8.059
0.2000	8.059
0.2083	8.059
0.2166	8.059
0.2250	8.059
0.2333	8.059
0.2416	8.059
0.2500	8.059
0.2583	8.059
0.2666	8.054
0.2750	8.059
0.2833	8.059
0.2916	8.059
0.3000	8.059
0.3083	8.059
0.3166	8.059
0.3250	8.059
0.3333	8.059
0.3500	8.059
0.3666	8.054
0.3833	8.059
0.4000	8.059
0.4166	8.059

Elapsed Time (min)	Water Level (ft)
0.4333	8.059
0.4500	8.059
0.4666	8.059
0.4833	8.059
0.5000	8.054
0.5166	8.059
0.5333	8.059
0.5500	8.059
0.5666	8.059
0.5833	8.059
0.6000	8.059
0.6166	8.059
0.6333	8.059
0.6500	8.059
0.6666	8.059
0.6833	8.059
0.7000	8.059
0.7166	8.059
0.7333	8.059
0.7500	8.059
0.7666	8.059
0.7833	8.063
0.8000	8.059
0.8166	8.059
0.8333	8.059
0.8500	8.059
0.8666	8.059
0.8833	8.059
0.9000	8.059
0.9166	8.059
0.9333	8.059
0.9500	8.059
0.9666	8.059
0.9833	8.059
1.0000	8.059
1.2000	8.059
1.4000	8.059
1.6000	8.059
1.8000	8.059
2.0000	8.054
2.2000	8.054
2.4000	8.054
2.6000	8.059
2.8000	8.059
3.0000	8.059
3.2000	8.059

Elapsed Time (min)	Water Level (ft)
3.4000	8.059
3.6000	8.063
3.8000	8.063
4.0000	8.068
4.2000	8.073
4.4000	8.077
4.6000	8.077
4.8000	8.077
5.0000	8.087
5.2000	8.087
5.4000	8.092
5.6000	8.096
5.8000	8.096
6.0000	8.101
6.2000	8.106
6.4000	8.111
6.6000	8.111
6.8000	8.115
7.0000	8.120
7.2000	8.125
7.4000	8.130
7.6000	8.134
7.8000	8.139
8.0000	8.144
8.2000	8.148
8.4000	8.153
8.6000	8.158
8.8000	8.163
9.0000	8.167
9.2000	8.167
9.4000	8.172
9.6000	8.177
9.8000	8.182
10.0000	8.186
12.0000	8.229
14.0000	8.267
16.0000	8.300
18.0000	8.328
20.0000	8.342
22.0000	8.376
24.0000	8.394
26.0000	8.399
28.0000	8.423
30.0000	8.432
32.0000	8.442
34.0000	8.461
36.0000	8.465

Elapsed Time (min)	Water Level (ft)
38.0000	8.470
40.0000	8.475
42.0000	8.484
44.0000	8.484
46.0000	8.489
48.0000	8.489
50.0000	8.494
52.0000	8.499
54.0000	8.508
56.0000	8.513
58.0000	8.518
60.0000	8.518
62.0000	8.527
64.0000	8.527
66.0000	8.532
68.0000	8.536
70.0000	8.541
72.0000	8.541
74.0000	8.541
76.0000	8.546
78.0000	8.541
80.0000	8.546
82.0000	8.541
84.0000	8.551
86.0000	8.551
88.0000	8.555
90.0000	8.555
92.0000	8.560
94.0000	8.560
96.0000	8.555
98.0000	8.560
100.000	8.560
120.000	8.617
140.000	8.674
160.000	8.702
180.000	8.711
200.000	8.721
220.000	8.735
240.000	8.773
260.000	8.782
280.000	8.811
300.000	8.834
320.000	8.853
340.000	8.863
360.000	8.868
380.000	8.877
400.000	8.882

APPENDIX D
CPT Logs

FUGRO GEOSCIENCES, INC.

6105 Rookin
Houston, TX 77074
Phone : 713-778-5580
Fax : 713-778-5501

December 5, 1997
Report Number: 0301-7257

Baker Environmental
AOP # 3
420 Brauser Rd.
Corapolis, PA 15108

Attention: Mr. John Andy

REPORT FOR
CONE PENETRATION TESTING
AND RELATED SERVICES
CAMP LEJEUNE, NORTH CAROLINA

Dear Mr. Andy:

Please find enclosed herewith the final results of the cone penetrometer tests conducted at the above referenced location.

For your information, the soil stratigraphy was identified using Campanella and Robertson's Simplified Soil Behavior Chart. Please note that because of the empirical nature of the soil behavior chart, the soil identification should be verified locally.

Fugro Geosciences appreciates the opportunity to be of service to your organization. If you should have any questions, or if we can be of further assistance, please do not hesitate to contact us. We look forward to working with you in the future.

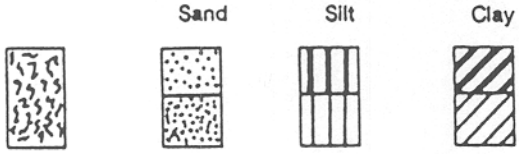
Very truly yours,
FUGRO GEOSCIENCES, INC.

Jeffery L. Ness
General Manager
CPT Operations

JLN/mw

Key To Soil Classification and Symbols

SOIL TYPE
(Shown in Symbol Column)



Predominant Type Shown Heavy

SAMPLE TYPE
(Shown in Samples Column)

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (Major portion Retained on No. 200 Sieve)
Includes (1) clean gravels and sand described as fine, medium or course, depending on distribution of grain sizes (2) silty or clayey gravels and sands and (3) fine grained low plasticity soils (PI < 10) such as sandy silts. Condition is rated according to relative density, as determined by lab tests or estimated from resistance to sampler penetration.

Descriptive Term	Penetration Resistance*	Relative Density
Loose	0 - 10	0 to 40%
Medium Dense	10 - 30	40 to 70%
Dense	30 - 50	70 to 90%
Very Dense	Over 50	90 to 100%

* Blows/Foot, 140# Hammer, 30" Drop

FINE GRAINED SOILS (Major Portion Passing No. 200 Sieve)
Includes (1) inorganic and organic silts and clays, (2) sandy, gravelly or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests for soils with PI $\geq$ 10.

Descriptive Term	Cohesive Shear Strength Tons/Square Foot
Very Soft	Less Than 0.125
Soft	0.125 to 0.25
Firm	0.25 to 0.50
Stiff	0.50 to 1.00
Very Stiff	1.00 to 2.00
Hard	2.00 and Higher

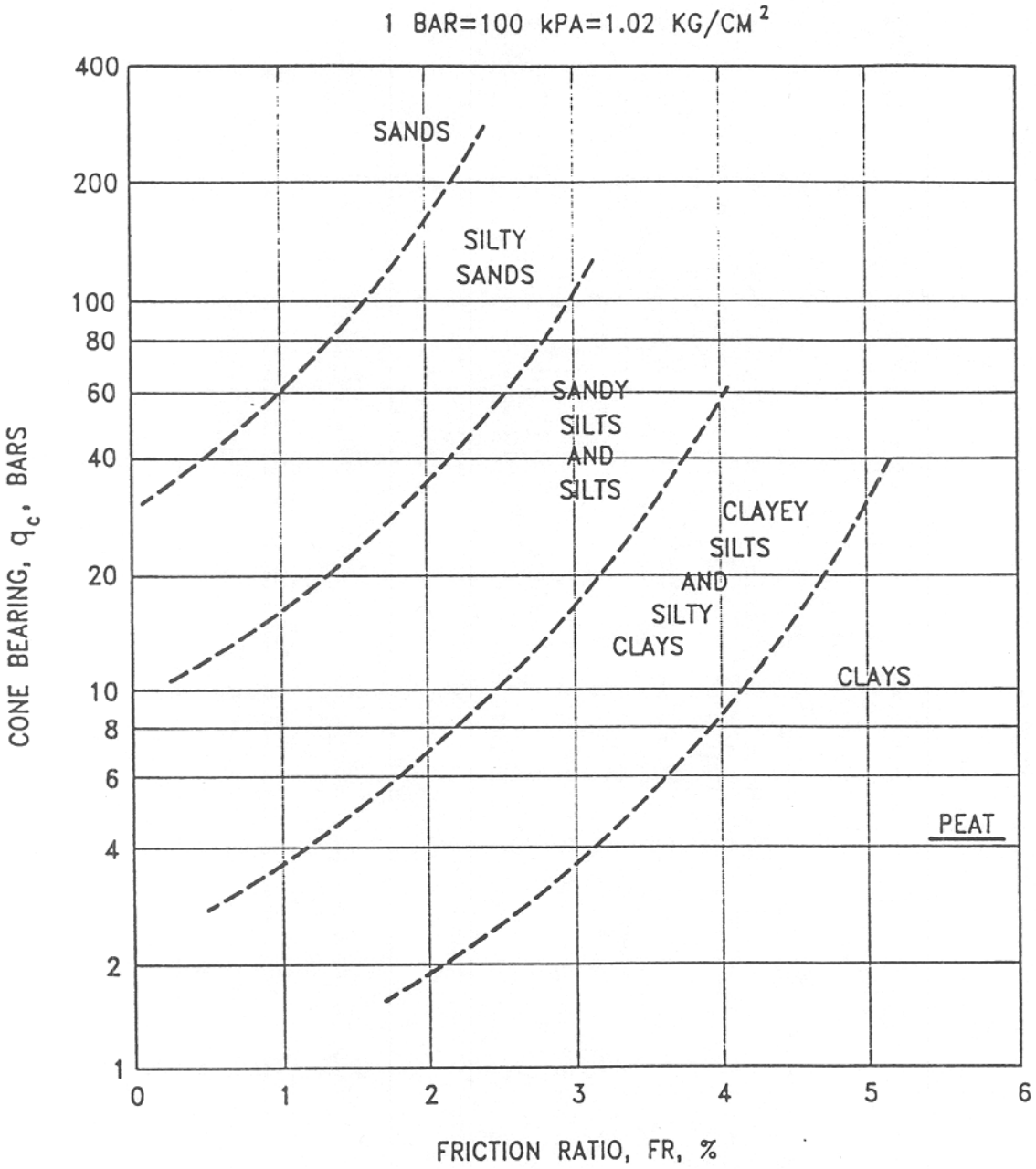
Note: Slickensided and fissured clay may have lower unconfined compressive strengths than shown above because of planes of weakness or shrinkage cracks; consistency ratings of such soils are based on hand penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

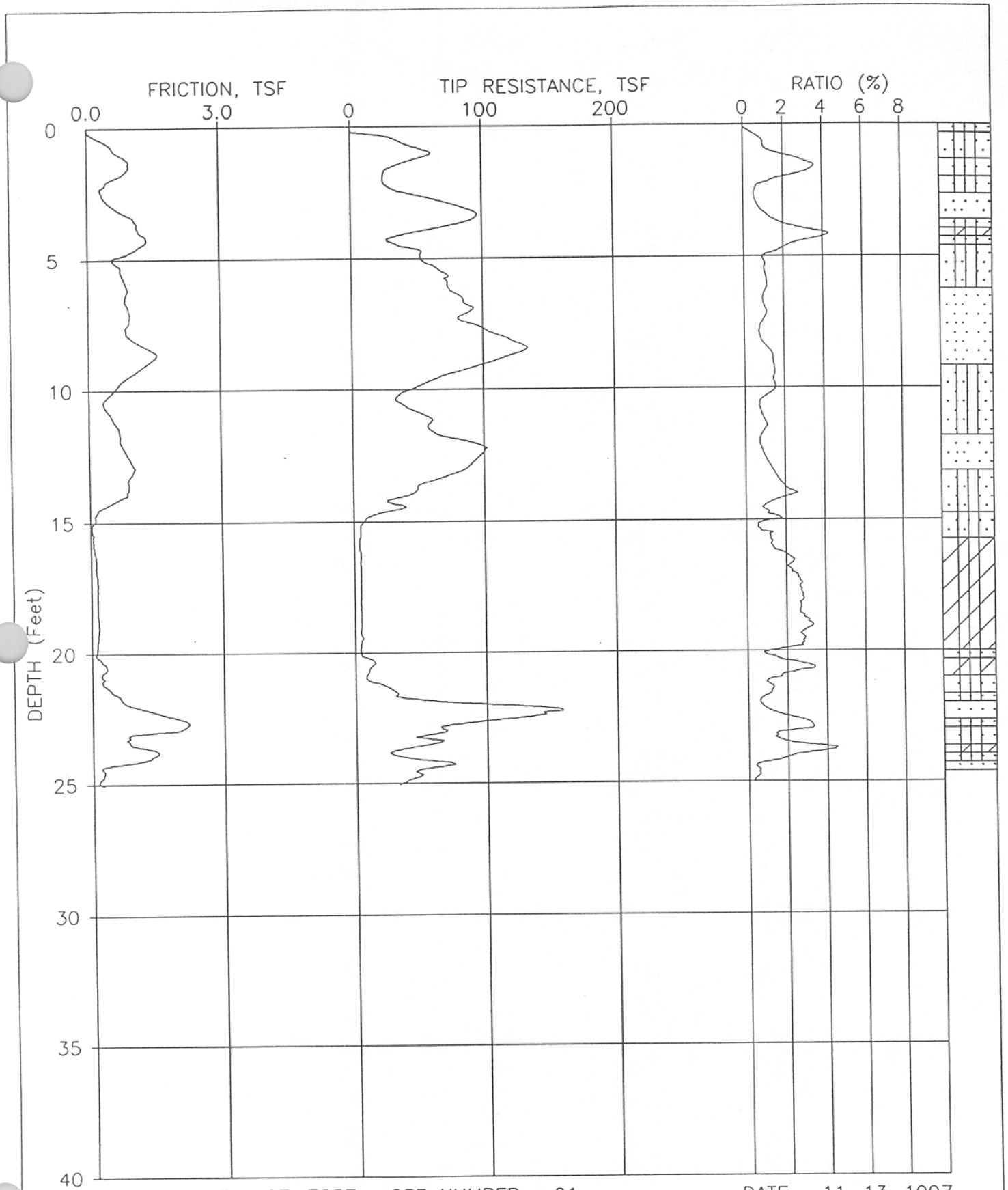
Parting:	paper thin in size
Seam:	1/8" to 3" thick
Layer:	greater than 3"
Fissured:	containing shrinkage cracks, frequently filled with fine sand or silt, usually more or less vertical
Sensitive:	pertaining to cohesive soils that are subject to appreciable loss of strength when remolded
Interbedded:	composed of alternate layers of different soil types
Laminated:	composed of thin layers of varying color and texture
Calcareous:	containing appreciable quantities of calcium carbonate
Well Graded:	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Poorly Graded:	predominantly of one grain size, or having a range of sizes with some intermediate size missing
Flocculated:	pertaining to cohesive soils that exhibit a loose knit or flakey structure
Slickensided:	having inclined planes of weakness that are slick and glossy in appearance.

Degree of Slickensided Development

Slightly Slickensided:	slickensides present at intervals of 1' to 2', soil does not easily break along these plates
Moderately Slickensided:	slickensides spaced at intervals of 1' to 2', soil breaks easily along these planes
Extremely Slickensided:	continuous and interconnected slickensides spaced at intervals of 4" to 12', soil breaks along the slickensides into pieces 3" to 6" in size
Intensely Slickensided:	slickensides spaced at intervals of less than 4", continuous in all directions; soil breaks down along planes into nodules 1/4" to 2" in size.



CAMPANELLA AND ROBERTSON CLASSIFICATION CHART (1983)

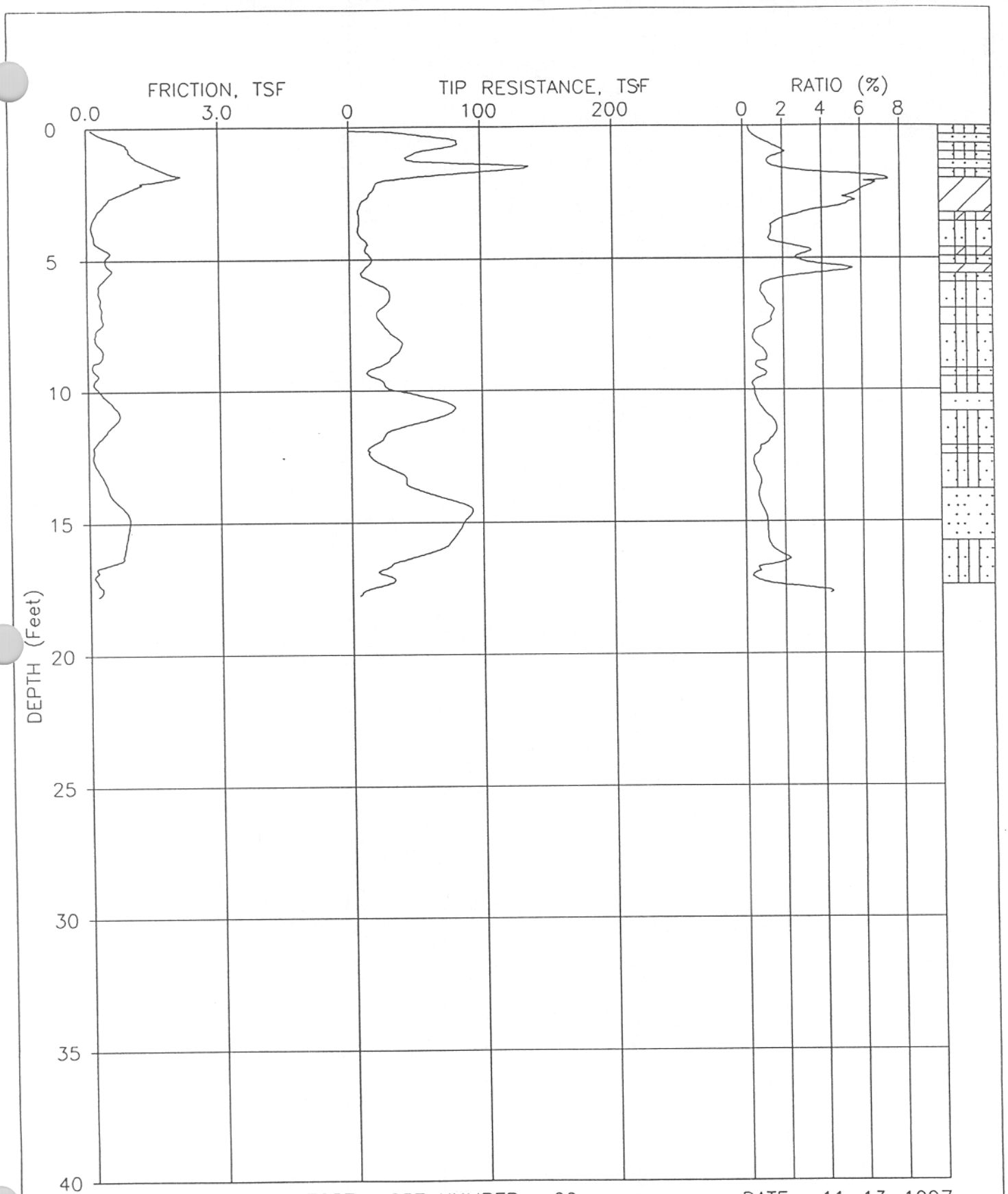


JOB NUMBER: 97-7257
ELEVATION: 0.00

CPT NUMBER: 01
CONE NUMBER: F7.5CKEV611

DATE: 11-13-1997
PLATE: 1 OF 1

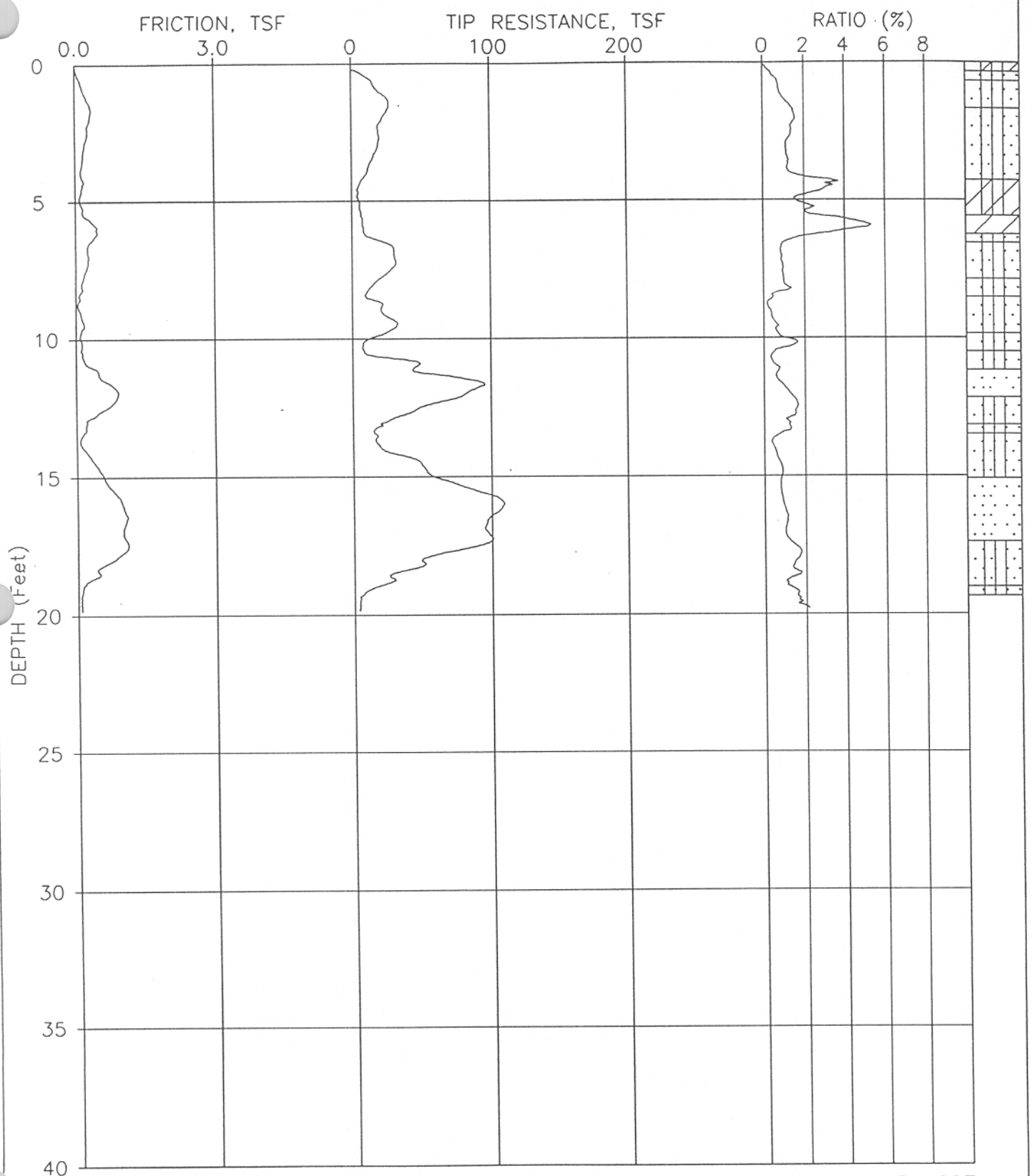
FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 02 DATE: 11-13-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

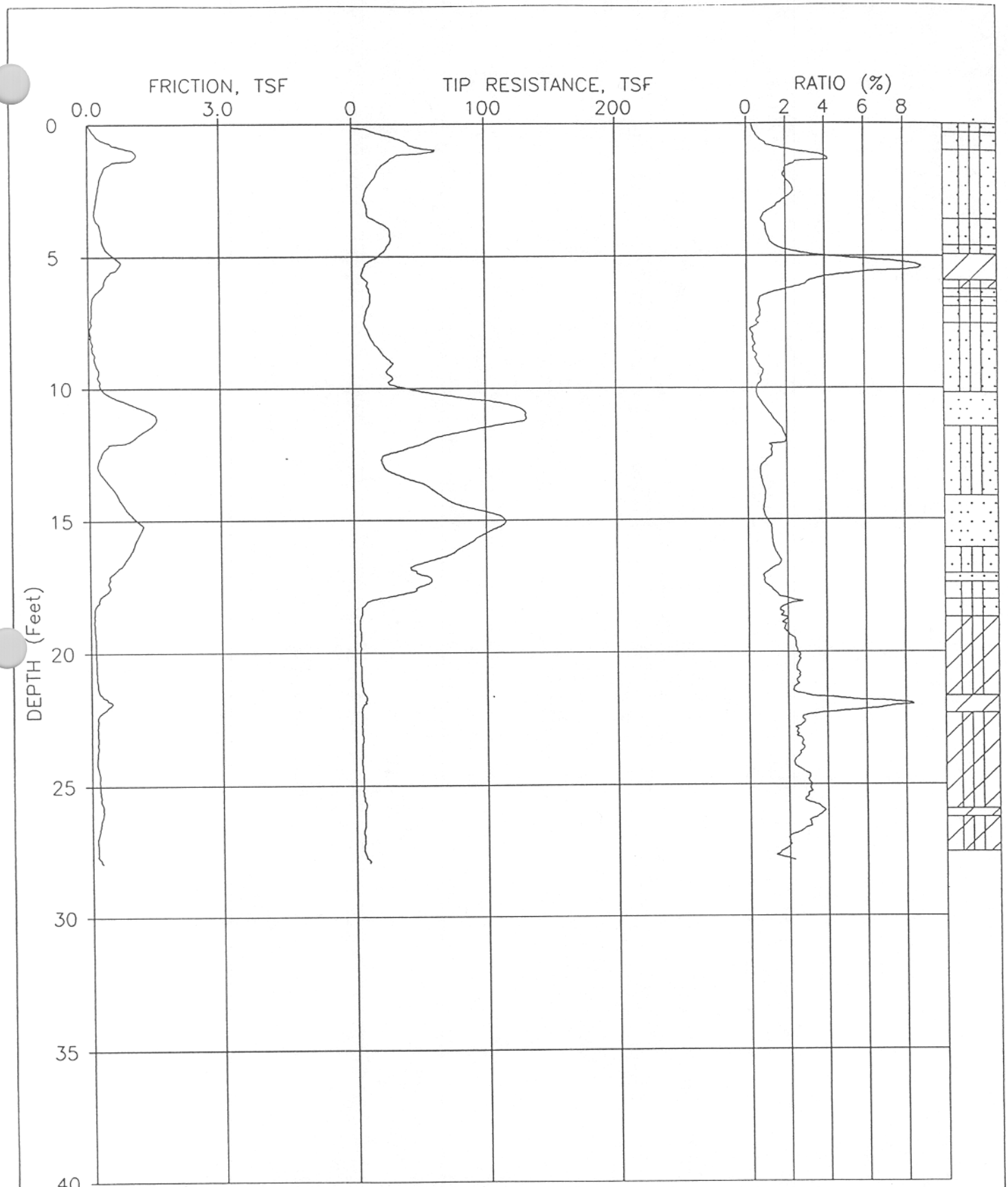
FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 03 DATE: 11-13-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

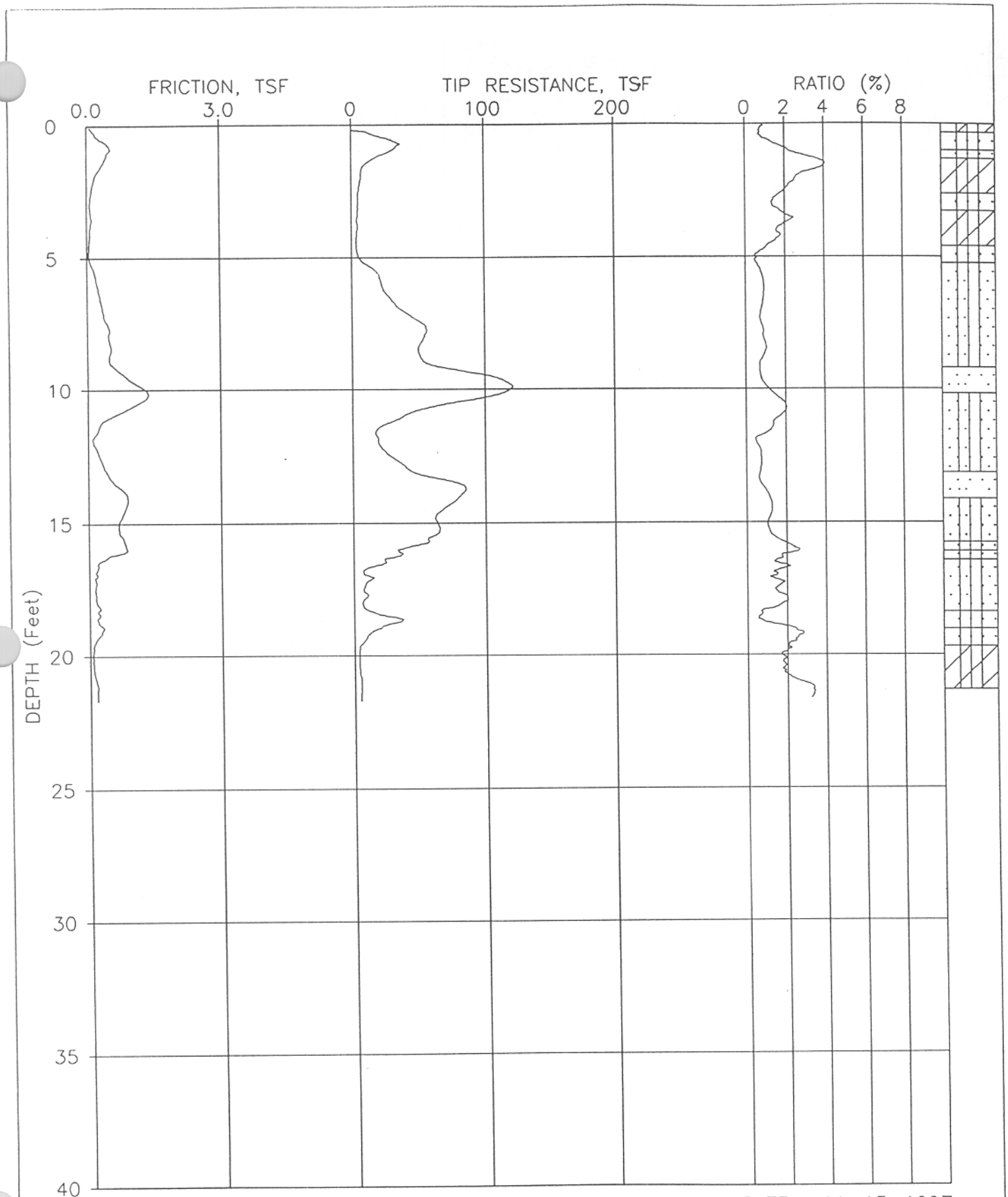


JOB NUMBER: 97-7257
ELEVATION: 0.00

CPT NUMBER: 04
CONE NUMBER: F7.5CKEV611

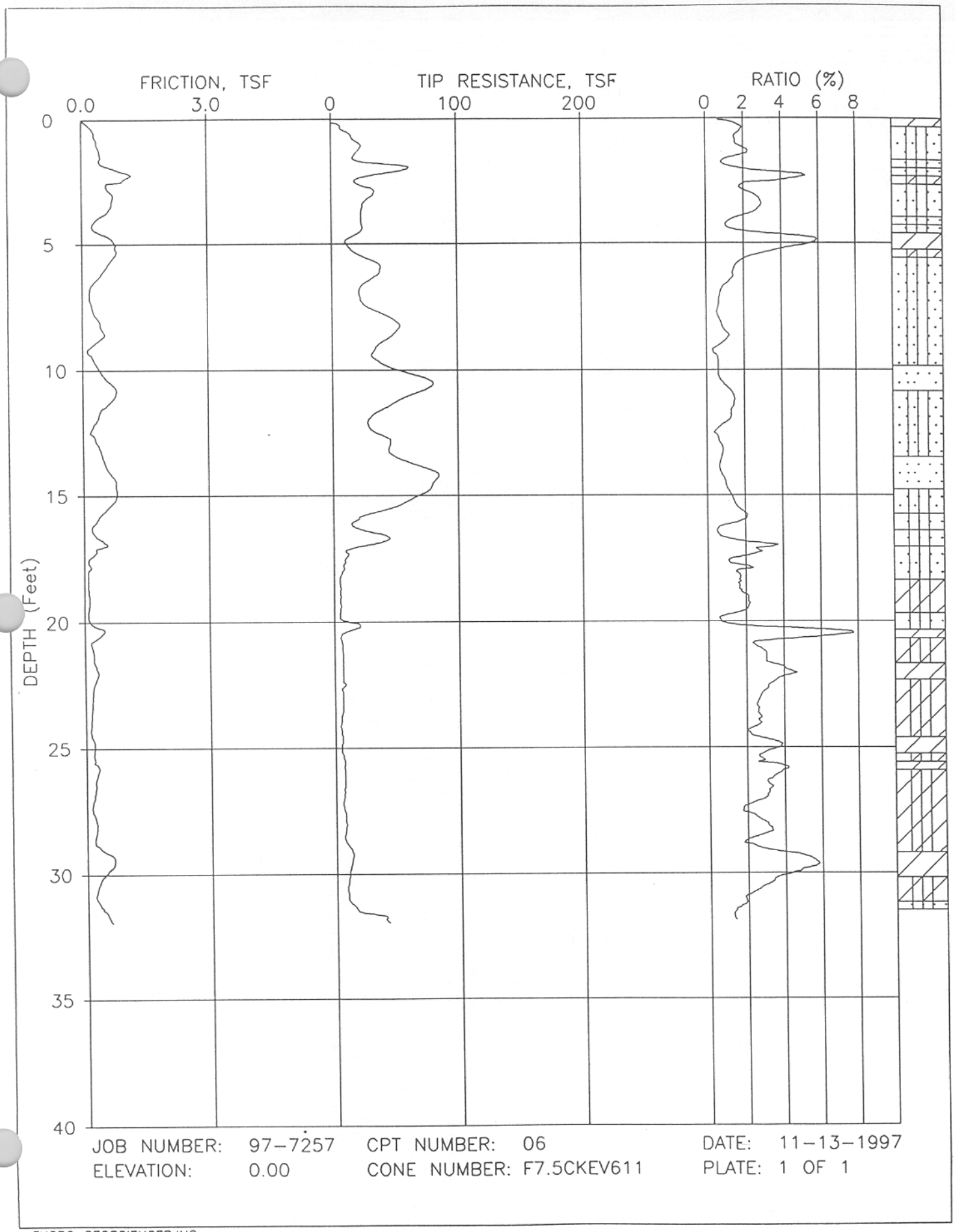
DATE: 11-13-1997
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257.DEPT NUMBER: 05 DATE: 11-13-1997
ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

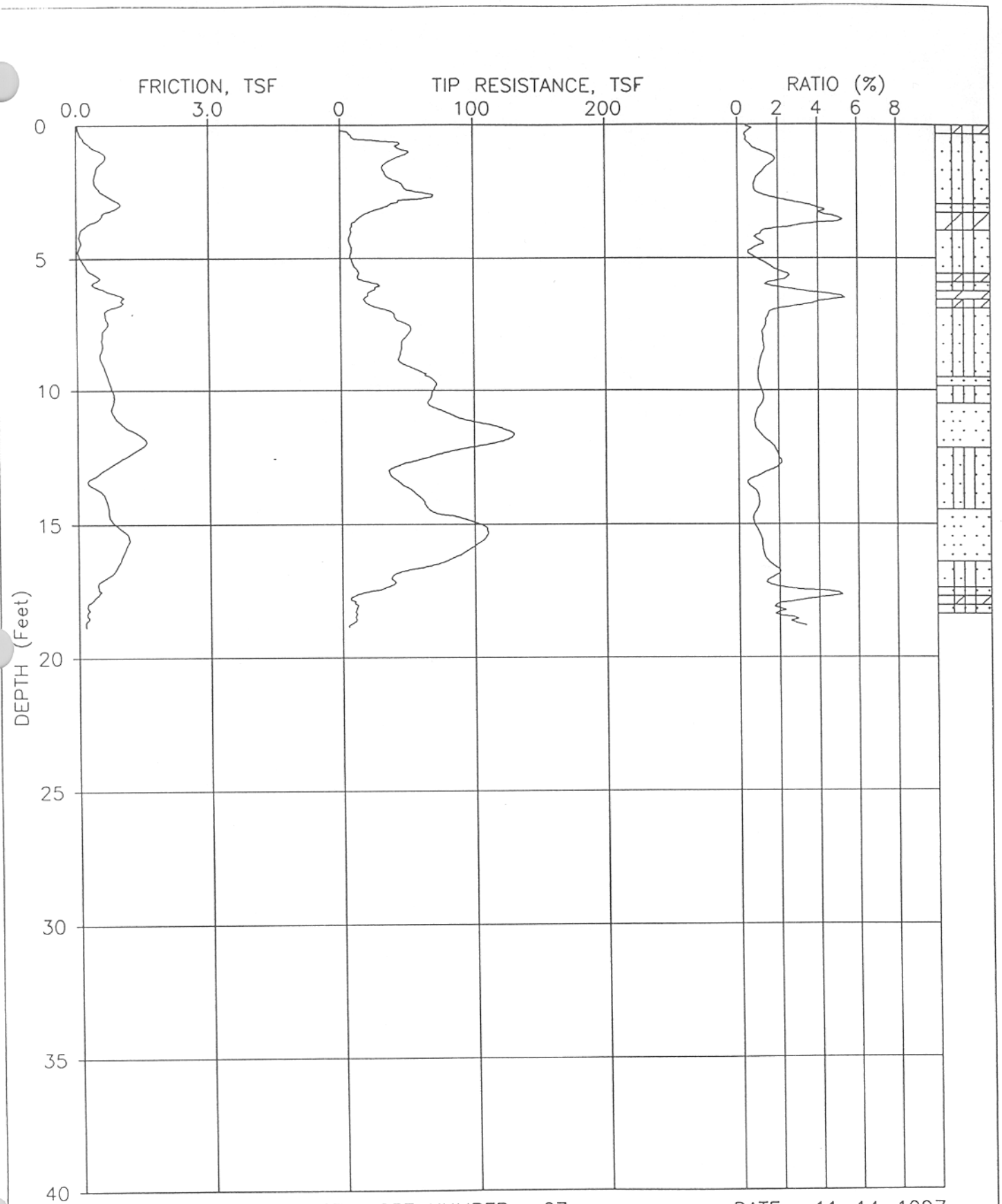


JOB NUMBER: 97-7257
ELEVATION: 0.00

CPT NUMBER: 06
CONE NUMBER: F7.5CKEV611

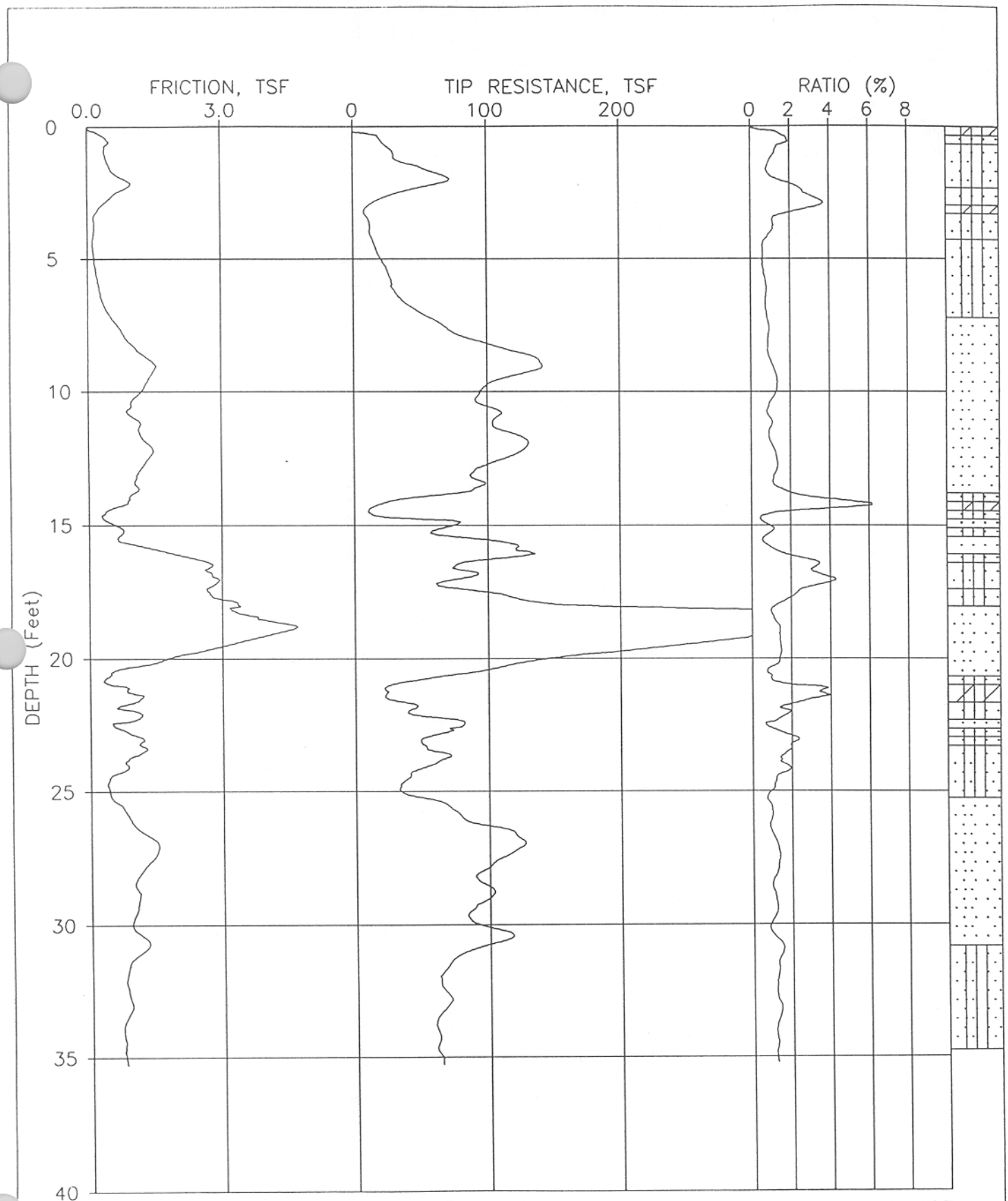
DATE: 11-13-1997
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257
ELEVATION: 0.00
CPT NUMBER: 07
CONE NUMBER: F7.5CKEV611
DATE: 11-14-1997
PLATE: 1 OF 1

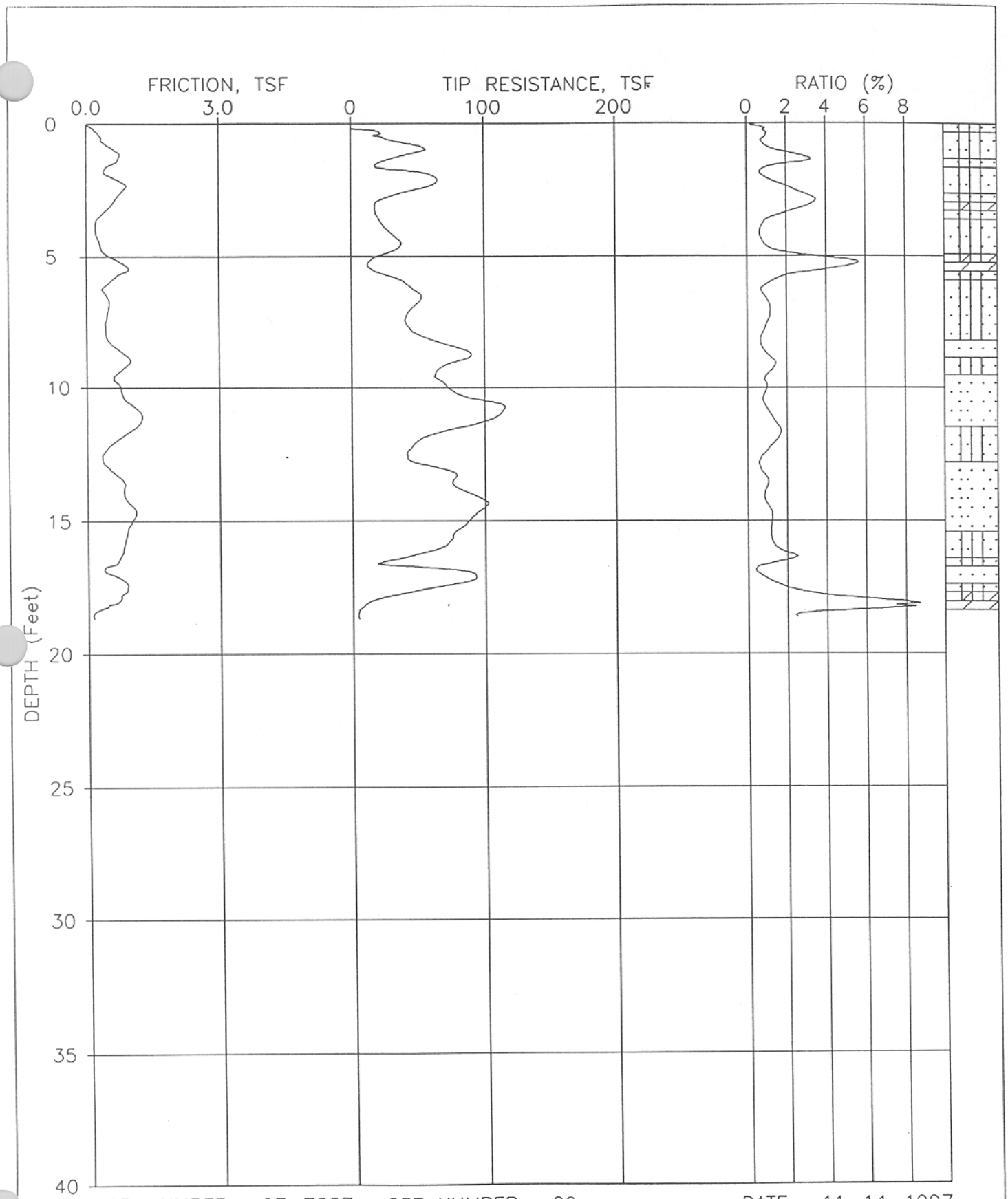
FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 08 DATE: 11-14-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

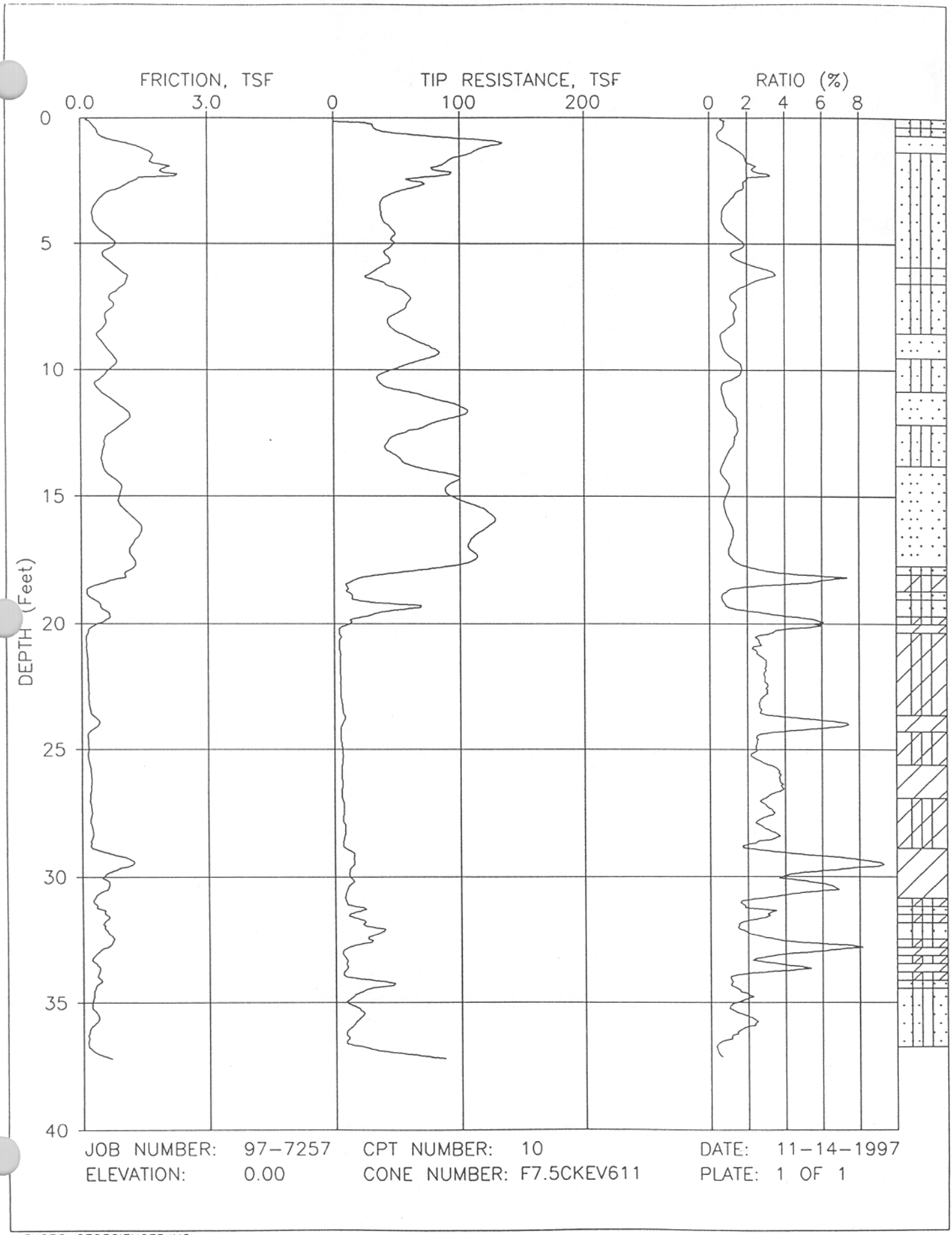
FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 09 DATE: 11-14-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

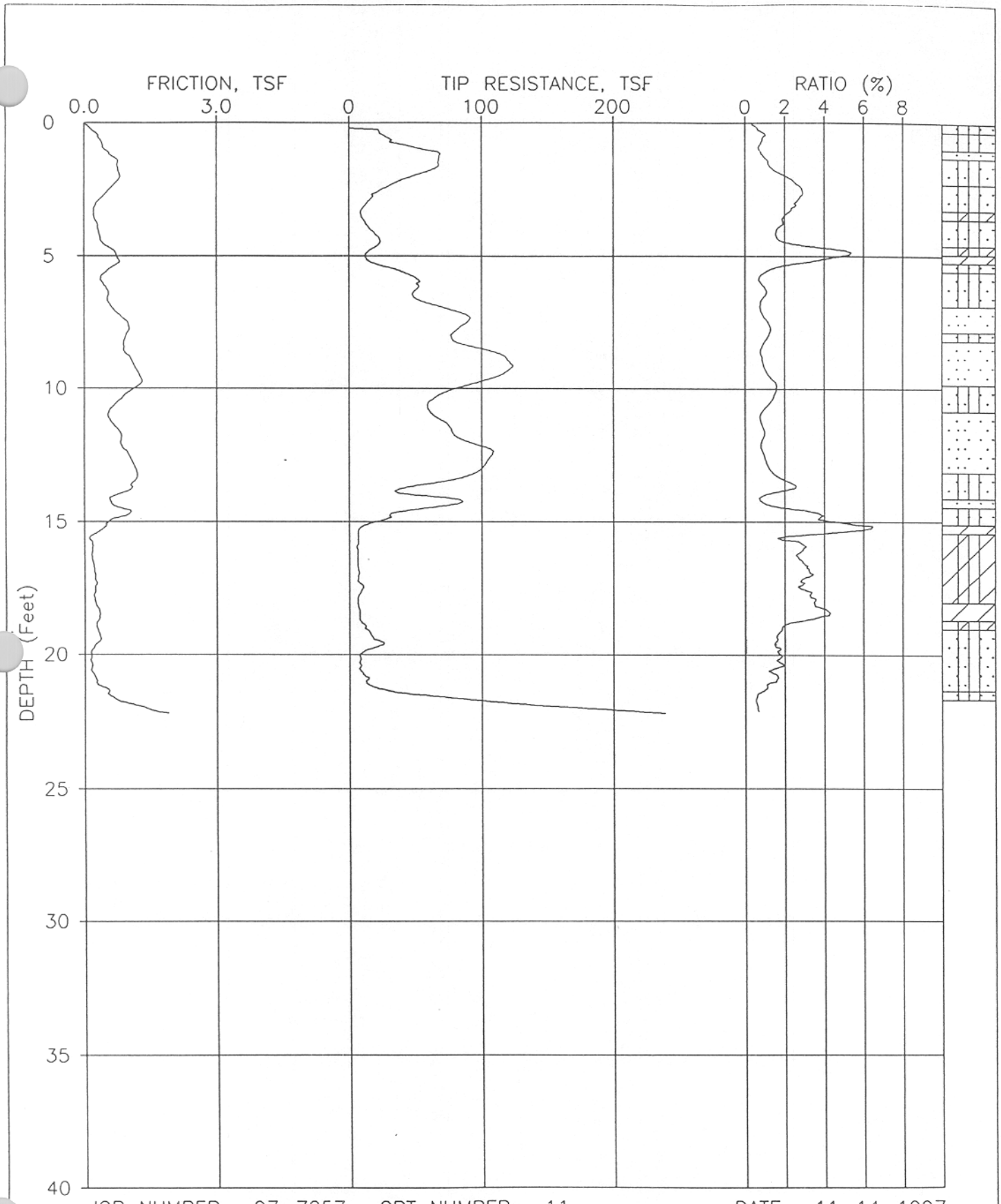
FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 10 DATE: 11-14-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

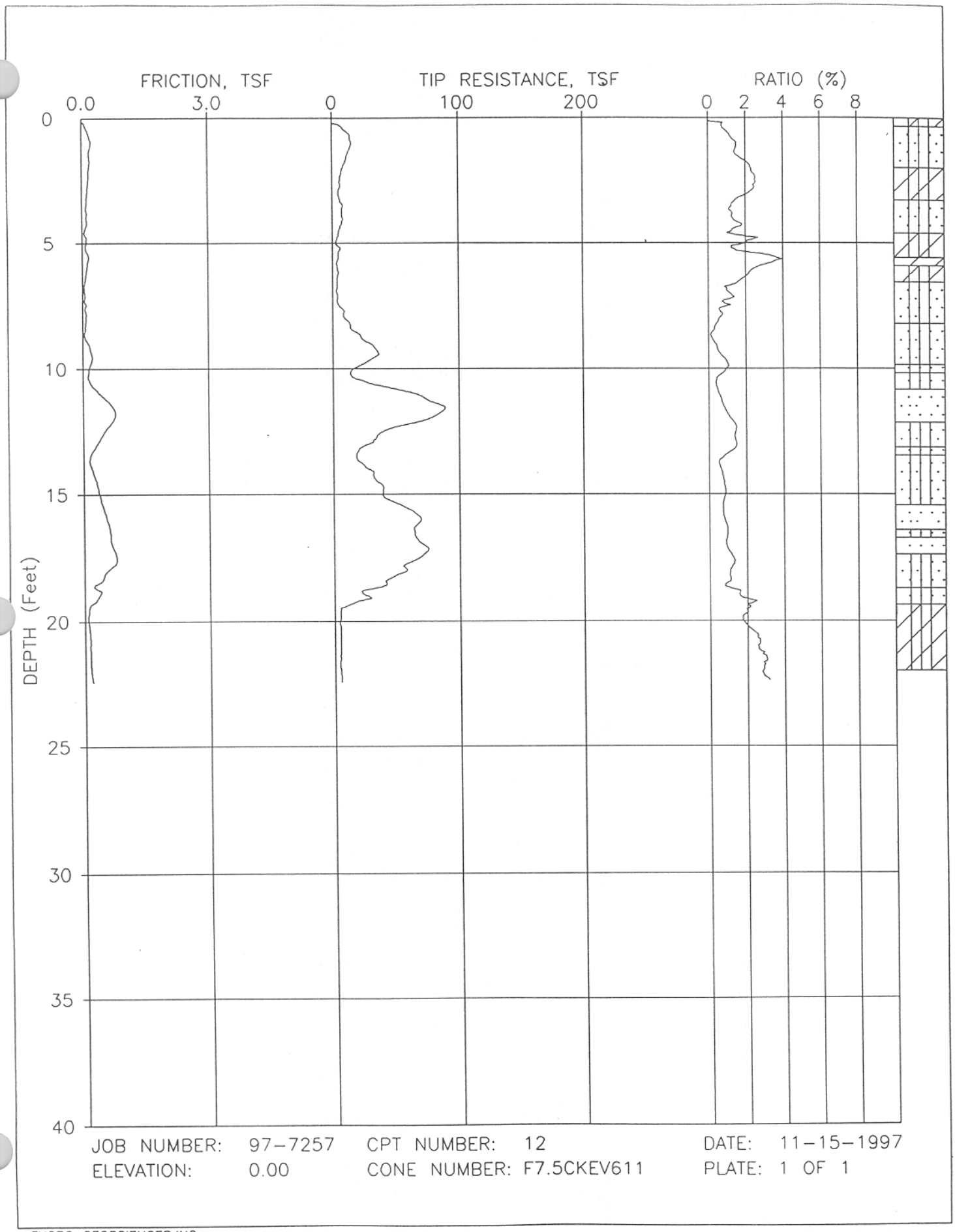
FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 11 DATE: 11-14-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



JOB NUMBER: 97-7257 CPT NUMBER: 12 DATE: 11-15-1997

ELEVATION: 0.00 CONE NUMBER: F7.5CKEV611 PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

APPENDIX E
Non-VOC Analyses (Soil Moisture, f_{oc}, XRD)

Major Ion Analyses (Ground Water And Source Water)

Ground-Water VOC Analyses

ANALYSYS INC.

4221 Freidrich Lane, Suite 190, Aus TX 78744
& 9320 Up River Road, Corpus Chr TX 78409
(512) 444-5896 • FAX (512) 447-4766

Client: Duke Engineering & Services
Attn: Fred Holzmer
Address: 9111 Research Blvd
Austin, Tx 78758

Phone: 425-2000 FAX: 425-2099

Report #/Lab ID#: 87533 Report Date: 12/9/97
Project ID: MCB Camp Lejeune
Sample Name: IS26-04
Sample Matrix: soil
Date Received: 12/5/97 Time: 16:30:00
Date Sampled: 11/21/97 Time: 00:00:00

REPORT OF ANALYSIS

Parameter	Result	Units	RQL[5]	Blank	Date	Method	QUALITY ASSURANCE DATA[1] Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Total organic carbon (foc)	1510	mg/Kg	200	<200	12/9/97	ASA 29-3.5.2	11.34	119.62	111.25	111.24

@ 16.5 ft in f. SAND

Respectfully Submitted,

Hopkins Haden

Hopkins Haden

1. Quality assurance data reported is for the lot analyzed which included this sample.
2. Precision (Prec.) is the absolute value of the relative percent (%) difference between duplicate measurements.
3. Recovery (Recov.) is the percent (%) of analyte recovered from a spiked sample.
4. Calibration Verification (CCV) and Lab Control Sample (LCS) results expressed as the percent (%) recovery of analyte from a known standard.
5. Reporting Quantitation Limit. The Practical Quantitation Limit (PQL) or the Method Detection Limit (MDL) reported for the analyte.
6. Method numbers typically denote USEPA procedures. Less than ("<") values reflect nominal quantitation limits, adjusted for any required dilution.

AnalySys Inc.
4221 Freidrich Lane, Suite 190, Aus TX 78744
& 9320 Up River Road, Corpus Chris TX 78409
(512) 444-5896 • FAX (512) 447-4766

Client: Duke Engineering & Services
Attn: Fred Holzmer
Address: 9111 Research Blvd
Austin, Tx 78758

Phone: 425-2000 **FAX:** 425-2099

Report #/Lab ID#: 87534 **Report Date:** 12/9/97
Project ID: MCB Camp Lejeune
Sample Name: IS26-05
Sample Matrix: soil
Date Received: 12/5/97 **Time:** 16:30:00
Date Sampled: 11/21/97 **Time:** 00:00:00

REPORT OF ANALYSIS

Parameter	Result	Units	RQL[5]	Blank	Date	Method	QUALITY ASSURANCE DATA[1] Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Total organic carbon (foc)	5560	mg/Kg	400	<200	12/9/97	ASA 29-3.5.2	11.34	119.62	111.25	111.24

@ 18.0 ft in cl-SILT

Respectfully Submitted,

Hopkins Haden

Hopkins Haden

1. Quality assurance data reported is for the lot analyzed which included this sample.
2. Precision (Prec.) is the absolute value of the relative percent (%) difference between duplicate measurements.
3. Recovery (Recov.) is the percent (%) of analyte recovered from a spiked sample.
4. Calibration Verification (CCV) and Lab Control Sample (LCS) results expressed as the percent (%) recovery of analyte from a known standard.
5. Reporting Quantitation Limit. The Practical Quantitation Limit (PQL) or the Method Detection Limit (MDL) reported for the analyte.
6. Method numbers typically denote USEPA procedures. Less than ("<") values reflect nominal quantitation limits, adjusted for any required dilution.

ANALYSYS INC.

4221 Freidrich Lane, Suite 190, Aust TX 78744
& 9320 Up River Road, Corpus Chri TX 78409
(512) 444-5896 • FAX (512) 447-4766

Client: Duke Engineering & Services
Attn: Fred Holzmer
Address: 9111 Research Blvd
Austin, Tx 78758

Phone: 425-2000 FAX: 425-2099

Report #/Lab ID#: 87535 Report Date: 12/9/97
Project ID: MCB Camp Lejeune
Sample Name: IS26-06
Sample Matrix: soil
Date Received: 12/5/97 Time: 16:30:00
Date Sampled: 11/21/97 Time: 00:00:00

REPORT OF ANALYSIS

QUALITY ASSURANCE DATA[1]

Parameter	Result	Units	RQL[5]	Blank	Date	Method	Prec.[2]	Recov.[3]	CCV[4]	LCS[4]
Total organic carbon (f_{oc})	6420	mg/Kg	400	<200	12/9/97	ASA 29-3.5.2	11.34	119.62	111.25	111.24

@ 19.0 ft in Si-CLAY

Respectfully Submitted,

Hopkins Haden

Hopkins Haden

1. Quality assurance data reported is for the lot analyzed which included this sample.
2. Precision (Prec.) is the absolute value of the relative percent (%) difference between duplicate measurements.
3. Recovery (Recov.) is the percent (%) of analyte recovered from a spiked sample.
4. Calibration Verification (CCV) and Lab Control Sample (LCS) results expressed as the percent (%) recovery of analyte from a known standard.
5. Reporting Quantitation Limit. The Practical Quantitation Limit (PQL) or the Method Detection Limit (MDL) reported for the analyte.
6. Method numbers typically denote USEPA procedures. Less than ("<") values reflect nominal quantitation limits, adjusted for any required dilution.

PTS Laboratories, Inc.

Duke Engineering & Services
File No.: 21585

X-RAY DIFFRACTION MINERAL PERCENTAGES

Project Name: MCB Camp Lejeune

Sample ID	BULK METHOD										CLAY METHOD						
	Qtz (%)	Feld (%)	Cal (%)	Dol (%)	Sid (%)	Pyr (%)	Bar (%)			Total Bulk (%)	Kao (%)	Ill (%)	Chl (%)	Sme (%)	EML	Total Clay (%)	Total (%)
IS25-05	81	11	*	*	*	1				93	3	2	1	1		7	100
IS25-06	85	2	*	*	*	4	*			91	4	2	1	2	*	9	100

* Denotes a trace percentage

Legend

Qtz	=	Quartz, SiO_2	Feld	=	Feldspar, (K, Na, Ca, Ba) $(Al, Si)_3 O_8$
Cal	=	Calcite, $CaCO_3$	Dol	=	Dolomite, $CaMg(CO_3)$
Sid	=	Siderite, $FeCO_3$	Pyr	=	Pyrite FeS_2
Bar	=	Barite $BaSO_4$	EML	=	Expandable Mixed Layer Illite/Smectite)
			Clay Minerals	=	Phyllosilicates

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7HZZ0200

Baker Environmental
Camp LeJeune
Project Number: CTO-356

Date Reported: 8/29/9

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Client Sample ID: IR88IW01-04					
Sample #: 001 Date Sampled: 08/20/97 08:10 Date Received: 08/22/97 Matrix: SOLID					
Inorganic Analysis					
Percent Moisture	17.3	0.10	%	MCAWW 160.3 MOD	Reviewed
N-Hexane Ext. Material, Silica Gel Treated (1664)	ND	330	mg/kg	CFR136A 1664 SGT	
Client Sample ID: IR88RW01-05					
Sample #: 002 Date Sampled: 08/19/97 12:39 Date Received: 08/22/97 Matrix: SOLID					
Inorganic Analysis					
Percent Moisture	17.5	0.10	%	MCAWW 160.3 MOD	Reviewed
N-Hexane Ext. Material, Silica Gel Treated (1664)	ND	330	mg/kg	CFR136A 1664 SGT	
Client Sample ID: IR88RW02-04					
Sample #: 003 Date Sampled: 08/19/97 16:29 Date Received: 08/22/97 Matrix: SOLID					
Inorganic Analysis					
Percent Moisture	18.1	0.10	%	MCAWW 160.3 MOD	Reviewed
N-Hexane Ext. Material, Silica Gel Treated (1664)	ND	330	mg/kg	CFR136A 1664 SGT	
Client Sample ID: IR88IS13-08					
Sample #: 004 Date Sampled: 08/20/97 11:15 Date Received: 08/22/97 Matrix: SOLID					
Inorganic Analysis					
Percent Moisture	21.2	0.10	%	MCAWW 160.3 MOD	Reviewed
N-Hexane Ext. Material, Silica Gel Treated (1664)	ND	330	mg/kg	CFR136A 1664 SGT	
Client Sample ID: IR88IW01-09					
Sample #: 005 Date Sampled: 08/20/97 08:50 Date Received: 08/22/97 Matrix: SOLID					

(Continued on next page)

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

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results shown below may still require additional laboratory review and are subject to
nge. Actions taken based on these results are the responsibility of the data user.

#: H7HZZ0200

Baker Environmental
Camp LeJeune
Project Number: CTO-356

Date Reported: 8/29/97

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
lient Sample ID: IR88IW01-09				
ample #: 005 Date Sampled: 08/20/97 08:50 Date Received: 08/22/97 Matrix: SOLID				
Inorganic Analysis				Reviewed
Percent Moisture	20.2	0.10	%	MCAWW 160.3 MOD
N-Hexane Ext. Material, Silica Gel Treated (1664)	ND	330	mg/kg	CFR136A 1664 SGT

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Baker Environmental, Inc. PAGE 1
Lot #: H7H250122 Camp LeJeune Date Reported: 9/03/97
Project Number: CTO-356

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Client Sample ID: IR88-RW01-97C					
Sample #: 001 Date Sampled: 08/21/97 12:20 Date Received: 08/25/97 Matrix: WATER					
Inductively Coupled Plasma					In Review
Silver	ND	10.0	ug/L	ICLP ILM03.0	
Aluminum	273	200	ug/L	ICLP ILM03.0	
Barium	141 B	200	ug/L	ICLP ILM03.0	
Beryllium	ND	5.0	ug/L	ICLP ILM03.0	
Calcium	15600	5000	ug/L	ICLP ILM03.0	
Cadmium	ND	5.0	ug/L	ICLP ILM03.0	
Cobalt	4.5 B	50.0	ug/L	ICLP ILM03.0	
Chromium	8.9 B	10.0	ug/L	ICLP ILM03.0	
Copper	ND	25.0	ug/L	ICLP ILM03.0	
Iron	15100	100	ug/L	ICLP ILM03.0	
Potassium	2080 B	5000	ug/L	ICLP ILM03.0	
Magnesium	4510 B	5000	ug/L	ICLP ILM03.0	
Manganese	126	15.0	ug/L	ICLP ILM03.0	
Sodium	12200	5000	ug/L	ICLP ILM03.0	
Nickel	75.1	40.0	ug/L	ICLP ILM03.0	
Antimony	ND	60.0	ug/L	ICLP ILM03.0	
Vanadium	ND	50.0	ug/L	ICLP ILM03.0	
Zinc	14.7 B	20.0	ug/L	ICLP ILM03.0	
Mercury (Cold Vapor Technique)					In Review
Mercury	ND	0.20	ug/L	ICLP ILM03.0	
Inductively Coupled Plasma					In Review
Arsenic	4.3 B	10.0	ug/L	ICLP ILM03.0	
Lead	1.4 B	3.0	ug/L	ICLP ILM03.0	
Selenium	ND	5.0	ug/L	ICLP ILM03.0	
Thallium	ND	10.0	ug/L	ICLP ILM03.0	

B Estimated result. Result is less than RL.

Volatile Organics by GC/MS					In Review
Benzene	ND	10000	ug/L	SW846 8260A	
Bromobenzene	ND	10000	ug/L	SW846 8260A	
Bromochloromethane	ND	10000	ug/L	SW846 8260A	
Bromodichloromethane	ND	10000	ug/L	SW846 8260A	
Bromoform	ND	10000	ug/L	SW846 8260A	

(Continued on next page)

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

e results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7H250122

Baker Environmental, Inc.
Camp LeJeune
Project Number: CTO-356

Date Reported: 9/03/97

Client Sample ID: IR88-RW01-97C
Sample #: 001 Date Sampled: 08/21/97 12:20 Date Received: 08/25/97 Matrix: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
Volatile Organics by GC/MS				In Review
Bromomethane	ND	20000	ug/L	SW846 8260A
n-Butylbenzene	ND	10000	ug/L	SW846 8260A
sec-Butylbenzene	ND	10000	ug/L	SW846 8260A
tert-Butylbenzene	ND	10000	ug/L	SW846 8260A
Carbon tetrachloride	ND	10000	ug/L	SW846 8260A
Chlorobenzene	ND	10000	ug/L	SW846 8260A
Chlorodibromomethane	ND	10000	ug/L	SW846 8260A
Chloroethane	ND	20000	ug/L	SW846 8260A
Chloroform	ND	10000	ug/L	SW846 8260A
Chloromethane	ND	20000	ug/L	SW846 8260A
2-Chlorotoluene	ND	10000	ug/L	SW846 8260A
4-Chlorotoluene	ND	10000	ug/L	SW846 8260A
1,2-Dibromo-3-chloro-propane	ND	20000	ug/L	SW846 8260A
1,2-Dibromoethane	ND	10000	ug/L	SW846 8260A
Dibromomethane	ND	10000	ug/L	SW846 8260A
1,2-Dichlorobenzene	ND	10000	ug/L	SW846 8260A
1,3-Dichlorobenzene	ND	10000	ug/L	SW846 8260A
1,4-Dichlorobenzene	ND	10000	ug/L	SW846 8260A
Dichlorodifluoromethane	ND	20000	ug/L	SW846 8260A
1,1-Dichloroethane	ND	10000	ug/L	SW846 8260A
1,2-Dichloroethane	ND	10000	ug/L	SW846 8260A
1,1-Dichloroethene	ND	10000	ug/L	SW846 8260A
cis-1,2-Dichloroethene	11000	5000	ug/L	SW846 8260A
trans-1,2-Dichloroethene	ND	5000	ug/L	SW846 8260A
1,2-Dichloropropane	ND	10000	ug/L	SW846 8260A
1,3-Dichloropropane	ND	10000	ug/L	SW846 8260A
2,2-Dichloropropane	ND	10000	ug/L	SW846 8260A
1,1-Dichloropropene	ND	10000	ug/L	SW846 8260A
Ethylbenzene	ND	10000	ug/L	SW846 8260A
Hexachlorobutadiene	ND	10000	ug/L	SW846 8260A
Isopropylbenzene	ND	10000	ug/L	SW846 8260A
p-Isopropyltoluene	ND	10000	ug/L	SW846 8260A
Methylene chloride	ND	10000	ug/L	SW846 8260A
Naphthalene	ND	10000	ug/L	SW846 8260A
n-Propylbenzene	ND	10000	ug/L	SW846 8260A
Styrene	ND	10000	ug/L	SW846 8260A

(Continued on next page)

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

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e results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7H250122

Baker Environmental, Inc.
Camp LeJeune
Project Number: CTO-356

Date Reported: 9/03/97

Client Sample ID: IR88-RW01-97C
Sample #: 001 Date Sampled: 08/21/97 12:20 Date Received: 08/25/97 Matrix: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
Volatile Organics by GC/MS				In Review
1,1,1,2-Tetrachloroethane	ND	10000	ug/L	SW846 8260A
1,1,2,2-Tetrachloroethane	ND	10000	ug/L	SW846 8260A
Tetrachloroethene	170000	10000	ug/L	SW846 8260A
Toluene	ND	10000	ug/L	SW846 8260A
1,2,3-Trichlorobenzene	ND	10000	ug/L	SW846 8260A
1,2,4-Trichlorobenzene	ND	10000	ug/L	SW846 8260A
1,1,1-Trichloroethane	ND	10000	ug/L	SW846 8260A
1,1,2-Trichloroethane	ND	10000	ug/L	SW846 8260A
Trichloroethene	3200 J	10000	ug/L	SW846 8260A
Trichlorofluoromethane	ND	20000	ug/L	SW846 8260A
1,2,3-Trichloropropane	ND	10000	ug/L	SW846 8260A
1,2,4-Trimethylbenzene	ND	10000	ug/L	SW846 8260A
1,3,5-Trimethylbenzene	ND	10000	ug/L	SW846 8260A
Vinyl chloride	ND	20000	ug/L	SW846 8260A
o-Xylene	ND	5000	ug/L	SW846 8260A
m-Xylene & p-Xylene	ND	5000	ug/L	SW846 8260A

J Estimated result. Result is less than RL.

Client Sample ID: IR88-RW02-97C
Sample #: 002 Date Sampled: 08/22/97 09:12 Date Received: 08/25/97 Matrix: WATER

Volatile Organics by GC/MS				In Review
Benzene	ND	10000	ug/L	SW846 8260A
Bromobenzene	ND	10000	ug/L	SW846 8260A
Bromochloromethane	ND	10000	ug/L	SW846 8260A
Bromodichloromethane	ND	10000	ug/L	SW846 8260A
Bromoform	ND	10000	ug/L	SW846 8260A
Bromomethane	ND	20000	ug/L	SW846 8260A
n-Butylbenzene	ND	10000	ug/L	SW846 8260A
sec-Butylbenzene	ND	10000	ug/L	SW846 8260A
tert-Butylbenzene	ND	10000	ug/L	SW846 8260A
Carbon tetrachloride	ND	10000	ug/L	SW846 8260A
Chlorobenzene	ND	10000	ug/L	SW846 8260A
Chlorodibromomethane	ND	10000	ug/L	SW846 8260A

(Continued on next page)

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

ie results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7H250122

Baker Environmental, Inc.
Camp LeJeune
Project Number: CTO-356

Date Reported: 9/03/97

Client Sample ID: IR88-RW02-97C
Sample #: 002 Date Sampled: 08/22/97 09:12 Date Received: 08/25/97 Matrix: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Volatile Organics by GC/MS					In Review
Chloroethane	ND	20000	ug/L	SW846 8260A	
Chloroform	ND	10000	ug/L	SW846 8260A	
Chloromethane	ND	20000	ug/L	SW846 8260A	
2-Chlorotoluene	ND	10000	ug/L	SW846 8260A	
4-Chlorotoluene	ND	10000	ug/L	SW846 8260A	
1,2-Dibromo-3-chloro-propane	ND	20000	ug/L	SW846 8260A	
1,2-Dibromoethane	ND	10000	ug/L	SW846 8260A	
Dibromomethane	ND	10000	ug/L	SW846 8260A	
1,2-Dichlorobenzene	ND	10000	ug/L	SW846 8260A	
1,3-Dichlorobenzene	ND	10000	ug/L	SW846 8260A	
1,4-Dichlorobenzene	ND	10000	ug/L	SW846 8260A	
Dichlorodifluoromethane	ND	20000	ug/L	SW846 8260A	
1,1-Dichloroethane	ND	10000	ug/L	SW846 8260A	
1,2-Dichloroethane	ND	10000	ug/L	SW846 8260A	
1,1-Dichloroethene	ND	10000	ug/L	SW846 8260A	
cis-1,2-Dichloroethene	10000	5000	ug/L	SW846 8260A	
trans-1,2-Dichloroethene	ND	5000	ug/L	SW846 8260A	
1,2-Dichloropropane	ND	10000	ug/L	SW846 8260A	
1,3-Dichloropropane	ND	10000	ug/L	SW846 8260A	
2,2-Dichloropropane	ND	10000	ug/L	SW846 8260A	
1,1-Dichloropropene	ND	10000	ug/L	SW846 8260A	
Ethylbenzene	ND	10000	ug/L	SW846 8260A	
Hexachlorobutadiene	ND	10000	ug/L	SW846 8260A	
Isopropylbenzene	ND	10000	ug/L	SW846 8260A	
p-Isopropyltoluene	ND	10000	ug/L	SW846 8260A	
Methylene chloride	ND	10000	ug/L	SW846 8260A	
Naphthalene	ND	10000	ug/L	SW846 8260A	
n-Propylbenzene	ND	10000	ug/L	SW846 8260A	
Styrene	ND	10000	ug/L	SW846 8260A	
1,1,1,2-Tetrachloroethane	ND	10000	ug/L	SW846 8260A	
1,1,2,2-Tetrachloroethane	ND	10000	ug/L	SW846 8260A	
Tetrachloroethene	150000	10000	ug/L	SW846 8260A	
Toluene	ND	10000	ug/L	SW846 8260A	
1,2,3-Trichlorobenzene	ND	10000	ug/L	SW846 8260A	
1,2,4-Trichlorobenzene	ND	10000	ug/L	SW846 8260A	
1,1,1-Trichloroethane	ND	10000	ug/L	SW846 8260A	

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QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7H250122

Baker Environmental, Inc.
Camp LeJeune
Project Number: CTO-356

Date Reported: 9/03/97

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
Client Sample ID: IR88-RW02-97C				
Sample #: 002 Date Sampled: 08/22/97 09:12 Date Received: 08/25/97 Matrix: WATER				
				In Review
Volatile Organics by GC/MS				
1,1,2-Trichloroethane	ND	10000	ug/L	SW846 8260A
Trichloroethene	3500 J	10000	ug/L	SW846 8260A
Trichlorofluoromethane	ND	20000	ug/L	SW846 8260A
1,2,3-Trichloropropane	ND	10000	ug/L	SW846 8260A
1,2,4-Trimethylbenzene	ND	10000	ug/L	SW846 8260A
1,3,5-Trimethylbenzene	ND	10000	ug/L	SW846 8260A
Vinyl chloride	ND	20000	ug/L	SW846 8260A
o-Xylene	ND	5000	ug/L	SW846 8260A
m-Xylene & p-Xylene	ND	5000	ug/L	SW846 8260A
J Estimated result. Result is less than RL.				
				In Review
Inorganic Analysis				
Carbonate Alkalinity	ND	5.0	mg/L	SM18 2320 B
Client Sample ID: IR88-DRM01				
Sample #: 003 Date Sampled: 08/22/97 16:40 Date Received: 08/25/97 Matrix: SOLID				
				In Review
Volatile Organics by GC/MS TCLP				
Benzene	ND	0.62	mg/L	SW846 8260A
Carbon tetrachloride	0.50 J	0.62	mg/L	SW846 8260A
Chlorobenzene	ND	0.62	mg/L	SW846 8260A
Chloroform	ND	0.62	mg/L	SW846 8260A
1,2-Dichloroethane	ND	0.62	mg/L	SW846 8260A
1,1-Dichloroethylene	ND	0.62	mg/L	SW846 8260A
Methyl ethyl ketone	ND	3.0	mg/L	SW846 8260A
Tetrachloroethylene	37	0.62	mg/L	SW846 8260A
Trichloroethylene	0.42 J	0.62	mg/L	SW846 8260A
Vinyl chloride	ND	1.2	mg/L	SW846 8260A
J Estimated result. Result is less than RL.				

(Continued on next page)

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Baker Environmental
Camp LeJeune
Project Number: CTO-356

Lot #: H7K180134 PAGE 4
Date Reported: 12/15/97

Client Sample ID: IR88-RW01-87D
Sample #: 012 Date Sampled: 11/17/97 12:20 Date Received: 11/18/97 Matrix: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Aluminum	0.28	0.20	mg/L	SW846 6010A	
Barium	ND	0.20	mg/L	SW846 6010A	
Beryllium	ND	0.0050	mg/L	SW846 6010A	
Calcium	15.7	5.0	mg/L	SW846 6010A	
Cadmium	ND	0.0050	mg/L	SW846 6010A	
Cobalt	ND	0.050	mg/L	SW846 6010A	
Chromium	ND	0.010	mg/L	SW846 6010A	
Copper	ND	0.025	mg/L	SW846 6010A	
Iron	25.8	0.10	mg/L	SW846 6010A	
Potassium	ND	5.0	mg/L	SW846 6010A	
Magnesium	ND	5.0	mg/L	SW846 6010A	
Manganese	0.094	0.015	mg/L	SW846 6010A	
Sodium	19.7	5.0	mg/L	SW846 6010A	
Nickel	ND	0.040	mg/L	SW846 6010A	
Antimony	ND	0.060	mg/L	SW846 6010A	
Vanadium	ND	0.050	mg/L	SW846 6010A	
Zinc	0.023	0.020	mg/L	SW846 6010A	
Mercury in Liquid Waste (Manual Cold-Vapor)					Reviewed
Mercury	ND	0.00020	mg/L	SW846 7470A	
Inorganic Analysis					Reviewed
Alkalinity, Total	28.2	5.0	mg/L	SM18 2320 B	
Alkalinity, Total	31.5	5.0	mg/L	SM18 2320 B	
Bromide	0.84	0.50	mg/L	MCAWW 300.0A	
Chloride	66.0	5.0	mg/L	MCAWW 300.0A	
Fluoride	ND	1.0	mg/L	MCAWW 300.0A	
Nitrite as N	ND	0.50	mg/L	MCAWW 300.0A	
Nitrate as N	ND	0.50	mg/L	MCAWW 300.0A	
o-Phosphate as P	ND	1.0	mg/L	MCAWW 300.0A	
Sulfate	16.1	1.0	mg/L	MCAWW 300.0A	

(Continued on next page)

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7K180134

Baker Environmental
Camp LeJeune
Project Number: CTO-356

Date Reported: 12/15/97

Client Sample ID: IR88-RW02-97D
Sample #: 013 Date Sampled: 11/17/97 12:35 Date Received: 11/18/97 Matrix: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Trace Inductively Coupled Plasma (ICP) Metals					Reviewed
Arsenic	ND	0.010	mg/L	SW846 6010A	
Lead	ND	0.0030	mg/L	SW846 6010A	
Selenium	ND	0.0050	mg/L	SW846 6010A	
Thallium	ND	0.010	mg/L	SW846 6010A	
Inductively Coupled Plasma (ICP) Metals					Reviewed
Silver	ND	0.010	mg/L	SW846 6010A	
Aluminum	0.33	0.20	mg/L	SW846 6010A	
Barium	ND	0.20	mg/L	SW846 6010A	
Beryllium	ND	0.0050	mg/L	SW846 6010A	
Calcium	15.1	5.0	mg/L	SW846 6010A	
Cadmium	ND	0.0050	mg/L	SW846 6010A	
Cobalt	ND	0.050	mg/L	SW846 6010A	
Chromium	ND	0.010	mg/L	SW846 6010A	
Copper	ND	0.025	mg/L	SW846 6010A	
Iron	6.1	0.10	mg/L	SW846 6010A	
Potassium	9.9	5.0	mg/L	SW846 6010A	
Magnesium	5.3	5.0	mg/L	SW846 6010A	
Manganese	0.10	0.015	mg/L	SW846 6010A	
Sodium	30.9	5.0	mg/L	SW846 6010A	
Nickel	ND	0.040	mg/L	SW846 6010A	
Antimony	ND	0.060	mg/L	SW846 6010A	
Vanadium	ND	0.050	mg/L	SW846 6010A	
Zinc	0.039	0.020	mg/L	SW846 6010A	
Mercury in Liquid Waste (Manual Cold-Vapor)					Reviewed
Mercury	ND	0.00020	mg/L	SW846 7470A	
Inorganic Analysis					Reviewed
Alkalinity, Total	ND	5.0	mg/L	SM18 2320 B	
Bromide	ND	0.50	mg/L	MCAWW 300.0A	
Chloride	45.5	5.0	mg/L	MCAWW 300.0A	
Fluoride	ND	1.0	mg/L	MCAWW 300.0A	
Nitrite as N	ND	0.50	mg/L	MCAWW 300.0A	
Nitrate as N	1.0	0.50	mg/L	MCAWW 300.0A	
o-Phosphate as P	ND	1.0	mg/L	MCAWW 300.0A	

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QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Baker Environmental
Camp LeJeune
Project Number: CTO-356

Lot #: H7K180134 Date Reported: 12/15/97

Client Sample ID: IR88-FB02
Sample #: 014 Date Sampled: 11/17/97 14:20 Date Received: 11/18/97 Matrix: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Inorganic Analysis					Reviewed
Alkalinity, Total	63.9	5.0	mg/L	SM18 2320 B	
Bromide	ND	0.50	mg/L	MCAWW 300.0A	
Chloride	12.4	1.0	mg/L	MCAWW 300.0A	
Fluoride	ND	1.0	mg/L	MCAWW 300.0A	
Nitrite as N	ND	0.50	mg/L	MCAWW 300.0A	
Nitrate as N	ND	0.50	mg/L	MCAWW 300.0A	
o-Phosphate as P	ND	1.0	mg/L	MCAWW 300.0A	
Sulfate	5.4	1.0	mg/L	MCAWW 300.0A	

QUANTERRA INCORPORATED

PRELIMINARY DATA SUMMARY

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: H7K180134

Baker Environmental
Camp LeJeune
Project Number: CTO-356

Date Reported: 12/15/97

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Client Sample ID: IR88-RW02-97D					
Sample #: 013 Date Sampled: 11/17/97 12:35 Date Received: 11/18/97 Matrix: WATER					
Sulfate					Reviewed
Sulfate	46.7	5.0	mg/L	MCAWW 300.0A	
Client Sample ID: IR88-FB02 SOURCE WATER SAMPLE					
Sample #: 014 Date Sampled: 11/17/97 14:20 Date Received: 11/18/97 Matrix: WATER					
Trace Inductively Coupled Plasma (ICP) Metals					Reviewed
Arsenic	ND	0.010	mg/L	SW846 6010A	
Lead	ND	0.0030	mg/L	SW846 6010A	
Selenium	ND	0.0050	mg/L	SW846 6010A	
Thallium	ND	0.010	mg/L	SW846 6010A	
Inductively Coupled Plasma (ICP) Metals					Reviewed
Silver	ND	0.010	mg/L	SW846 6010A	
Aluminum	0.20	0.20	mg/L	SW846 6010A	
Barium	ND	0.20	mg/L	SW846 6010A	
Beryllium	ND	0.0050	mg/L	SW846 6010A	
Calcium	26.9	5.0	mg/L	SW846 6010A	
Cadmium	ND	0.0050	mg/L	SW846 6010A	
Cobalt	ND	0.050	mg/L	SW846 6010A	
Chromium	ND	0.010	mg/L	SW846 6010A	
Copper	ND	0.025	mg/L	SW846 6010A	
Iron	ND	0.10	mg/L	SW846 6010A	
Potassium	ND	5.0	mg/L	SW846 6010A	
Magnesium	ND	5.0	mg/L	SW846 6010A	
Manganese	ND	0.015	mg/L	SW846 6010A	
Sodium	9.0	5.0	mg/L	SW846 6010A	
Nickel	ND	0.040	mg/L	SW846 6010A	
Antimony	ND	0.060	mg/L	SW846 6010A	
Vanadium	ND	0.050	mg/L	SW846 6010A	
Zinc	ND	0.020	mg/L	SW846 6010A	
Mercury in Liquid Waste (Manual Cold-Vapor)					Reviewed
Mercury	ND	0.00020	mg/L	SW846 7470A	

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ACCREDITED

Duke Engineering & Services	Project:	MCB Camp Lejune - Site 88 Sear	Sampled:	9/24/98
9111 Research Blvd.	Project Number:	none	Received:	9/25/98
Austin, TX 78758	Project Manager:	Fred Holzmer	Reported:	10/21/98 13:13

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
88 Source - 98	8090283-01	Water	9/24/98
88 Source - 98	8090283-02	Water	9/24/98

Source Water : Major ion analysis

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The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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Duke Engineering & Services	Project:	MCB Camp Lejune - Site 88 Sear	Sampled:	9/24/98
9111 Research Blvd.	Project Number:	none	Received:	9/25/98
Austin, TX 78758	Project Manager:	Fred Holzmer	Reported:	10/21/98 13:13

Total Metals by EPA 200 Series Methods
Star Analytical, Inc.

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
88 Source - 98			**8090283-01**				**Water**	
Magnesium	10V8211	10/11/98	10/14/98	EPA 200.7	0.500	**2.00**	mg/l	
Calcium	"	"	"	EPA 200.7	2.00	**21.0**	"	
Potassium	10V8323	"	10/20/98	EPA 200.7	0.500	**1.40**	"	
Sodium	"	"	"	EPA 200.7	5.00	**8.00**	"	

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Duke Engineering & Services	Project:	MCB Camp Lejune - Site 88 Sear	Sampled:	9/24/98
9111 Research Blvd.	Project Number:	none	Received:	9/25/98
Austin, TX 78758	Project Manager:	Fred Holzmer	Reported:	10/21/98 13:13

Conventional Chemistry Parameters by APHA/EPA Methods
Star Analytical, Inc.

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
88 Source - 98			**8090283-02**				**Water**	
Chloride	10V8138	10/8/98	10/8/98	EPA 325.3	0.30	**13**	mg/l	
Fluoride	10V8074	10/2/98	10/2/98	EPA 340.2	0.100	ND	"	
Nitrate-Nitrogen	09V8385	9/28/98	9/25/98	EPA 352.1	0.20	ND	"	
Nitrate/Nitrite-Nitrogen	09V8397	9/18/98	"	EPA 353.3	0.10	ND	"	
Phosphorus	10V8120	10/5/98	10/1/98	EPA 365.2	0.10	ND	"	
Sulfate	09V8456	9/29/98	9/29/98	EPA 375.4	1.0	**7.7**	"	
Bicarbonate Alkalinity	10V8194	10/7/98	10/7/98	SM 2320B	10	**33**	"	

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Duke Engineering & Services	Project:	MCB Camp Lejune - Site 88 Sear	Sampled: 9/24/98
9111 Research Blvd.	Project Number:	none	Received: 9/25/98
Austin, TX 78758	Project Manager:	Fred Holzmer	Reported: 10/21/98 13:13

Total Metals by EPA 200 Series Methods/Quality Control
Star Analytical, Inc.

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 10V8211	**Date Prepared: 10/11/98**				**Extraction Method: General Preparation**					
Blank	**10V8211-BLK1**									
Calcium	10/14/98			**ND**	mg/l	**0.200**				
Magnesium	"			**ND**	"	**0.100**				
Blank	**10V8211-BLK2**									
Calcium	10/14/98			**ND**	mg/l	**0.200**				
Magnesium	"			**ND**	"	**0.100**				
LCS	**10V8211-BS1**									
Calcium	10/14/98	1.00		1.30	mg/l	80.0-120	130			
Magnesium	"	1.00		1.20	"	80.0-120	120			
LCS	**10V8211-BS2**									
Calcium	10/14/98	1.00		1.10	mg/l	80.0-120	110			
LCS Dup	**10V8211-BSD1**									
Calcium	10/14/98	1.00		1.10	mg/l	80.0-120	110	20.0	16.7	
Magnesium	"	1.00		1.10	"	80.0-120	110	20.0	8.70	
LCS Dup	**10V8211-BSD2**									
Calcium	10/14/98	1.00		1.30	mg/l	80.0-120	130	20.0	16.7	
Batch: 10V8323	**Date Prepared: 10/11/98**				**Extraction Method: General Preparation**					
Blank	**10V8323-BLK1**									
Potassium	10/20/98			**ND**	mg/l	**0.500**				
Sodium	"			**ND**	"	**0.500**				
LCS	**10V8323-BS1**									
Potassium	10/20/98	10.0		10.0	mg/l	80.0-120	100			
Sodium	"	1.00		0.960	"	80.0-120	96.0			
LCS Dup	**10V8323-BSD1**									
Potassium	10/20/98	10.0		9.70	mg/l	80.0-120	97.0	20.0	3.05	
Sodium	"	1.00		0.900	"	80.0-120	90.0	20.0	6.45	

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9111 Research Blvd.	Project Number:	none	Received: 9/25/98
Austin, TX 78758	Project Manager:	Fred Holzmer	Reported: 10/21/98 13:13

Conventional Chemistry Parameters by APHA/EPA Methods/Quality Control
Star Analytical, Inc.

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 09V8385	**Date Prepared: 9/18/98**					**Extraction Method: General Preparation**				
Blank	**09V8385-BLK1**									
Nitrate-Nitrogen	9/18/98			**ND**	mg/l	**0.20**				
Duplicate	**09V8385-DUP1**		**8090192-02**							
Nitrate-Nitrogen	9/28/98		ND	ND	mg/l					
Batch: 09V8397	**Date Prepared: 9/18/98**					**Extraction Method: EPA 1311/3010**				
Blank	**09V8397-BLK1**									
Nitrate/Nitrite-Nitrogen	9/25/98			**ND**	mg/l	**0.10**				
LCS	**09V8397-BS1**									
Nitrate/Nitrite-Nitrogen	9/18/98	0.80		0.85	mg/l	70-130	110			
LCS Dup	**09V8397-BSD1**									
Nitrate/Nitrite-Nitrogen	9/18/98	0.80		0.85	mg/l	70-130	110	30	0	
Duplicate	**09V8397-DUP1**		**8090283-02**							
Nitrate/Nitrite-Nitrogen	9/25/98		ND	ND	mg/l			30		
Batch: 09V8456	**Date Prepared: 9/29/98**					**Extraction Method: General Preparation**				
Blank	**09V8456-BLK1**									
Sulfate	9/23/98			**1.8**	mg/kg	**1.0**				
LCS	**09V8456-BS1**									
Sulfate	9/23/98	20		9.8	mg/kg	70-130	49			
LCS Dup	**09V8456-BSD1**									
Sulfate	9/29/98	20		9.5	mg/kg	70-130	48	30	2.1	
Duplicate	**09V8456-DUP1**		**8090283-02**							
Sulfate	9/29/98		7.7	7.7	mg/kg			30	**0**	
Batch: 10V8074	**Date Prepared: 10/2/98**					**Extraction Method: General Preparation**				
Blank	**10V8074-BLK1**									
Fluoride	10/2/98			**ND**	mg/l	**0.100**				
LCS	**10V8074-BS1**									
Fluoride	10/2/98	0.100		0.100	mg/l	78.0-113	100			
Duplicate	**10V8074-DUP1**		**8090283-02**							
Fluoride	10/2/98		ND	ND	mg/l			25.0		

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Duke Engineering & Services	Project:	MCB Camp Lejune - Site 88 Sear	Sampled:	9/24/98	
9111 Research Blvd.	Project Number:	none	Received:	9/25/98	
Austin, TX 78758	Project Manager:	Fred Holzmer	Reported:	10/21/98 13:13	

Conventional Chemistry Parameters by APHA/EPA Methods/Quality Control
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Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 10V8120	**Date Prepared: 10/5/98**					**Extraction Method: General Preparation**				
Blank	**10V8120-BLK1**									
Phosphorus	10/1/98			**ND**	mg/l	**0.10**				
Duplicate	**10V8120-DUP1**		**8090304-06**							
Phosphorus	10/1/98		1.5	1.8	mg/l			30	**18**	
Batch: 10V8138	**Date Prepared: 10/8/98**					**Extraction Method: General Preparation**				
Blank	**10V8138-BLK1**									
Chloride	10/8/98			**ND**	mg/l	**0.30**				
LCS	**10V8138-BS1**									
Chloride	10/8/98	890		910	mg/l	90-110	100			
Duplicate	**10V8138-DUP1**		**8090283-02**							
Chloride	10/8/98		13	12	mg/l			16	**8.0**	
Batch: 10V8194	**Date Prepared: 10/7/98**					**Extraction Method: General Preparation**				
Blank	**10V8194-BLK1**									
Bicarbonate Alkalinity	10/7/98			**ND**	mg/l	**1.00**				
Duplicate	**10V8194-DUP1**		**8090283-02**							
Bicarbonate Alkalinity	10/7/98		33	26	mg/l			30.0	**24**	

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Duke Engineering & Services		Project:	MCB Camp Lejune - Site 88 Sear	Sampled:	9/24/98
9111 Research Blvd.		Project Number:	none	Received:	9/25/98
Austin, TX 78758		Project Manager:	Fred Holzmer	Reported:	10/21/98 13:13

Notes and Definitions

#	Note
D	Data reported from a dilution.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

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APPENDIX F

Soil Concentration Correction Calculations: Extract Volume Calculation and Soil Concentration Conversion

Appendix F
Extract Volume Calculation and Soil Concentration Conversion

Extract Volume Correction Calculation (VE)

$$VE = V_{meoh} + V_{sw}$$

Where:

VE = Extract Volume (mL)
V_{meoh} = Volume of methanol (mL)
V_{sw} =Volume of soil water (mL)

$$V_{meoh} = M_{meoh}\ \rho_{meoh}$$

Where:

M_{meoh} = mass Methanol (gms)
ρ_{meoh} = density of methanol (0.79 gms/mL)

$$M_w = \%\ \text{soil moisture}\ (M_s)$$

Where:

M_w = Mass soil water (gms)
M_s = Mass soil (gms)

Since density of water = I gm/ml then mass in grams is equal to volume in ml.

Sample calculation for sample IS07-02

Volume of methanol	(57.0gms -126.9gms)/ 0.79gm/ml = 38.1ml
Mass of Soil	303.0 gms- 157.0 gms = 146 gms
Mass of Water	146gms (0.2) = 29.2 gms percent soil moisture = 20%
Volume of water	29.2 ml assuming density of water = I gm/ml
Extract Volume	38.ml + 29.2 ml = 67.3 ml

Extract Concentration from Reported Soil Concentration

$$\text{RO OCC (df) } (V_{meoh})/[1{,}000(M_s]$$

Where:

RC = Reported soil concentration (µg/kg)
OCC = On column concentration (µg/L)
df = sample dilution factor
M_s = Mass of soil (gms)
1,000 = unit conversion factor

$$EC = OCC(df)$$

Where:

EC = extract concentration (µg/L)

Then:

$$EC\ RC(M_s)(1000)N_{meoh}$$

Sample calculation for sample IS07-02

Extract concentration (µg/L)

110,830µg/kg(146gms)(1,000)/38, I00µl = 424,703 (µg/L)

Soil Concentration Conversion

$$M_{pce} = EC(V_E)(I{,}000)$$

Where:

M_{pce} = mass of POE (mg)

$$SC = M_{pce}(1000)/M_s$$

Where:

SC = concentration of PCE in soil (µg/kg)

Sample calculation for sample IS07-02

Mass of PCE (µg)

424,703 (µg/L) (67.3 ml)/(1,000 ml/L) 28582.5 µg

Concentration in soil (µg/kg)

28582.5 µg (1,000 gms/kg)/146 gms = 195,771µg/kg

Soil VOC Concentration Correction Calculations

The reason for the correction to the lab-reported soil VOC concentrations is explained as follows. As discussed in Section 3.1.1, the soil samples collected for VOC analysis were preserved in the field with methanol to minimize volatile losses of VOCs from the samples during sample collection, shipment, and analysis. In addition to acting as a VOC preservative for the samples, the methanol also functions as a solvent to extract VOCs from the soil samples. The liquid extract m each soil sample jar, "as received" by the lab, was then analyzed for VOCs by the lab. The soil concentration results reported by the laboratory were incorrect because the calculations to determine soil VOC concentrations were based on the assumption that the total volume of liquid extract in each sample jar was composed only of methanol and VOCs. However, since water is also miscible with methanol, along with the VOCs, the total liquid volume in the soil samples received by the lab consisted of methanol, soil water, and VOCs. Soil water can account for as much as 45% of the total liquid volume in a methanol-preserved soil sample, and therefore, must be accounted for in the analysis in order to accurately convert to soil VOC concentrations. The volume of water in the soil samples can be calculated if the percent soil moisture (by weight) is known. The soil moisture values in Table 3.3 indicates that 20% is generally representative of the moisture content of the soil samples collected at Site 88. The laboratory-reported analytical values were corrected for the sample volume error by assuming 20% moisture content for all samples. The corrected raw analytical results were then converted from a concentration of VOC in μg/L of extract solution to μg/Kg of wet soil.

The correction calculations are a 3-part calculation process:

1) Extract volume correction;

2) Extract concentration from misreported soil concentration;

3) Soil concentration conversion

The process is shown below and includes a sample calculation.

1) Extract Volume Correction (V_E)

$$V_E \; V_{meoh} + V_{sw}$$

Where:

V_E = Extract Volume (mL)
V_{meoh} = Volume of methanol (mL)
V_{sw} = Volume of soil water (mL)

$$V_{meoh} = M_{meoh} \; \rho_{meoh}$$

Where:

M_{meoh} = mass Methanol (gms)
P_{meoh} = density of methanol (0.79 gms/mL)

$$M_w = \% \text{ soil moisture } (M_s)$$

Where:

M_w = Mass soil water (gms)
M_s = Mass soil (gms)

Since density of water = I gm/mI then mass in grams is equal to volume in ml.

Sample calculation for sample IS07-02

Volume of methanol	(157.Ogms -I 26.9gms)/ 0.79gm/ml 38.1ml
Mass of Soil	303.0 gms- 157.0 gms = 146 gms
Mass of Water	146gms (0.2) = 29.2 gms percent soil moisture = 20%
Volume of water	29.2 ml assuming density of water = I gm/ml
Extract Volume	38.1ml + 29.2 ml 67.3 ml

2) Extract Concentration from Misreported Soil Concentration

$$RC \; OCC \; (df) \; (V_{meoh})/[1{,}000(M_s)]$$

Where:

RC = Reported soil concentration (µg/kg)
0CC = On column concentration (µg/L)
df = sample dilution factor
M_s = Mass of soil (gms)
1,000 = unit conversion factor

$$EC = OCC(df)$$

Where:

EC = extract concentration (µg/L)

Then:

$$EC\ RC(M_s)(1000)/V_{meoh}$$

Sample calculation for sample IS07-02

Extract concentration (µg/L)

110,830µg/kg(146gms)(I,000)/38,I00µl 424,703 (µg/L)

3) Soil concentration Conversion

$$M_{pce} = EC(V_E)(1,000)$$

Where:

M_{pce}= mass of PCE (mg)

$$SC\ M_{pce}(1000)/M_s$$

Where:

SC = concentration of PCE in soil (µg/kg)

Sample calculation for sample IS07-02

Mass of PCE (p.g)

424,703 (µg/L) (67.3 ml)/(I,000 ml/L) 28582.5 µg

Concentration in soil (µg/kg)

28582.5 µg (1,000 gms/kg)/146 gms = 195,771µg/kg

INTERA
A Duke Engineering & Services Company

Project Number TDN 200
Date 7-25 to 7/27/97
Page 1 of 3

SOIL SAMPLES PRESERVATIVE LOG

Sample Number	Tare (gm)	Tare + Methanol (gm)	Final Weight (gm) Soil + methanol	Volume Added (ml)
IS01-1	127.3	156.8	264.7	
1S01-2	127.3	150.5	291.3	
1S01-3	128.6	161.2	285.9	
1S01-4	127.5	152.7	271.9	
1S02-1	126.6	153.0	297.0	
1S02-2	126.3	152.8	302.3	
1S02-3	128.4	161.5	274.9	
1S03-#1	127.6	150.8	251.2	
1S03-#2	128.6	163.2	288.2	
1S03-#3	126.6	152.8	280.3	
1S02-4	127.6	159.5	232.1	
1S04-1	127.6	157.8	299.3	
1S05-1	127.3	156.6	268.66	
1S05-2	127.1	156.2	279.5	
1S05-3	128.2	158.7	287.1	
1S05-4	127.0	155.7	280.3	
1S06-1	127.4	159.2	317.9	
1S07-1	127.4	156.9	292.3	
1S07-2	126.9	157.0	303.0	
1S07-3	125.6	156.1	311.9	
1S07-4	126.0	152.7	250.6	
1S08-1	126.5	156.6	241.1	
1S08-2	127.5	153.7	229.8	
1S08-3	126.0	151.8	225.3	
~~1S08-4~~	126.3	159.2	280.0	

1S08-4

MILD SPLASH

BAKER ENVIRONMENTAL

Lab Name:QUANTERRA

SDG Number:

Matrix: (soil/water) SOLID
Method: SW846 8260A
Volatile Organics, GC/MS (8260A)

Lab Sample ID:H7G290134 019

Sample WT/Vol: 5 / mL
Work Order: CC006202
Dilution factor: 870
Moisture %:

Date Received: 07/29/97
Date Extracted:08/03/97
Date Analyzed: 08/03/97

QC Batch: 7215125

Client Sample Id: IS07-2 -RE 1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/kg) ug/kg	Q
71-43-2	Benzene	4400	U
108-86-1	Bromobenzene	4400	U
74-97-5	Bromochloromethane	4400	U
75-27-4	Bromodichloromethane	4400	U
75-25-2	Bromoform	4400	U
74-83-9	Bromomethane	8700	U
104-51-8	n-Butylbenzene	4400	U
135-98-8	sec-Butylbenzene	4400	U
98-06-6	tert-Butylbenzene	4400	U
56-23-5	Carbon tetrachloride	4400	U
108-90-7	Chlorobenzene	4400	U
124-48-1	Chlorodibromomethane	4400	U
75-00-3	Chloroethane	8700	U
67-66-3	Chloroform	4400	U
74-87-3	Chloromethane	8700	U
95-49-8	2-Chlorotoluene	4400	U
106-43-4	4-Chlorotoluene	4400	U
96-12-8	1,2-Dibromo-3-chloropropane	8700	U
106-93-4	1,2-Dibromoethane	4400	U
74-95-3	Dibromomethane	4400	U
95-50-1	1,2-Dichlorobenzene	4400	U
541-73-1	1,3-Dichlorobenzene	4400	U
106-46-7	1,4-Dichlorobenzene	4400	U
75-71-8	Dichlorodifluoromethane	8700	U
75-34-3	1,1-Dichloroethane	4400	U
107-06-2	1,2-Dichloroethane	4400	U
75-35-4	1,1-Dichloroethene	4400	U
156-59-2	**cis-1,2-Dichloroethene**	**46000**	
156-60-5	trans-1,2-Dichloroethene	2200	U

BAKER ENVIRONMENTAL

Lab Name:QUANTERRA

SDG Number:

Matrix: (soil/water) SOLID
Method: SW846 8260A
Volatile Organics, GC/MS (8260A)

Lab Sample ID:H7G290134 019

Sample WT/Vol: 5 / mL
Work Order: CC006202
Dilution factor: 870
Moisture %:

Date Received: 07/29/97
Date Extracted:08/03/97
Date Analyzed: 08/03/97

QC Batch: 7215125

Client Sample Id: IS07-2 -RE 1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/kg) ug/kg	Q
78-87-5	1,2-Dichloropropane	4400	U
142-28-9	1,3-Dichloropropane	4400	U
594-20-7	2,2-Dichloropropane	4400	U
563-58-6	1,1-Dichloropropene	4400	U
100-41-4	Ethylbenzene	4400	U
87-68-3	Hexachlorobutadiene	4400	U
98-82-8	Isopropylbenzene	4400	U
99-87-6	p-Isopropyltoluene	4400	U
75-09-2	Methylene chloride	4400	U
91-20-3	Naphthalene	4400	U
103-65-1	n-Propylbenzene	4400	U
100-42-5	Styrene	4400	U
630-20-6	1,1,1,2-Tetrachloroethane	4400	U
79-34-5	1,1,2,2-Tetrachloroethane	4400	U
127-18-4	**Tetrachloroethene**	**110000**	
108-88-3	Toluene	4400	U
87-61-6	1,2,3-Trichlorobenzene	4400	U
120-82-1	1,2,4-Trichlorobenzene	4400	U
71-55-6	1,1,1-Trichloroethane	4400	U
79-00-5	1,1,2-Trichloroethane	4400	U
79-01-6	**Trichloroethene**	**3900**	J
75-69-4	Trichlorofluoromethane	8700	U
96-18-4	1,2,3-Trichloropropane	4400	U
95-63-6	**1,2,4-Trimethylbenzene**	**3800**	J
108-67-8	**1,3,5-Trimethylbenzene**	**1700**	J
75-01-4	**Vinyl chloride**	**4800**	J
95-47-6	o-Xylene	2200	U
136777-61-2	m-Xylene & p-Xylene	2200	U

Data File: /chem/gcms/mw.i/W080397.b/CC006202.d
Report Date: 03-Aug-97 17:46:16

Quanterra - Knoxville

SW-846 Method 8260A - Volatile Organics

Data file : /chem/gcms/mw.i/W080397.b/CC006202.d
Lab Smp Id: CC006202
Inj Date : 03-AUG-97 16:12:00
Operator : 60487 Inst ID: mw.i
Smp Info : CC006202,870,0,,,
Misc Info : W080397,MS8260_L,
Comment :
Method : /chem/gcms/mw.i/W080397.b/MS8260_L.m
Meth Date : 03-Aug-97 13:19:28 wilesd Quant Type: ISTD
Cal Date : 30-JUL-97 20:57:00 Cal File: WI0730A.d
Als bottle: 1
Dil Factor: 870.00000
Integrator: HP RTE Compound Sublist: all.sub
Target Version: 3.30
Processing Host: hpuxcs12

Concentration Formula: Vt/(Ws*1000)

Name	Value	Description
Vt	5000.000	Sample Volume Purged
Ws	5.000	Weight of sample

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/L)	FINAL (ug/Kg)
*	1 Fluorobenzene	96	9.483	9.517	(1.000)	255535	50.0000	
*	2 Chlorobenzene-d5	117	13.833	13.900	(1.000)	237432	50.0000	
*	3 1,4 Dichlorobenzene-d4	152	17.417	17.517	(1.000)	176643	50.0000	
$	4 1,2-Dichloroethane-d4	65	9.100	9.133	(0.960)	86542	37.8135	37.814(a)
$	5 Toluene-d8	98	11.683	11.733	(0.845)	221489	46.1209	46.121(a)
$	6 4-Bromofluorobenzene	95	15.617	15.700	(0.897)	195307	41.3967	41.397(a)
	7 Dichlorodifluoromethane	85.00	Compound Not Detected.					
	8 Chloromethane (spcc)	50.00	Compound Not Detected.					
	9 Vinyl Chloride (ccc)	62	3.050	3.050	(0.322)	9396	5.54636	4825.3(a)
	10 Bromomethane	94.00	Compound Not Detected.					
	11 Chloroethane	64.00	Compound Not Detected.					
	12 Trichlorofluoromethane	101.00	Compound Not Detected.					
	13 1,1-Dichloroethene (ccc)	96.00	Compound Not Detected.					
	14 Carbon Disulfide	76.00	Compound Not Detected.					
	15 Acetone	43	5.383	5.400	(0.568)	625	1.03861	903.59(a)
	16 Methylene Chloride	84	6.017	6.033	(0.634)	2030	1.03158	897.48(a)
	17 trans-1,2-Dichloroethene	96.00	Compound Not Detected.					

Data File: /chem/gcms/mw.i/W080397.b/CC006202.d
Report Date: 03-Aug-97 17:46:16

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/L)	FINAL (ug/Kg)
	18 1,1-Dichloroethane (spcc)	63.00	Compound Not Detected.					
	19 2,2-Dichloropropane	77.00	Compound Not Detected.					
	20 cis 1,2-Dichloroethene	96	7.917	7.950	(0.835)	108219	53.3411	46407
M	21 1,2-Dichloroethene (total)	96				108219	53.3411	46407
	22 2-Butanone	43	7.967	7.983	(0.840)	736	0.58136	~~505.78(aQ)~~
	23 Bromochloromethane	128.00	Compound Not Detected.					
	24 Chloroform (ccc)	83.00	Compound Not Detected.					
	25 1,1,1-Trichloroethane	97.00	Compound Not Detected.					
	26 Carbon Tetrachloride	117.00	Compound Not Detected.					
	27 1,1-Dichloropropene	75.00	Compound Not Detected.					
	28 Benzene	78.00	Compound Not Detected.					
	29 1,2-Dichloroethane	62	9.483	9.233	(1.000)	2706	1.00733	~~876.38(a)~~
	30 Trichloroethene	130	9.967	10.017	(1.051)	12495	4.52553	3937.2(a)
	31 1,2-Dichloropropane (ccc)	63.00	Compound Not Detected.					
	32 Dibromomethane	93.00	Compound Not Detected.					
	33 Bromodichloromethane	83.00	Compound Not Detected.					
	34 cis-1,3-Dichloropropene	75.00	Compound Not Detected.					
	35 4-Methyl-2-pentanone	43.00	Compound Not Detected.					
	36 Toluene (ccc)	91.00	Compound Not Detected.					
	37 trans-1,3-Dichloropropene	75.00	Compound Not Detected.					
	38 1,1,2-Trichloroethane	97	12.533	12.500	(0.906)	1796	0.76042	~~661.37(aQ)~~
	39 Tetrachloroethene	164	12.533	12.583	(0.906)	~~346227~~	~~127.392~~	~~110830~~
	40 1,3-Dichloropropane	76.00	Compound Not Detected.					
	41 2-Hexanone	43.00	Compound Not Detected.					
	42 Chlorodibromomethane	129.00	Compound Not Detected.					
	43 1,2-Dibromoethane	107.00	Compound Not Detected.					
	44 Chlorobenzene (spcc)	112.00	Compound Not Detected.					
	45 Ethylbenzene (ccc)	106.00	Compound Not Detected.					
	46 1,1,1,2-Tetrachloroethane	131.00	Compound Not Detected.					
	47 m&p-Xylene	106.00	Compound Not Detected.					
	48 o-Xylene	106.00	Compound Not Detected.					
M	49 Xylene (total)	106.00	Compound Not Detected.					
	50 Styrene	104.00	Compound Not Detected.					
	51 Bromoform (spcc)	173.00	Compound Not Detected.					
	52 Isopropylbenzene	105.00	Compound Not Detected.					
	53 Bromobenzene	156.00	Compound Not Detected.					
	54 1,1,2,2-Tetrachloroethane(sp)	83.00	Compound Not Detected.					
	55 n-Propylbenzene	91.00	Compound Not Detected.					
	56 1,2,3-Trichloropropane	75.00	Compound Not Detected.					
	57 2-Chlorotoluene	91.00	Compound Not Detected.					
	58 1,3,5-Trimethylbenzene	105	16.183	16.267	(0.929)	11347	1.97959	1722.2(a)
	59 4-Chlorotoluene	91.00	Compound Not Detected.					
	60 tert-Butylbenzene	119.00	Compound Not Detected.					
	61 1,2,4-Trimethylbenzene	105	16.783	16.883	(0.964)	25716	4.33953	3775.4(a)
	62 sec-Butylbenzene	105.00	Compound Not Detected.					
	63 1,3-Dichlorobenzene	146.00	Compound Not Detected.					
	64 p-Isopropyltoluene	119	17.233	17.333	(0.989)	3880	0.56635	492.72(a)
	65 1,4-Dichlorobenzene	146.00	Compound Not Detected.					

8/4/97

APPENDIX G

Porosity Calculation and NAPLANAL paper (Mariner et al, 1997)

POROSITY FROM PERCENT SOIL MOISTURE

Assume pores are fully saturated with water, then:

$$\%w = m_p/m_t \times 100 \qquad \text{and}$$

$$m_p = V_p\rho_w \qquad \text{then:}$$

$$\%w = (V_p\rho_w/m_t) \times 100 \qquad \text{rearranging}$$

$$V_p = \%w\ m_t/100\rho_w$$

where:

%w = percent soil moisture
m_p = mass of water in pores
m_t = total mass of sample
V_p = volume of pores
ρ_w = density of water

$$V_t = V_s + V_p \qquad \text{Then}$$

$$V_t = m_s/\rho_s + V_p \qquad \text{and}$$

$$m_s = m_t - m_p \qquad \text{substituting}$$

$$V_t = (m_t - m_p)/\rho_s + V_p \qquad \text{Finally}$$

$$V_t = (m_t - V_p\rho_w)/\rho_s + V_p$$

where:

V_T = total volume of sample
V_s = volume of soil
m_s = mass of soil
ρ_s = density of soil

$$\eta = V_p/V_t \qquad \text{Substituting}$$

$$\eta = (\%w\ m_t/100\rho_w)/((m_t - V_p\rho_w)/\rho_s + V_p) \qquad \text{Substitute for } V_p$$

$$\eta = (\%w\ m_t/100\rho_w)/(((m_t - (\%w\ m_t/100\rho_w))/\rho_s + \%w\ m_t/100\rho_w)$$

Divide top and bottom by m_t then:

$$\eta = (\%w\ /100\rho_w)/(((1 - (\%w\ /100\rho_w))/\rho_s + \%w\ /100\rho_w)$$

Multiply top and bottom by $100\rho_w$ then:

$$\eta = \%w\ /((100\rho_w\ - \%w\ )/\rho_s + \%w)$$

where:

η = porosity

For soil correction calculations a value of 1 gm/ml was used for ρ_w and a value of 2.64 gm/ml was used for ρ_s. The above equation then becomes:

$$\eta = \%w\ /((100\ - \%w\ )/2.64 + \%w)$$

Sample Calculation

Assuming soil moisture content of 20%.

$$\eta = 20\ /((100\ - 20\ )/2.64 + 20)$$

$$\eta = 20\ /((80)/2.64 + 20)$$

$$\eta = 20\ /(30.3 + 20)$$

$$\eta = 0.398$$

An Algorithm for the Estimation of NAPL Saturation and Composition from Typical Soil Chemical Analyses

by Paul E. Mariner, Minquan Jin, and Richard E. Jackson

Abstract

An algorithm is presented that allows estimation of the saturation and composition of a single or multi-component NAPL within a core sample. These estimates are possible because, in addition to distributing the organic chemicals between aqueous, sorbed, air, and NAPL phases according to traditional partitioning equations, the algorithm incorporates equations for the conservation of mass and volume. A unique solution is obtained by solving the set of nonlinear equations implicitly. The algorithm is built into a code called NAPLANAL, which is tested and applied to actual core samples collected in the field.

Pages 122–129

Introduction

It is an extraordinary feature of modern hydrogeological practice that estimating the mass or volume of nonaqueous phase liquid (NAPL) in a soil or rock is not deemed essential to the design of remediation systems. A brief inspection of past issues of this journal will show that NAPL volumes are seldom estimated from field data. Such a volume estimate permits the calculation of an approximate remediation period for the NAPL-contaminated soil or rock. An essential parameter for estimating NAPL volumes in a NAPL-contaminated soil or rock is the NAPL saturation of the porous medium. Mercer and Cohen (1990) have tabulated NAPL saturation data from the literature.

Paraphrasing Bear (1972), when the pore space of an aquifer sediment or fractured rock is contaminated with NAPL, the saturation (or degree of saturation) of NAPL at a particular point is defined as the fraction of pore space occupied by NAPL within a representative elementary volume (REV) around the considered point:

$$S_N = \frac{\text{volume of NAPL within REV}}{\text{total pore volume within REV}} \quad (1)$$

As pointed out by Corey (1994), "saturation can be conceptualized (but not measured) as a point property varying in space in a manner entirely analogous to porosity." The constraint of being unable to measure the saturation at a point arises from the size of the REV, which

Mayer and Miller (1992) found to vary directly with the nonuniformity of the porous medium such that "the upper range of these REV estimates (i.e., ~10-10^4 cm^3) exceeds the scale of ... field samples typically taken to estimate NAPL residual saturation levels." It is for this reason of scale that Jin et al. (1995) have proposed using a partitioning interwell tracer test for measuring NAPL volume over a large interwell pore volume.

While soil cores cannot provide reliable NAPL saturations over large zones of the subsurface, they can provide information on the approximate volumes of NAPL present in the core samples. Furthermore, continuous coring can indicate the relative NAPL saturations with depth, which may allow an experienced observer to deduce whether pooling of NAPL may be occurring upon some capillary barrier, such as a clay lens. In addition, the analysis and interpretation of soil chemical data from cores indicate the nature of the chemical composition of the NAPL in the source zone. Finally, the chemical analysis of soil cores provides an approximate initial value of NAPL saturation which can be used in multiphase, multicomponent simulators such as UTCHEM for modeling surfactant-enhanced aquifer remediation (e.g., Brown et al. 1994) and the application of partitioning interwell tracer tests (e.g., Jin et al. 1995).

We are not aware of any published method for calculating NAPL saturation from a soil sample chemical analysis when more than one organic compound is identified in the analysis. Feenstra et al. (1991) showed how a measured organic concentration can be used to assess whether a single- or multicomponent NAPL is present in a soil sample, but not how NAPL saturation could be calculated. In addition, the method requires an a priori assumption of the NAPL chemical composition. Mott (1995) improved on the Feenstra et al. (1991) method by presenting a method that can be used to estimate multicomponent NAPL composition from a complete organic chemical soil sample analysis and to determine whether NAPL is present in the sample. The method, which is incorporated in a code called SOILCALC, distributes mass among all phases including the NAPL phase. However, because the method assumes that NAPL occupies no pore space, SOILCALC cannot be used to calculate NAPL saturation. Consequently, its calculations of NAPL composition and the concentrations of organic compounds in each phase are not accurate unless NAPL saturation is approximately two orders of magnitude lower than typical residual NAPL saturations. Typical residual NAPL saturations range from 10 percent to 20 percent in the vadose zone and from 15 percent to 50 percent in the saturated zone (Mercer and Cohen 1990).

In this paper, a model is presented for the implicit calculation of NAPL saturation, NAPL composition, and phase distribution of organic compounds in a core sample of soil or rock. This model was developed in 1993 as an extension of the model presented in Feenstra et al. (1991). In addition to the phase partitioning relationships, the model incorporates equations for the conservation of mass and volume. The algorithm distributes the organic chemicals among aqueous, air, sorbed, and NAPL phases so that both the NAPL saturation and the correct NAPL composition are determined regardless of the amount of NAPL in the sample.

Partitioning Theory

If NAPL exists in a core sample from the unsaturated zone, the NAPL components will be distributed among four physical phases: air, soil, water, and NAPL. Each NAPL component (i.e., each compound in the NAPL) is distributed among the phases according to thermodynamic equilibrium principles and mass transfer kinetic factors. The system reaches equilibrium when the chemical potential of any constituent is equal in all phases. Figure 1 shows a schematic representation of the equilibrium relationship.

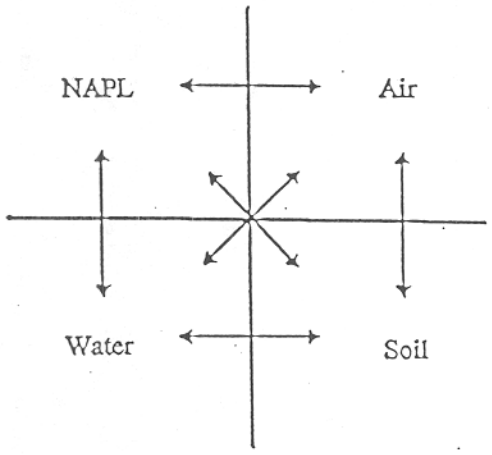

Figure 1. Schematic representation of phase equilibrium and partitioning.

To estimate the distribution of the total mass of a chemical among the phases at equilibrium, the chemical's phase partitioning behavior must be known. All nonaqueous concentrations are defined using traditional equilibrium equations that are functions of aqueous concentrations. These relationships are presented later. In each relationship, at least one chemical property of each organic compound (e.g., aqueous solubility, vapor pressure, and partition coefficient) must be known. In each case, the value of the chemical property is temperature dependent. Consequently, the values used in the model must be representative of the original soil or rock temperature. Values for these properties at specific temperatures can be found in the literature (e.g., Mercer et al. 1990) or estimated (e.g., Lyman et al. 1990; Drefahl and Reinhard 1995).

NAPL-Water Partitioning

NAPL-water partitioning depends on the aqueous solubilities of the NAPL components and the concentrations of the NAPL components in the NAPL. The relationship is analogous to Raoult's law for ideal gas mi tures. For an ideal NAPL in contact with water the

aqueous phase concentration of a NAPL component is equal to the pure phase aqueous solubility of the component multiplied by the mole fraction of the component in the NAPL mixture. Mathematically, this relationship is written as:

$$C_w^i = x_i S_i \quad (2)$$

where C_w^i is the aqueous phase concentration of component i (mass i in water per volume water); x_i is the mole fraction of the component in the NAPL mixture (mole i in NAPL per mole NAPL); and S_i is the aqueous solubility of pure component i (mass i in water per volume water). Feenstra et al. (1991) refers to C_w^i as the effective aqueous solubility of component i when the aqueous phase is at equilibrium with a NAPL. This general NAPL-water partitioning relationship has been confirmed by Banerjee (1984), Mackay et al. (1991), Cline et al. (1991), Lee et al. (1992a,b), and Broholm and Feenstra (1995) for NAPL mixtures of structurally similar compounds. This relationship is not highly dependent on temperature.

Air-Water Partitioning

The equilibrium concentration of component i in air is related to the aqueous concentration by Henry's law. Henry's law states that equilibrium water-air partitioning is described by a linear relationship. The relationship can be written as:

$$C_a^i = K_H^i C_w^i \quad (3)$$

where C_a^i is the concentration of i in air (mass i in air per volume air), and K_H^i is the dimensionless Henry's constant. The Henry's constant is often reported in the literature in its dimensional form, $K_H^{i\prime}$ (e.g., atm-L/mol). The dimensional Henry's constant is calculated from the equation:

$$K_H^{i\prime} = \frac{P_{vap}^i}{S_i} MW_i \quad (4)$$

where P_{vap}^i is the component's vapor pressure (e.g., atm), and MW_i is the component's molecular weight (mass i per mole i), which is needed to convert the previously defined mass-based aqueous solubility S_i to molar units. The two Henry's constants are related through the equation:

$$K_H^i = \frac{K_H^{i\prime}}{RT} \quad (5)$$

where R is the universal gas constant (0.08206 atm-L/mol-K) and T is temperature in Kelvin. As the equation reveals, air-water partitioning is highly dependent on temperature.

Soil-Water Partitioning

Sorption to soil organic matter can also be described by a linear function of the aqueous organic compound concentration. The relationship can be written as:

$$C_s^i = K_{oc}^i f_{oc} C_w^i \quad (6)$$

where C_s^i is the sorbed concentration of component i (mass i sorbed per mass soil); K_{oc}^i is the organic carbon to water partition coefficient of component i (mass i sorbed per mass organic carbon divided by mass i in water per volume water); and f_{oc} is the mass fraction of natural organic carbon within the soil matrix (mass natural organic carbon per mass soil).

The mass fraction of natural organic carbon has to be measured for the particular soil to be evaluated. Although the effect of temperature is small, the K_{oc}^i value can be highly sensitive to pH if the organic compound is ionizable (Drefahl and Reinhard 1995).

The linear isotherm model of Equation 6 has been experimentally verified for various organic compounds by Karickhoff et al. (1979), Chiou et al. (1979), Schwarzenbach and Westall (1981), and Chiou et al. (1983). It has been noted, however, that linear sorption is valid only for f_{oc} greater than about 0.001 (Schwarzenbach and Westall 1981) and greater than about 3 to 7 percent of the solid mass fraction of clay (Karickhoff 1984); otherwise, sorption of organic compounds on clays and mineral surfaces can be significant.

Conservation Equations and Relationships

Soil, water, air, and NAPL account for the total volume of a soil sample containing NAPL. The volume conservation equation is:

$$\phi_s + \phi_w + \phi_a + \phi_n = 1 \quad (7)$$

where ϕ_s is the volumetric soil content (volume soil per total volume); ϕ_w is the volumetric water content (volume water per total volume); ϕ_a is the volumetric air content (volume air per total volume); and ϕ_n is the volumetric NAPL content (volume NAPL per total volume). The soil porosity ϕ (volume void per total volume) is equal to the sum of the volumetric air, water, and NAPL contents:

$$\phi = \phi_a + \phi_w + \phi_n \quad (8)$$

Thus, the volumetric soil content ϕ_s equals $1 - \phi$.

Each NAPL component in a soil sample is distributed among the phases present. As a result, the total mass of component i in the sample equals the sum of the masses of component i in all phases. The mass conservation equation is:

$$\rho_t C_t^i = \phi_w C_w^i + \phi_a C_a^i + \phi_n C_n^i + \phi_s \rho_s C_s^i \quad (9)$$

where ρ_t is the total density of the soil sample (mass of sample per volume of sample); C_t^i is the measured total concentration of i in the sample (mass i in sample per mass of sample); C_n^i is the concentration of i in the NAPL (mass i in NAPL per volume NAPL); and ρ_s is the density of the solid (approximately 2.65 kg/L for sand). The total density, ρ_t, is approximately equal to

the weighted average of the densities of the four phases:

$$\rho_t = \phi_w\rho_w + \phi_a\rho_a + \phi_n\rho_n + \phi_s\rho_s \quad (10)$$

where ρ_w is the density of water (approximately 1.0 kg/L); ρ_a is the density of air (approximately 0.0013 kg/L at 20°C); and ρ_n is the density of the NAPL mixture (mass NAPL per volume NAPL). ρ_n can be expressed as:

$$\rho_n = \Sigma C_n^i = \frac{\Sigma x_i MW_i}{\sum_i \frac{x_i MW_i}{\rho_i}} \quad (11)$$

where ρ_i is the density of pure component i in liquid form (mass i per volume i). Some components, such as vinyl chloride or anthracene, may not occur as liquid in their pure form under environmental conditions. For these components, hypothetical pure phase liquid densities are computed by extrapolation.

The mole fraction of component i in the NAPL mixture is related to mass concentration by the equation:

$$x_i = \frac{C_n^i MW_n}{\rho_n MW_i} \quad (12)$$

where MW_n is the equivalent molecular weight of the NAPL mixture (mass NAPL per mole NAPL). MW_n is approximately equal to the weighted average of the molecular weights of the NAPL components:

$$MW_n = \Sigma x_i MW_i \quad (13)$$

Finally, the sum of the NAPL mole fractions is equal to 1:

$$\Sigma x_i = 1 \quad (14)$$

Estimation of NAPL Saturation and Composition

A complete chemical analysis of a core sample provides the total mass of each component per unit mass of sample (i.e., the value of C_t^i for each component). To determine the saturation and composition of NAPL in the sample, the total mass of each component in each phase and the total volume of each phase must be determined. The partitioning theory and conservation relationships presented in the previous section can be used for this purpose. The solution allows calculation of the NAPL saturation from the equation:

$$S_N = \frac{\phi_n}{\phi} \quad (15)$$

The method presented here is a numerical solution of the partitioning and conservation equations. PC software called NAPLANAL was developed to perform the numerical simulation. NAPLANAL can be used to estimate the following: (1) the NAPL saturation and composition in a soil sample containing NAPL; (2) the concentrations of organic compounds in each phase; and (3) the NAPL composition and NAPL volume in samples of NAPL-water emulsions ($\phi_s = 0$). A copy of NAPLANAL is available from the INTERA web site (http://www.intera.com) for a small fee.

The algorithm is first demonstrated by considering a hypothetical soil sample from an unsaturated formation containing NAPL with N chemical components. Calculation of NAPL saturation and composition requires the following measurements or estimates as input: total concentrations of NAPL components in the soil sample (C_t^i), volumetric water content (ϕ_w), soil porosity (ϕ), volumetric soil content ($\phi_s = 1 - \phi$), soil organic carbon content (f_{oc}), organic carbon to water partition coefficients (K_{oc}^i), Henry's law constants in dimensionless form (K_H^i), molecular weight of each component (MW_i), and densities of water, air, soil, and each NAPL component (ρ_w, ρ_a, ρ_s, and ρ_i).

Equations 2, 3, 6, and 8 through 14 provide a total of 5N+5 independent equations that describe partitioning and conservation of organic compounds in a soil sample. Given the measurements and estimates listed in the previous paragraph, there are 5N+5 unknowns. These unknowns are as follows: NAPL component concentrations in water, air, soil, and NAPL (C_w^i, C_a^i, C_s^i, and C_n^i); component mole fractions in the NAPL mixture (x_i); volumetric contents of air and NAPL (ϕ_a and ϕ_n); density of sample (ρ_t); and the equivalent density and molecular weight of the NAPL (ρ_n and MW_n).

An equal number of unknowns and independent equations guarantees a unique solution. NAPLANAL solves the system of equations and unknowns using an algorithm that combines the rapid local convergence of the Newton-Raphson method for a system of nonlinear equations with a globally convergent strategy. For the sample problems tested so far, the computation time for reaching a solution is less than one minute using a 486 DX66 PC.

For core samples from the saturated zone, the air volumetric content (ϕ_a) and air phase concentrations (C_a^i) are equal to zero. Thus, the terms and equations involving the air phase are dropped from the system of equations. As a result, the number of equations reduces to 4N+5, while the number of unknowns reduces to 4N+4. Because there are fewer unknowns than equations, a measurement for either soil porosity (ϕ) or soil volumetric water content (ϕ_w) is sufficient for estimation purposes. Users of NAPLANAL have the choice of treating either ϕ or ϕ_w as an unknown parameter. A gas chromatography method is currently being developed to allow simultaneous measurement of ϕ_w and the concentrations of organic compounds in a soil sample.

The NAPLANAL code begins with the assumption that there is no NAPL present in the sample (i.e., $\phi_n = 0$). The density of the sample can then be calculated from Equation 10 as:

$$\rho_t = \phi_w\rho_w + (\phi - \phi_w)\rho_a + (1 - \phi)\rho_s \quad (16)$$

The first approximation of the aqueous concentration can be calculated from Equation 9 by:

$$C_w^i = \frac{C_t^i \rho_t}{\phi_w + K_H^i(\phi - \phi_w) + f_{oc} K_{oc}^i \rho_s (1 - \phi)} \quad (17)$$

shown by Feenstra et al. (1991). If NAPL exists in the sample, then this first approximation of C_w^i should exceed the effective aqueous solubility of component i. Equations 2 and 14 imply that C_w^i equals the effective aqueous solubility when:

$$\sum \frac{C_w^i}{S_i} = 1 \quad (18)$$

Thus, a summation exceeding 1 when Equation 17 is used to estimate C_w^i implies that NAPL is present in the sample and that the NAPL saturation algorithm must be used instead to estimate C_w^i. A summation in Equation 18 equal to or less than one indicates there is no NAPL in the sample (i.e., S_N and ϕ_n equal zero). In this case, Equation 17 provides valid explicit estimates of aqueous concentrations. Air and sorbed concentrations are then calculated directly from Equations 3 and 6. When the summation in Equation 18 is less than 1, C_w^i is less than the effective aqueous solubility and calculation of x_i from Equation 2 is invalid.

Petroleum Hydrocarbon Example

In this example, the petroleum hydrocarbon data from Mott (1995) are used to compare the results of NAPLANAL and SOILCALC. The example problems consider hypothetical soil samples contaminated with C6 through C9 n-aliphatic hydrocarbons. For direct comparison of NAPLANAL and SOILCALC results, the input data are identical. The physical and chemical properties of the soil samples and the petroleum hydrocarbons used in the calculations are summarized in Table 1.

Table 1
Chemical Property Data Used in the Examples by Mott (1995)

Component i	K_{oc}^i (mL/g)	K_H^i	S_i (mg/L)	ρ_i (kg/L)	MW_i (g/mol)
Hexane	6025.60	46.49	12.31	0.66	86.07
Heptane	22908.68	63.59	3.06	0.68	100.20
Octane	77624.71	95.74	0.68	0.70	114.22
Nonane	263026.8	45.80	0.47	0.72	128.26
		f_{oc}	ϕ_w	ϕ	
Soil Sample Data		0.01	0.08	0.4	

The three soil samples differ only in the total hydrocarbon component concentration. These data are shown in Table 2. The first data set represents a soil sample containing 250 mg/kg of each component. The second data set, which is a borderline case (NAPL may or may not be present based on SOILCALC results), represents a soil sample containing 192 mg/kg each component. The third data set, which is a no NAPL case, represents a soil sample containing 100 mg/kg each component. Results from SOILCALC and NAPLANAL are summarized in Table 2. SOILCALC results are in parentheses.

SOILCALC assumes that NAPL occupies zero void space (i.e., the NAPL saturation is assumed insignificant relative to water and air content). Because of this assumption, SOILCALC does not have NAPL saturation estimation capability. In contrast, NAPLANAL implicitly calculates NAPL saturation. For the first two sets of data, the results indicate NAPL saturations of 0.15 percent and 0.02 percent, respectively. At such low NAPL saturations (i.e., approximately 1 percent or less of typical residual NAPL saturations [Mercer and Cohen 1990]), the pore space occupied by NAPL is indeed insignificant relative to pore space occupied by water and air. As a result, the two models give similar results, as shown in Table 2. However, there are still differences in the component mass distributions, especially for the mass of components in the NAPL phase. Because NAPLANAL calculates NAPL saturation, it should provide more accurate results than SOILCALC, especially at higher NAPL saturations.

Field DNAPL Examples

NAPLANAL was used to calculate the saturations and compositions of DNAPL and the phase distributions of DNAPL components in several core samples collected from a chemical plant on the Gulf Coast. DNAPL is NAPL that is denser than water. The plant has manufactured a variety of chlorinated ethanes and ethenes, such as 1,2-dichloroethane (EDC), trichloroethene (TCE), tetrachlorothene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1,2-trichloroethane (1,1,2-TCA),

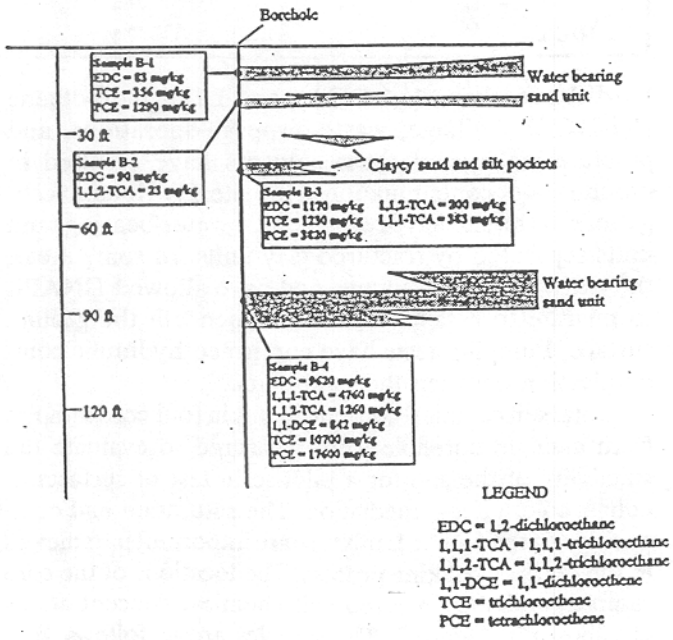

Figure 2. Cross-sectional view of soil sample location and total soil concentration.

Table 2

Comparison of NAPLANAL and SOILCALC Results

SOILCALC Results Are in Parentheses (Mott 1995). Concentrations Are Normalized by Total Sample Mass. For Comparison Purposes, Calculations Are Not Rounded to Reflect Significant Figures.

Component i	Measured Sample Conc. C_t^i (mg/kg)	Sample Conc. in Aq. Phase $C_w^i \phi_w \rho_t^{-1}$ (mg/kg)	Sample Conc. in Air Phase $C_a^i \phi_a \rho_t^{-1}$ (mg/kg)	Sample Conc. Sorbed $C_s^i \phi_s \rho_s \rho_t^{-1}$ (mg/kg)	Sample Conc. in NAPL $C_n^i \phi_n \rho_t^{-1}$ (mg/kg)	Mole Fraction in NAPL x_i
Data Set #1						
Hexane	250	1.467E-01 (1.493E-01)	2.680E+01 (2.795E+01)	1.735E+02 (1.800E+02)	4.953E+01 (4.193E+01)	0.2460 (0.2429)
Heptane	250	3.949E-02 (4.062E-02)	9.871E+00 (1.040E+01)	1.776E+02 (1.861E+02)	6.251E+01 (5.347E+01)	0.2667 (0.2663)
Octane	250	1.055E-02 (1.104E-02)	3.970E+00 (4.258E+00)	1.607E+02 (1.715E+02)	8.530E+01 (7.427E+01)	0.3193 (0.3245)
Nonane	250	3.852E-03 (3.926E-03)	6.936E-01 (6.710E-01)	1.989E+02 (2.065E+02)	5.040E+01 (4.272E+01)	0.1680 (0.1663)
NAPL saturation = 0.15%					$\sum x_i$ =	1.0000 (1.0000)
Data Set #2						
Hexane	192	1.366E-01 (1.378E-01)	2.499E+01 (2.580E+01)	1.615E+02 (1.661E+02)	5.322E+00 (1.060E-02)	0.2290 (0.2241)
Heptane	192	3.894E-02 (3.968E-02)	9.749E+00 (1.016E+01)	1.751E+02 (1.818E+02)	7.114E+00 (1.445E-02)	0.2629 (0.2602)
Octane	192	1.160E-02 (1.207E-02)	4.374E+00 (4.653E+00)	1.768E+02 (1.873E+02)	1.083E+01 (2.224E-02)	0.3511 (0.3546)
Nonane	192	3.601E-03 (3.637E-03)	6.493E-01 (6.710E-01)	1.859E+02 (1.913E+02)	5.438E+00 (1.087E-02)	0.1570 (0.1540)
NAPL saturation = 0.02%					$\sum x_i$ =	1.0000 (0.9929)
Data Set #3						
Hexane	100	7.316E-02 (7.177E-02)	1.339E+01 (1.344E+01)	8.654E+01 (8.648E+01)	(6.720E-15)	(0.1167)
Heptane	100	2.106E-02 (2.067E-02)	5.274E+00 (5.293E+00)	9.471E+01 (9.469E+01)	(8.132E-15)	(0.1355)
Octane	100	6.404E-03 (6.285E-03)	2.415E+00 (2.423E+00)	9.758E+01 (9.757E+01)	(1.364E-15)	(0.1847)
Nonane	100	1.930E-03 (1.894E-03)	3.481E-01 (3.495E-01)	9.965E+01 (9.965E+01)	(7.434E-15)	(0.0802)
No NAPL					$\sum x_i$ =	(0.5171)

1,1-dichloroethane (1,1-DCA), and 1,1-dichloroethene (1,1-DCE). Spillage, waste-disposal operations, and pipeline leakage of these solvents have resulted in ground water contamination at the site. Previous investigations at the site have revealed silty water-bearing sand units separated by fractured clay units. In some areas, the clays are discontinuous and have allowed DNAPL to migrate to a sand unit 80 feet beneath the ground surface. Pumping tests have confirmed hydraulic communication between the sand units.

Total soil chemical concentrations in four core samples from a single borehole were measured to evaluate the suitability of the site for a pilot-scale test of surfactant-enhanced aquifer remediation. The saturation and composition of the DNAPL mixture are important parameters in the decision-making process. The locations of the core samples and the analyzed soil chemical concentrations are shown in Figure 2. The samples are as follows: B-1, located in a sand unit at about 10 feet below ground surface (bgs); B-2, located in a sand unit at about 20 feet bgs; B-3, located in a unit of clayey sand with silt pockets at about 43 feet bgs; and B-4, located in a sand unit at about 80 feet bgs. The volumetric water contents of the core samples were not measured. The porosity and fraction organic carbon content of the sands were assumed

Table 3

Chemical Property Data Used in the Analysis of the Soil Samples

Component i	K_{oc}^i (mL/g)	K_H^i	S_i (mg/L)	ρ_i (kg/L)	MW_i (g/mol)
1,1-dichloroethene	65	0.87	400	1.22	97
1,2-dichloroethane	14	0.038	8690	1.26	99
1,1,1-trichloroethane	152	0.54	720	1.35	133.4
1,1,2-trichloroethane	56	0.031	4500	1.44	133.4
trichloroethene	126	0.3	1100	1.47	131.5
tetrachloroethene	364	0.54	200	1.63	165.8

Table 4
NAPLANAL Calculations from Soil Sample Analyses
Concentrations Are Normalized by Total Sample Mass. Results Are Rounded to Two Significant Figures.

Component i	Measured Sample Conc. C_t^i (mg/kg)	Sample Conc. in Aq. Phase $C_w^i \phi_w \rho_t^{-1}$ (mg/kg)	Sample Conc. Sorbed $C_s^i \phi_s \rho_s \rho_t^{-1}$ (mg/kg)	Sample Conc. in NAPL $C_n^i \phi_n \rho_t^{-1}$ (mg/kg)	Mole Fraction in NAPL x_i
Sample B-1					
1,2-dichloroethane	83	50	0.74	32	0.032
trichloroethene	356	46	6.4	300	0.23
tetrachloroethene	1290	27	11	1300	0.74
NAPL saturation = 0.54%					
Sample B-2					
1,2-dichloroethane	90	89	1.7		
1,1,2-trichloroethane	23	22	1.4		
No NAPL					
Sample B-3					
1,2-dichloroethane	1170	300	4.8	860	0.19
1,1,1-trichloroethane	383	8.2	1.4	370	0.063
1,1,2-trichloroethane	200	24	1.5	170	0.029
trichloroethene	1230	40	5.7	1200	0.20
tetrachloroethene	3820	18	7.6	3800	0.51
NAPL saturation = 2.3%					
Sample B-4					
1,2-dichloroethane	9620	370	6.8	9200	0.28
1,1,1-trichloroethane	4760	12	2.3	4700	0.11
1,1,2-trichloroethane	1260	19	1.4	1200	0.028
1,1-dichloroethene	842	1.6	0.14	840	0.026
trichloroethene	10700	40	6.8	11000	0.24
tetrachloroethene	17600	9.6	4.6	18000	0.32
NAPL saturation = 17%					

to be 0.375 and 0.0015, respectively. These values are equivalent to average values measured by Liljestrand and Charbeneau (1987) in similar shallow sands in the area. Table 3 lists the physical properties attributed to the chlorinated solvents in the core samples.

According to the results of the NAPLANAL calculations, presented in Table 4, only a small amount of DNAPL is present in sample B-1. The ground water in B-2 appears to contain no DNAPL. Samples B-3 and B-4 have calculated NAPL saturations of about 2.3 percent and 17 percent, respectively. The computed NAPL composition in each of these core samples is different. Although PCE appears to be the predominant NAPL component in all samples containing NAPL, the mole fraction of PCE decreases with depth while the TCE and EDC mole fractions increase. This trend suggests historical variations in the composition of infiltrating DNAPL and/or different locations of DNAPL releases having different DNAPL compositions.

In the aforementioned calculations, soil porosity was estimated. Neither porosities nor water contents had been measured for these samples. A graph relating the porosity to the calculated NAPL saturation and composition for samples B-3 and B-4 is shown in Figure 3. Samples B-3 and B-4 represent soil samples having relatively low and high NAPL saturations, respectively. The graph shows that the uncertainty of the porosity value

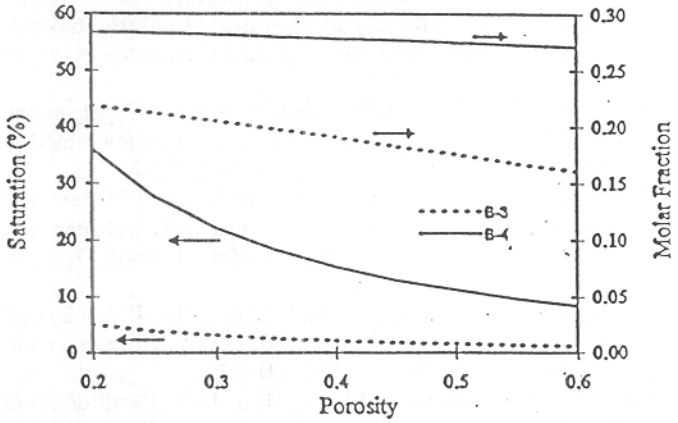

Figure 3. Effect of porosity on NAPL saturation and composition estimation results.

on the calculations of NAPL saturation and composition is small considering the relatively small possible range of soil porosity in sandy sediments.

Conclusions

The NAPL saturation algorithm presented in this paper provides a useful tool to investigators involved in site characterization studies at NAPL-contaminated sites. This algorithm allows the quantification of NAPL saturation and NAPL composition in a soil sample from

a typical soil chemical analysis. This information is useful in modeling and designing site-specific surfactant-enhanced aquifer remediation strategies (e.g., Brown et al. 1994) and partitioning interwell tracer tests (e.g., Jin et al. 1995). The calculations require only the soil information typically gathered in ground water contamination studies, specifically total chemical concentrations, water moisture content, porosity, natural organic content, and specific physical and chemical properties of the contaminants. A PC software program, NAPLANAL, was developed to perform these calculations.

The accuracy of the calculations depends on the accuracy of the input data. A sample's chemical analysis can be compromised by improper sampling and preservation, failure to identify and quantify all organic contaminants, and incomplete extraction of contaminants. In addition, the values of the physical properties of the soil sample and the chemical properties of the NAPL components affect the results. Thus, sensitivity analyses, such as the example shown for porosity, are strongly encouraged. Such sensitivity analyses can be performed easily using NAPLANAL.

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