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RCRA WELL INSTALLATION REPORT TASK 9.4
APRIL 1988

04/30/88

WMCO/DOE-FMPC
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REPORT

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RCRA WELL INSTALLATION REPORT

TASK 9.4

APRIL 1988

Prepared for:

U.S. Department of Energy

Feed Materials Production Center

Fernald, Ohio

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U.S. DEPT. OF ENERGY
REFERENCE MATERIAL

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RCRA WELL INSTALLATION REPORT

TASK 9.4

APRIL 1988

Prepared for:

U.S. Department of Energy

Feed Materials Production Center

Fernald, Ohio

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1.0 INTRODUCTION

Six monitoring wells were installed to meet the Resource Conservation and Recovery Act (RCRA) monitoring requirements at the Feed Materials Processing Center (FMPC) located near Fernald, Ohio, Figure 1. The wells will be used to monitor ground water conditions around Pit #4 in the Waste Storage Area. This report documents the installation of these wells and provides a summary interpretation of geologic setting.

Wells 124, 266, and 366 will be used as upgradient wells to establish background water quality while Wells 184, 284, and 384 will be used to monitor for potential groundwater contamination downgradient from Pit #5, Figure 2. Approximate well screen depths are identified by the series number of each well. One hundred series wells are screened in the glacial till. Two hundred series wells are screened in the upper portion of the upper sand and gravel aquifer to straddle the water table. Three hundred series wells are screened in the lower portion of the upper sand and gravel aquifer just above the blue clay. Table 1 presents completion data summaries for the six monitoring wells. Appendix A contains the soil classification logs and Appendix B contains the Well Completion Diagrams of the six wells.

2.0 MONITORING WELL INSTALLATION

The monitoring wells were constructed according to guidelines provided in the RCRA Groundwater Monitoring Technical Enforcement Guidance Document. General drilling procedures were as follows:

1. All boreholes were drilled using cable tool drilling methods and casing techniques.

2. Temporary casing and downhole tools were steam cleaned prior to drilling.

3. Boreholes were 10 inches in diameter except for borehole 266 which was 12 inches in diameter.

4. No oil, grease, or other lubricant was applied to the threads of any casing.

2.1 Drilling Procedure

Drilling and sampling operations were conducted according to the following procedure:

1. From ground surface drive a split spoon sampler 18 inches into the ground according to ASTM Method D 1586-84 (Appendix C).

2. Drill the borehole out to the total depth of the driven sampler.

3. After repeating steps 1 and 2 five times, drive the temporary casing to current total depth of seven and one-half feet.

4. Repeat steps 1 and 2 without advancing the borehole more than 10 feet ahead of the temporary casing. Drive the casing as needed and advance the borehole to the bottom of the till unit.

5. After entering the sand and gravel aquifer, reduce the split spoon sampling frequency to one sample every five feet. Advance the borehole to the required depth.

This sampling procedure was followed for the deepest well in each cluster to provide an accurate geologic record at each drill site. Shallower wells were not sampled. Wells that did not require sampling the borehole were advanced as quickly as possible, but were never advanced more than 10 feet deeper than the temporary casing. Drilling operations were facilitated by adding water to the borehole. The water was obtained from FMPC fire hydrants. A record of the amount of added water is located on the soil classification logs included in Appendix A.

2.2 Monitoring Well Completion

The monitoring wells were installed according to the well construction diagram shown in Figure 3. Seven feet of well screen were installed in Well 124, ten feet in Wells 184, 366, and 384, and 15 feet in Wells 266 and 284.

Prior to installation all screen and casing materials were steam cleaned. No oil, grease or other lubricant was applied to the casing threads.

A protective casing extends 2.5 feet above the ground and has the well identification number welded on the protective casing cap. Well construction diagrams and summary sheets are also located in Appendix A. A three foot by three foot, four-inch thick, concrete apron was poured around each well.

2.3 Completion Procedure

The monitoring wells were installed according to the following procedure:

1. Pull the temporary casing back to the well screen installation depth and allow the borehole to collapse below that point.

2. Lower the stainless steel monitoring well screen and casing down the borehole inside the temporary casing.

3. Pour sandpack in place around the screen and extending two feet above the screen.

4. Withdraw the temporary casing from the stabilized section of the borehole.

5. Pour a five foot bentonite plug in place on top of the sandpack.

6. Remove temporary casing from that stabilized section of the borehole.

7. Tremie volclay grout down the borehole on top of the bentonite plug.

8. Remove temporary casing after that section of the borehole is stabilized with well pack.

9. Repeat steps 7 and 8 until the borehole is grouted to ground surface.

10. Install the protective casing unit and concrete pad.

11. After 48 hours, develop the well to RCRA specifications.

2.4 Construction Materials

The monitoring wells are constructed of the following materials.

Protective Casing: Carbon steel, 10 inch diameter, at least one-quarter inch wall thickness, five feet in length, locking cap, painted aviation orange.

Riser: 316 stainless steel, 4 inch I.D., schedule 05, thread with flush joints.

Caps: Well Wizard PVC caps, 4 inch I.D. for the 200 and 300 series wells. A 316 stainless steel, 4 inch I.D. cap was used for the 100 series wells.

Sand: Inert quartz. Sieve analyzed to match screen slot size.

Bentonite: Sodium bentonite pellets.

Grout: American Colloid Company Volclay Grout.

Concrete Mix: Portland type II cement and gravel.

3.0 SOIL SAMPLING

Split barrel sampling was conducted using an 18-inch drive split spoon sampler in accordance with ASTM method D 1586-84. The samplers are two inches outer diameter and one and three-eighths inch inner diameter.

After opening the split spoon the soil sample was monitored with an HNu photoionization detector, an alpha scintillator, and a beta/gamma pancake probe. The sample was described according to the Unified Soil Classification System (USCS). Colors were classified using Munsell Color Charts. Compressibility was measured with a pocket penotrometer. The above information is recorded on the soil classification logs included in Appendix A.

Between sampling events the split spoons were decontaminated by the following procedure:

1. Alconox detergent wash.

2. Potable water rinse.

3. Methanol rinse.

4. Two deionized water rinses.

At each cluster location, soil samples were taken continuously through the glacial till and at five foot intervals through the sand and gravel aquifers. For the cluster at location 66 the logs from Wells 266 and 366 constitute a complete sampling sequence. Also the lithologic log for Well 324, which is not a designated RCRA well, represents the lithologic control for Well 124.

4.0 LITHOLOGY

The soil classification logs for Wells 266, 366, 124, 324, 184, 284, and 384 are provided in Appendix A. A comparison of these well logs reveals similar lithologies in the glacial till at all three well cluster locations.

4.1 Well 366

In Well 266 and 366 the glacial till is composed predominantly of gray clay with traces of sand, silt, and gravel to a depth of 33 feet. From 33 to 43 feet the upper portion of the upper sand and gravel aquifer is characterized by brown sand and gravel. The section from 43 to 84 feet is mostly gray silt and clay. From 56 to 61 feet a 5 foot section of gray sand occurs within the gray clay and silt. Gray sand with gray clay layers are also encountered from 84 to 95 feet. From 95 to 120 feet there is gray clay and silt, and from 120 to 139 feet there is gray sand. From 139 feet to the borehole bottom of the hole at 152 feet

sandy clay predominates. None of these clays and silts appear to be the "blue clay" which was encountered in Wells 324 and 384.

Well 366 is on the northern edge of the sand and gravel aquifer. This sand and gravel aquifer underlies most of the FMPC. The frequent changes from sand and gravel to clay and silt indicates interlayering of the sand and gravel aquifer with other depositional environments.

4.2 Well 324

Well 324, located approximately 2500 feet southwest of Well 366, illustrates the more typical sand and gravel sequence underlying the FMPC. From ground surface to 34 feet is the glacial till sequence dominated by gray clay. Well 324 encounters brown sand between 34 feet and 56 feet. At 56 feet a gray sand, then gravel sequence was encountered until 99 feet. From 99 to 102 feet is a clay layer. From 102 feet to 112 feet is sand and at 112 feet silty clay begins grading into the "blue clay" which was encountered at approximately 115 feet. The blue clay is eight feet thick at this location and is underlain by olive brown gravel from 123 to 135 feet, and then dark grayish brown sand and gravel to the bottom of the borehole at 156.5 feet.

4.3 Well 384

This sequence is very similar to the lithology encountered in Well 384 which is located approximately 600 feet south of Well 324. In Well 384 the upper sand and gravel aquifer is encountered at 38 feet. The color changes from yellow to gray at 61 feet, and the blue clay was encountered at 119 ft.

5.0 DEDICATED SAMPLING PUMPS

Wells 266 and 366 have dedicated Well Wizard pump systems installed for water sampling. Wells 284 and 384 will also have dedicated pump systems after they are developed. All wells will have a dedicated bladder type pump for sampling and Wells 284, 384, and 366 will have an additional high flow rate purge pump which is used to remove well water before sampling. The construction specifications for the dedicated pump systems are as follows:

Bladder pump: Model T-1200, Teflon/316 stainless steel construction.

Purge pump: Model HR-4700, Teflon/316 stainless steel construction.

Tubing: Model PT-5100, Teflon lined polyethylene.

Caps: Models 2020-C and 2050-C, PVC.

a

Driver Controller: Model 3111, automatically cycles sampling and purge pumps. A three horse power Briggs and Stratton engine coupled to an oilless 100 psi compressor is mounted in a cart for easy transport.

6.0 SUMMARY

Six monitoring wells have been installed for the purpose of monitoring ground water conditions around Pit 4. These wells will be used for RCRA ground water monitoring, and are constructed according to RCRA guidelines. Soil Sampling conducted during drilling operations provides an accurate subsurface picture for the area north of Pit 5.

Dedicated Well Wizard pump systems are installed in Wells 266 and 366. The pump systems will be used to gather ground water samples for RCRA monitoring. Wells 284 and 384 will receive dedicated pump systems after the wells are developed.

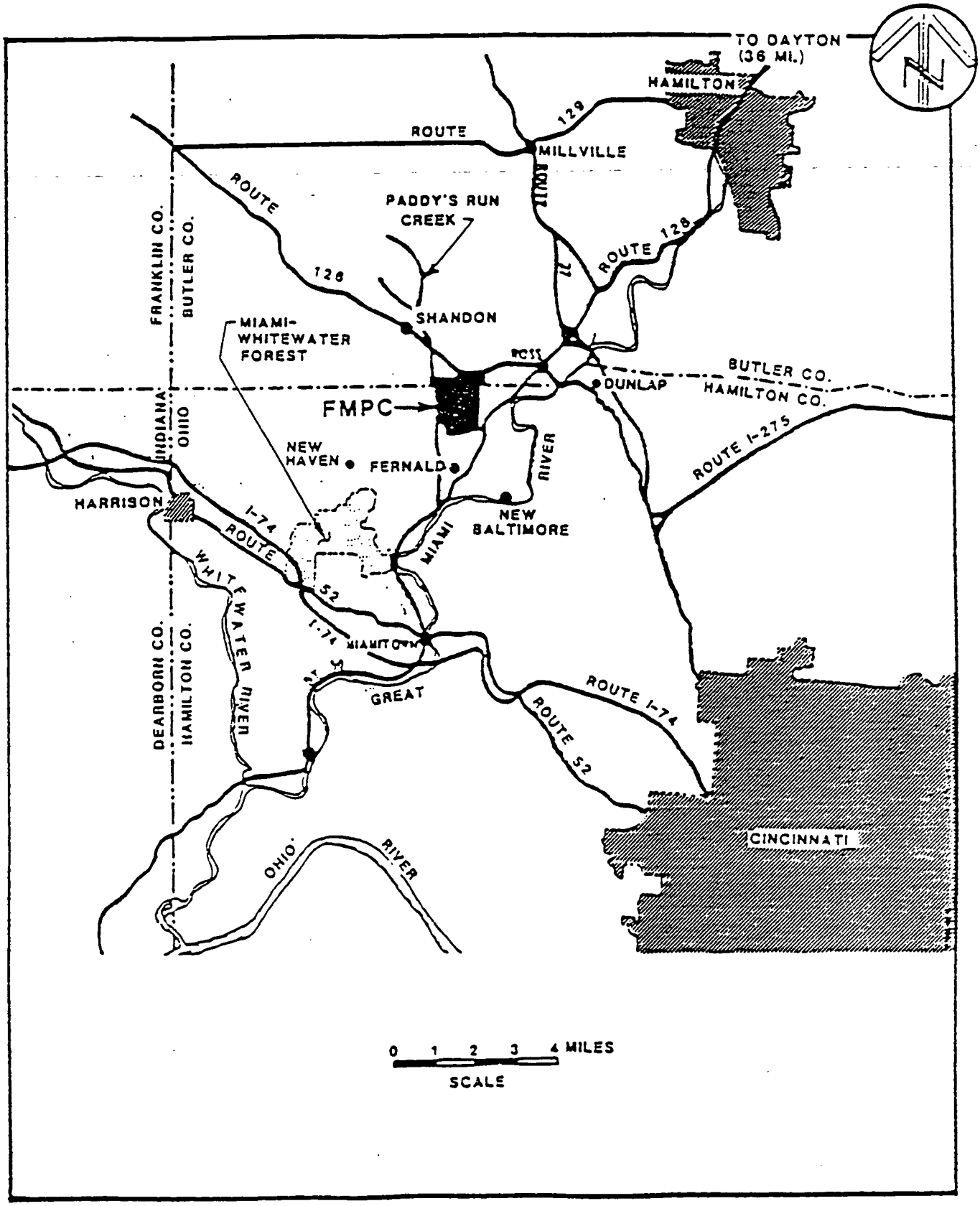


FIGURE 1
SITE LOCATION MAP

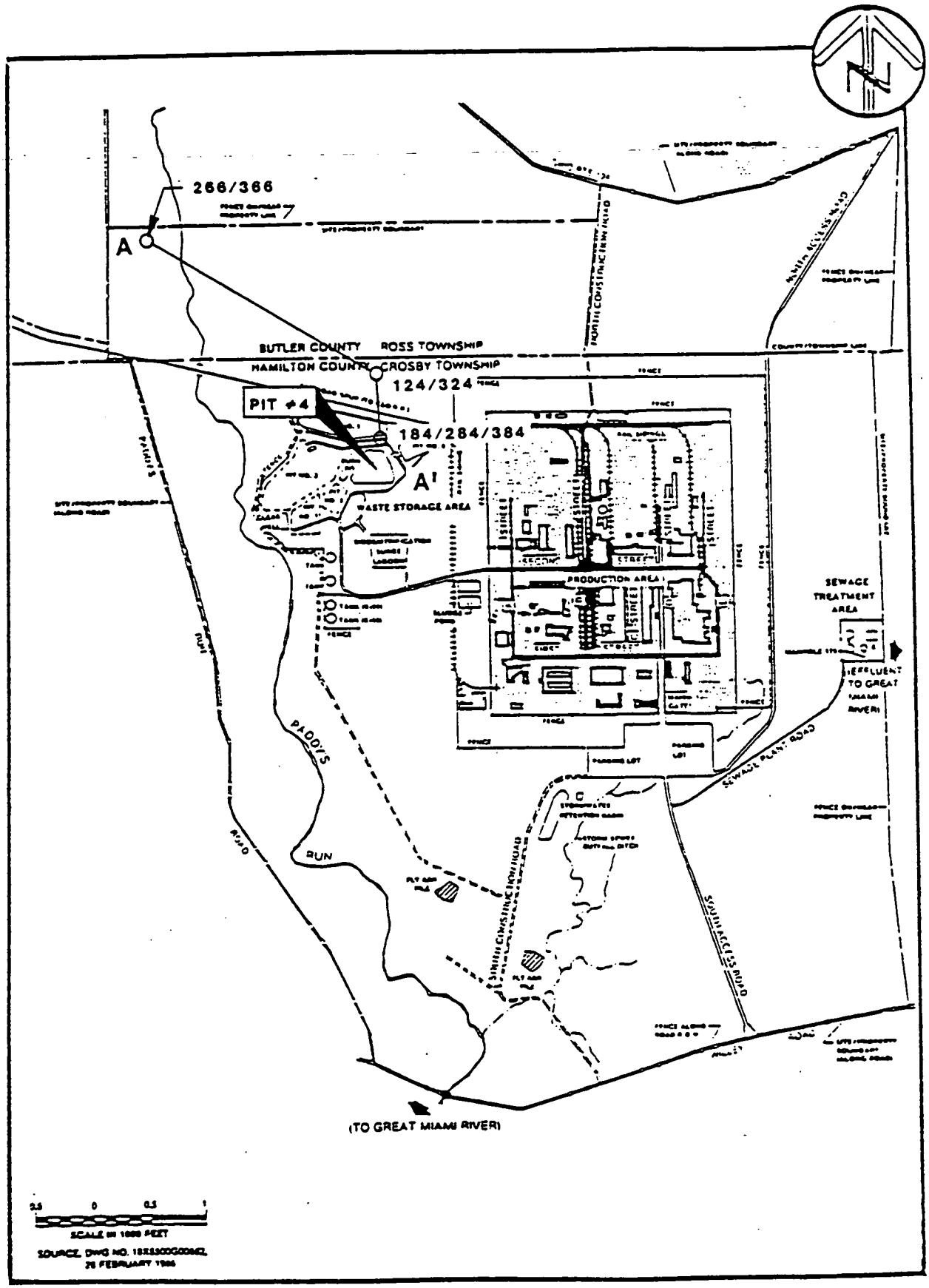


FIGURE 2
WELL LOCATION MAP

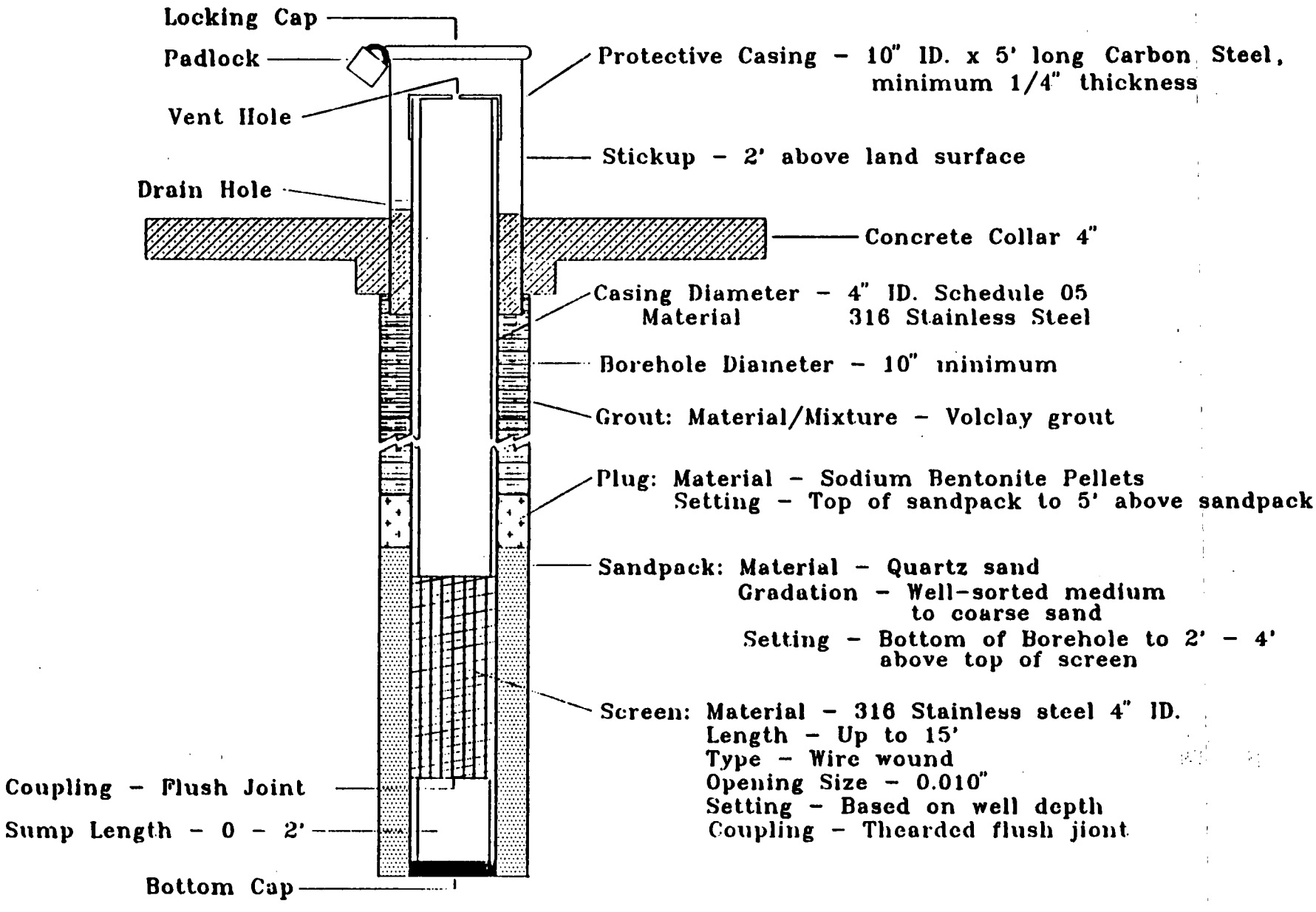


FIGURE 3
TYPICAL MONITORING WELL CONSTRUCTION SPECIFICATIONS

TABLE 1

COMPLETION DATA SUMMARY

WELL NO.	SCREEN INTERVAL ELEVATION IN FEET TOP	BOTTOM
184	562.2	552.2
284	524.59	509.6
384	480.07	470.07
124	562.7	555.7
266	533.2	518.2
366	453.2	443.2

APPENDIX A

SOIL CLASSIFICATION LOGS AND WELL COMPLETION DIAGRAMS

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS		
BORING NUMBER: 124	COORDINATES:	DATE: 10-4-87	
ELEVATION:	GWL: Depth 9.3' Date/Time 10-17/1100	DATE STARTED: 10-4-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10/16/87	
DRILLING METHODS: Cable Tool		PAGE 1 OF 2	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0				Detailed Continuous Samples were collected on borehole # 324. Please refer to that Soil Log for details			
1'							
2'							
3'							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14				Unsuccessful Shelby Tube Attempt.			Attempted to obtain a Shelby Tube from 14'-15.5'. Only recovered 5".
15'							

NOTES: Used a total of 35 gallons of water to drill hole.

MAC 100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

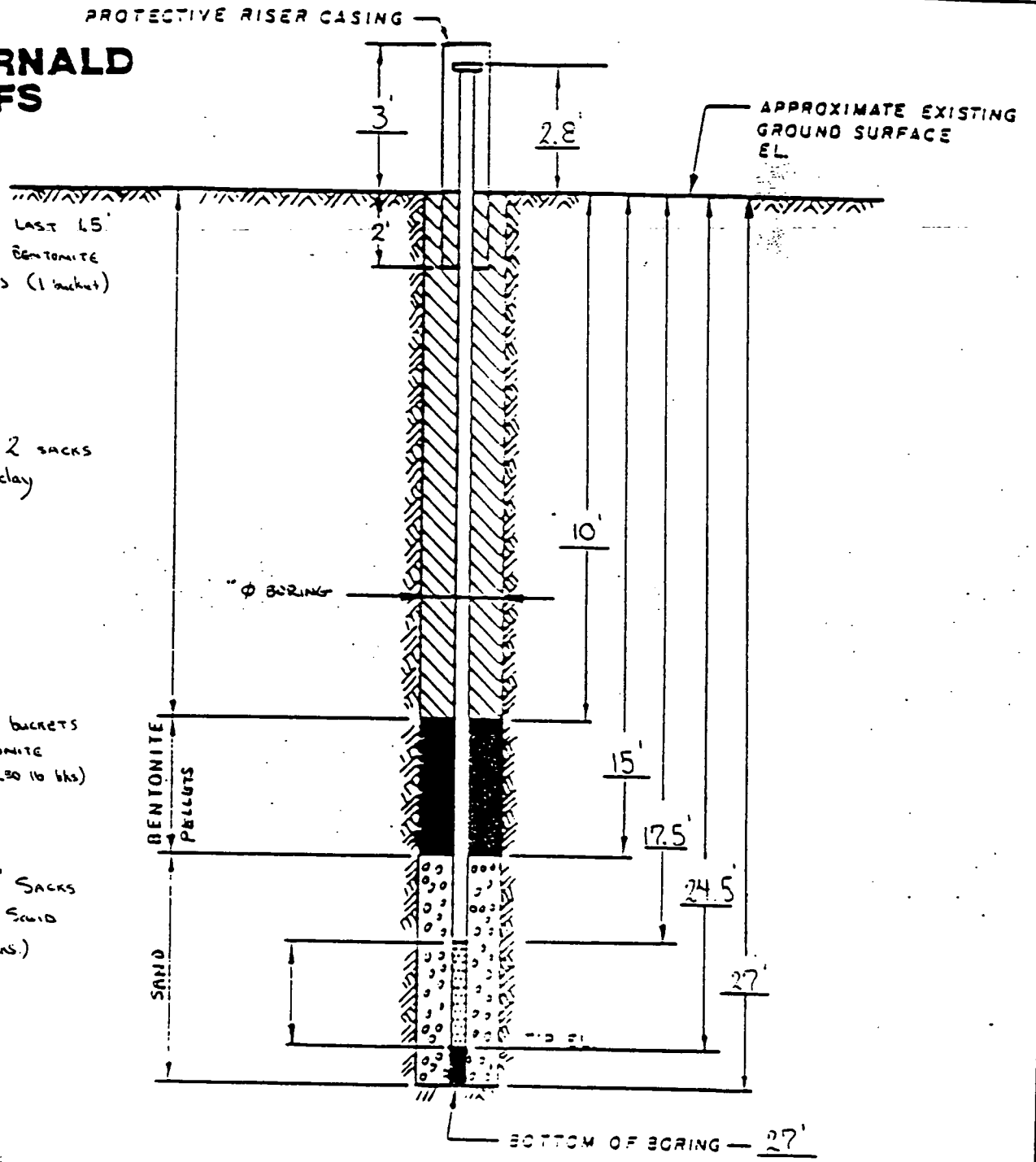
PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS		
BORING NUMBER: 124	COORDINATES:	DATE: 10/16 / 87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10-4-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10/16 / 87	
DRILLING METHODS: Cable Tool		PAGE 2 OF 2	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				See Well Log #324 for Soil descriptions			
16	ST 07247		= 8"		CL		Shelby Tube: Csg began pulling up after 8" collected
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27				Bottom of Boring = 27'			1st well - Drilling Completed but had to be redrilled to to bentonite pellets setting up & lifting Stainless Steel Csg with 10" Temp. Csg.
28							
29							
30							

NOTES:

WELL # 124 100

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. S.S. PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 124

PREPARED FOR

FMPC RI/FS

18

PAK
100

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. B. Dunning DATE 10/16/87
PROJECT NO. 662 CHECKED BY DATE
BORING NO. 124
PIEZOMETER NO. NA DATE OF INSTALLATION 10-18-87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0' TO 27'
FLUID NA FROM NA TO NA

TYPE OF BIT Hammer
CASING SIZE (S) USED:
SIZE 10" FROM Surface TO 27'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 IN.
TOTAL PERFORATED AREA 7'

RISER PIPE MATERIAL Stainless Steel (316)
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10'
JOINING METHOD Flush joint thread

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5'
PROTECTIVE PIPE O.D. 10"

OTHER PROTECTION Locking cap with lock.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft.)		ELEVATION (Ft.) MSL	
TOP OF RISER PIPE	2.8'			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	-2'			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 10'	TOP	BOTTOM
BENTONITE	TOP 10'	BOTTOM 15'	TOP	BOTTOM
SAND	TOP 15'	BOTTOM 27'	TOP	BOTTOM
no GRAVEL used	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 17.5'	BOTTOM 24.5'	TOP	BOTTOM
PIEZOMETER TIP	27.0 (silt trap)			
BOTTOM OF BOREHOLE	27'			
GWL AFTER INSTALLATION	-9'			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑
REMARKS

409-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 224	COORDINATES:	DATE: NA
ELEVATION:	GWL: Depth Date/Time	DATE STARTED:
ENGINEER/GEOLOGIST: W. ZEGLEY B DURNING	Depth Date/Time	DATE COMPLETED: 10-29-87
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 1

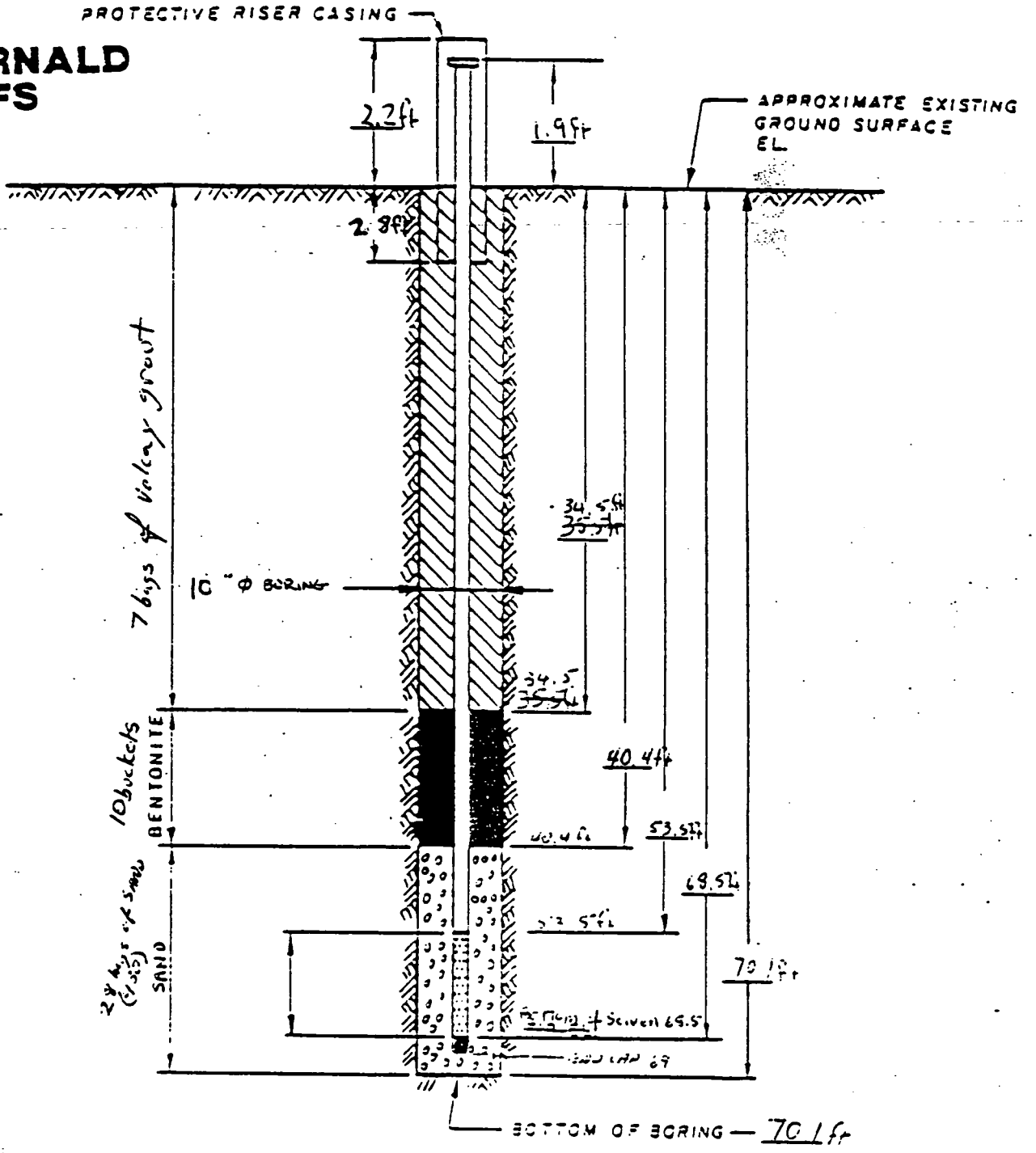
DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN.)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0							
5.0							
10.0							
15.0				FOR DESCRIPTION OF SOILS ENCOUNTERED IN WELL 224 SEE VISUAL CLASSIFICATION OF SOILS FOR WELL NO 324			NO SAMPLES collected DURING BORING OPERATIONS
20.0							
25.0							
30.0							
35.0							
40.0							
45.0							
50.0							
55.0							
60.0							
65.0							
70.0				70.1 BOTTOM OF BORING AT 70.1 FEET			
75.0							

NOTES:

1. DRILLING CONTRACTOR PENNSYLVANIA DRILLING
   DRILLER : Tim Harris
   HELPER : Steve Reber
   RIG Speed King 71
2. WATER ADDED TO BORING DURING DRILLING OPERATIONS (1 = 5 gal)
3. SOIL SAMPLING AS per ASTM STANDARD PENETRATION TEST
4. color descriptions AS per MUNSELL
5. FIELD MEASUREMENTS BACKGROUND levels.
   HNu = 0
   γ = 0
   O/a = 40-100

Boring 224

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 224

PREPARED FOR

DRAWN BY
CHECKED BY
APPROVED BY
DRAWING NUMBER

100 pf

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. Will Kegley DATE 10 29 87
PROJECT NO. 602 CHECKED BY DATE
BORING NO. 224
PIEZOMETER NO. 224 DATE OF INSTALLATION 10-29 87 thru 10 30 87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 0 TO 70.1 ft
FLUID NA FROM NA TO NA

TYPE OF BIT HAMMER (FLAT HEAD)
CASING SIZE (S) USED: (TEMPORARY)
SIZE 10" FROM 0 TO 73 ft
SIZE NA FROM NA TO NA.

PIEZOMETER DESCRIPTION

TYPE STAINLESS STEEL (316)
DIAMETER OF PERFORATED SECTION 4.0 in
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010 in
TOTAL PERFORATED AREA 15 ft

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. I.D. 4.0
LENGTH OF PIPE SECTIONS (1) 5 ft (2) 2 ft (3) 10 ft
JOINING METHOD FLUSH JOINT THREADED

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 ft
PROTECTIVE PIPE O.D. 10 inch

OTHER PROTECTION Locking top

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	1.9			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.8			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 2.1	BOTTOM 34.5	TOP	BOTTOM
BENTONITE	TOP 34.5	BOTTOM 40.4	TOP	BOTTOM
SAND	TOP 40.4	BOTTOM 70.1	TOP	BOTTOM
NO GRAVEL USED	TOP —	BOTTOM —	TOP	BOTTOM
PERFORATED SECTION	TOP 53.5	BOTTOM 65.5	TOP	BOTTOM
PIEZOMETER TIP	69.0			
BOTTOM OF BOREHOLE	70.1			
GWL AFTER INSTALLATION	NK			

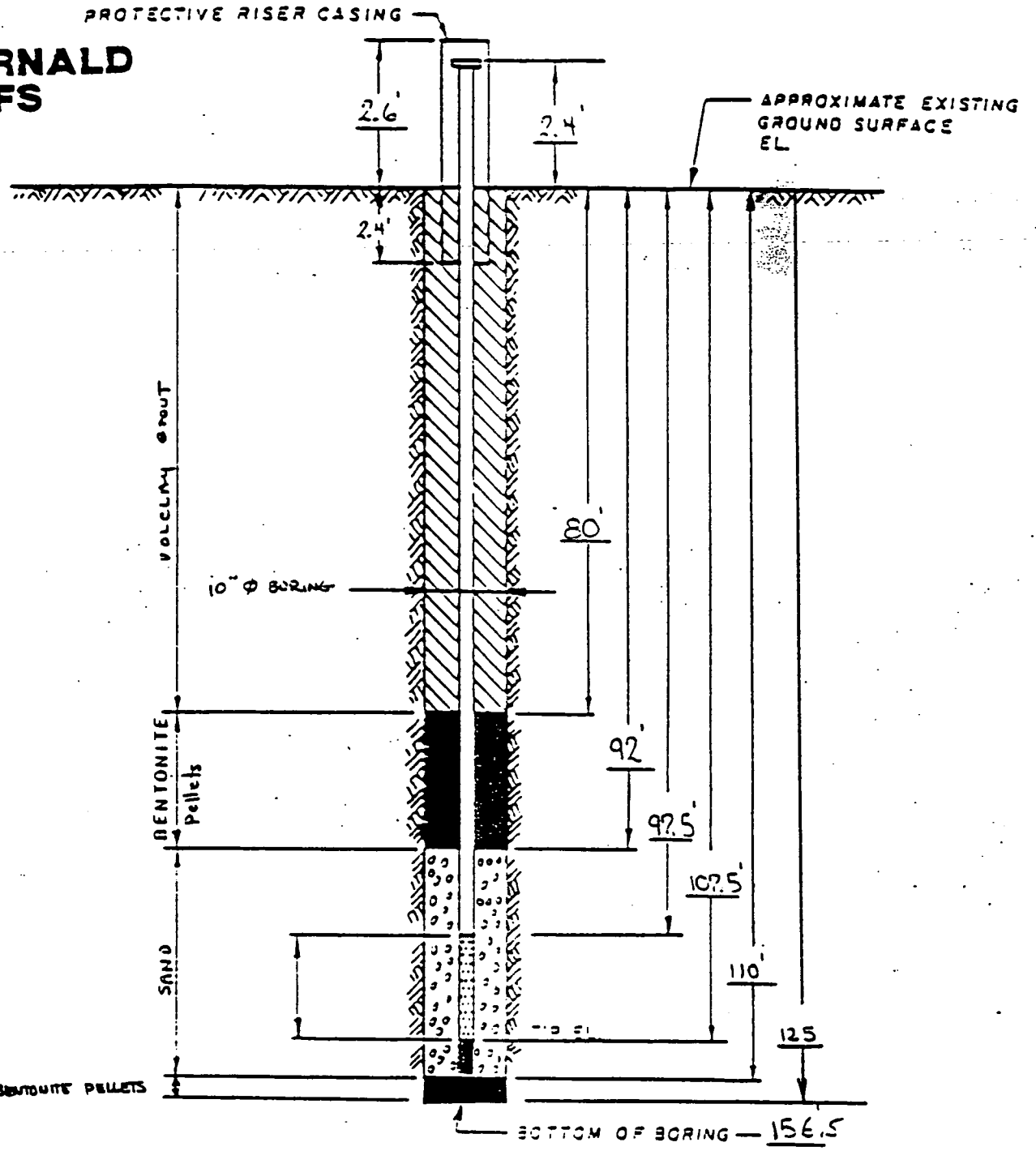
WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS

WELL # 324

100

FERNALD RI/FS



NOTE: HOLE WAS ALLOWED TO COLLAPSE TO 125'. PLUGGED WITH BENTONITE 125'-110'.

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 324

PREPARED FOR

FMPC RI/FS

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

23

ATL
100

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. B. Dunning DATE 10/15/87
PROJECT NO. 602 CHECKED BY DATE
BORING NO. 324
PIEZOMETER NO. 324 DATE OF INSTALLATION 10-3-87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID H_2O FROM 0 TO 155'
FLUID NA FROM NA TO NA

TYPE OF BIT Hammer
CASING SIZE (S) USED:
SIZE 10" FROM 0' TO 155'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel monitoring well
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010"
TOTAL PERFORATED AREA 10'

RISER PIPE MATERIAL Stainless Steel (316)
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10'
JOINING METHOD Flush Joint Threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5'
PROTECTIVE PIPE O.D. 10"

OTHER PROTECTION LOCKING CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft.)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	+ 2.4'			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	- 2.4'			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 80'	TOP	BOTTOM
BENTONITE	TOP 80'	BOTTOM 92'	TOP	BOTTOM
SAND	TOP 92	BOTTOM 110'	TOP	BOTTOM
BENTONITE PELLETS	TOP 110'	BOTTOM 125	TOP	BOTTOM
PERFORATED SECTION	TOP 97.5'	BOTTOM 107.5'	TOP	BOTTOM
PIEZOMETER TIP	~~[illegible]~~ ~110'			
BOTTOM OF BOREHOLE	155.5			
GWL AFTER INSTALLATION	58'			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

REMARKS Hole was drilled to 155' to clearly define stratigraphy. Casing was pulled up to 125' and sand-hole was allowed to collapse in. The well was then sealed from 125' to 110' with bentonite to insure that no communication through "Blue Clay" was present. Well was then set from 110'.

409-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:	DATE: 9-14-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87 @ 1330	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10/3/87	
DRILLING METHODS: Cazie Tool - Split Spoon Samples		PAGE 1 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inches)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
.5 1.0'	S 07089	5 11 10	12"	Medium stiff, yellowish-brown clay with some sand, moist	CL		Background ins $\gamma\beta$ = 40-60 α = 0 hmax = 0 Sample Caught (1345)
2' 3'	S 07090	12 17 19	24"	Stiff, dark yellowish-brown silty sand with some fine gravel moist	SM		Background Levels (1400)
4'	S 07091	12 25 32	18	Medium dense dark yellowish-brown silty sand with some gravel moist	SP		Background Levels (1440)
				4.3' Coarse Gravel - yellowish-brown	GW		
5' 6'	S 07092	22 12 15	14"	Medium dense dark yellowish-brown silty sandy gravel, moist.	GC		Background Levels (1445)
				5.5' Stiff yellowish-brown silty clay, moist	CL		
7'	S 07093	10 21 23	16"	Dense yellowish-brown silty gravel grading downward to a:	GC		Background Levels (1545)
				7' Hard dark gray clay with a trace of coarse sand and gravel moist 7'	CL	4.5	
8' 9'	S 07095	16 19 23	12"	Very stiff gray clay with a trace of fine gravel (slightly damp) moist.	CL	4.0	Background Levels End of Day 9-14-87 (1625)
10'	S 07096	6 11 15	6"	Medium dense, grayish-brown gravel moist.	GC		Start of Day 9-15-87 gravel is actually very heavily consolidated Background (0830)
11' 12'	S 07097	4 5 8	12"	Medium stiff olive-gray clay with a trace of fine gravel, moist.	CL	1.0	Background Lost entire first sample and had to use spring catcher (0935)
13	S 07098	6 11 17	18"		CL	.75	Background
				13.2' Loose gray, fine sand, moist. 13.2.	SM		(0942)
14' 15'	S 07100	2. 2 3	18"	Soft olive-gray clay with a trace of fine gravel, moist.	CL	.50	Background (1030)

NOTES: Background Levels 9-14-87 $\gamma\beta$ = 40 - 140 cpm, α = 0 hmax = 0

Background Levels 9-15-87 $\gamma\beta$ = 40 - 60 cpm α = 0 hmax = 0

Used 40 gallons of H_2O 9-14-87

402-11-86

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		Task 3.2
BORING NUMBER: 324	COORDINATES:		DATE: 9-15 & 9-16-87
ELEVATION:	GWL: Depth 17.2	Date/Time 9-15 @ 1450	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 11.3	Date/Time 9-15/ 1600	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool			PAGE 2 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 6"	RECOVERY (Total)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16'	SS 07101	6 6 9	18"	Soft, olive gray clay with a trace to some sand and gravel, moist	CL	.50	Background Levels (1040)
17'	SS 07102	2 3 12	6"			.50	Background Levels (1350)
18'				18.2' Soft olive gray clay, moist. 18.2'		.50	
19'	SS 07103	20 45 40	18"	Very dense gray fine gravel moist	GP		Background levels (1355)
20'	SS 07104	46 30 27	18"	19.8 Dark yellowish-brown coarse sand 19.8	SW	–	Background
21'				Very dense gray coarse gravel, moist Wet	GP	–	End of Day 9-15-87 (1530)
22'	SS 07105	16 33 47	18"	21.5 21.5 21.8 Very dense gray fine to medium sand moist 21.8	SC	–	Start Day 9-16-87 Sand is actually medium dense (0905)
				22 Hard olive-gray clay, trace of gravel moist. 22	CL	>4.0	
23'	SS 07106	14 16 22	18"	Dense gray unconsolidated gravel, moist. grading downwards to a: 23.5 Hard gray clay, some gravel moist 23.5	GW		Background (1005)
24' 25'	SS 07107	20 50 (3")	12"	Medium dense grayish-brown fine to medium sand with trace of large quartz rock fragments Wet	SP		Background Split spoon jammed with large rock (1420)
26' 27'	SS 07108	8 16 30	18"	Hard, dark gray olive-gray clay with some sand and fine gravel	CL	>4.5	Background (1400)
28	SS 07110	35 52 30	18"	27.5 Very stiff, grayish-brown silty clay 27.5	ML	3.5	Background
				28 Very hard gray clay 28	CL	>4.5	(1500)
29' 30'	SS 07111	46 50 –	12"	Very stiff, gray clay with twig-like fragments ?? and a trace of gravel	CL		Background End Day 9-11-87 (1520)

NOTES: Background levels 9-15-87 $\gamma\beta$ = 40-50 cpm α = 0 μrem = 0

Background Levels 9-16-87 $\gamma\beta$ = 40-50 cpm α = 0 μrem = 0

Water level 9-15-87 @ 1600 was 11.3'

" " 9-16-87 @ 0800 " 9.3'

There appears to be a substantial aquifer at 18' - 21.5'

402-11-86

100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:	DATE: 9-17-87	
ELEVATION:	GWL: Depth 41.2 Date/Time 9-17-87 @ 1730	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30'							Shift Day 9-17-87
31'	S 07112	12 20 24	6"	Stiff olive gray clay with a trace of fine gravel moist	CL	2.0	Background Levels (1045)
32' 33'	S 07113	10 11 16	18"	Very stiff gray clay with trace of gravel, moist			Background Levels-(B.G.) (1050)
34'	S 07114	10 25 37	24"	33.7 Stiff gray clay moist 33.7; 34 Very stiff olive-yellow clay moist 34'; Very dense yellow-brownish sand moist		1.5; 4.0	B.G. (1105)
35' 36'	S 07115	23 33 36	12"	Very dense yellowish-brown Sand moist.	SW	-	B.G. Sand is moist, but not saturated. (1400)
37'	S 07116	50 - -	9"	37' Medium stiff brownish-yellow silt clayey moist 37'	SM	-	B.G. (1530)
38' 39'	S 07117	9 24 42	13"	Very dense yellowish-brown, well sorted, fine grain sand Moist, but basically dry.			B.G. Very friable Sand actually (1555)
40' 41' 42' 43' 44'					SW	-	Begin catching 5' samples. Loose Unconsolidated Sand
45'	S 07118	25 43 45	18"				B.G. Sample 44'-45.5' Fin Day 9-18-87 1715

NOTES: Background Levels for 9-17-87 $\gamma\beta$ = 40-60 cpm, α = 0 hmm = 0

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FERNALD RI/FS

100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:	DATE: 9-18-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87	
DRILLING METHODS: Cable Tool		PAGE 4 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45'	07118	25 43 45	18"	SAND - As Described above	SW		End Day 9-17-87 (1715)
46' 47' 48' 49' 50'				Very dense yellowish-brown well sorted fine grain sand moist.	SW	-	Start Day 9-18-87
51'	S 07119	15 20 21	18"	Dense yellowish-brown, well sorted, damp, but not wet sand			B.G. Loose unconsolidated Sand (1345)
52' 53' 54' 55'							
56'	S 07120	13 27 (4")-50	12"	55.8 Loose grayish-brown coarse sand, moist 55.8; 56.1 Hard gray clay moist. 56.1	CL		B.G. (1415)
57' 58'	S 07121	13 23 43	12"	Very dense gray, salt & pepper looking, medium to coarse grain sand with trace of fine gravel. MOIST	SW		B.G. Sand is actually loose & unconsolidated. (1440)
59' 60'							

NOTES:

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 324	COORDINATES:	DATE: 9-19-87
ELEVATION:	GWL: Depth 51.6 Date/Time 9-19/1030	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 62.6 Date/Time 9-19/1730	DATE COMPLETED: 10-3-87
DRILLING METHODS:		PAGE 5 OF 11

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60'							
61'	S 07122	13 25 28	18"	Very dense, dark gray coarse sand with some fine gravel wet	SW		Background End of 9-18-87 (1515)
62'							~~End~~ Start of 9-19-87
63'							
64'	S 07123	6 3 3	14"	Loose gray, lightly salt & peppered looking fine to coarse grain sand with a trace of gravel WET	SW		Borehole drilled down to 70'. Blow sand came up hole to 63' where this sample was taken. 37. Levels (1545)
65'							
66'	S None	5 2 2	0"	Sand pump indicates very loose, grayish-brown unconsolidated sand, WET	SM ?		Blow Sand coming into hole. Could not obtain a sample even with catcher End Day 9-19-87
67'							Start Day 9-20-87
68'							
69'							
70'							6" Temporary Casing driven to 80' to cut off blow sand.
71'	S 07124	6 14 21	12"	Dense, gray coarse sand with some fine & coarse gravel. WET	SP		Background Levels Only (1000)
72'							
73'							Bailer - Sand Pump bringing up large cobbles i.e. 1 1/2" x 2 1/2" large - Diameter - = 1 1/2"
74'							
75'							

NOTES: Background Levels 9-19-87 $\gamma\beta$ = 40-80 α = 0 mw = 0
" " 9-20-87 $\gamma\beta$ = 40-70 α = 0 mw = 0

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:	DATE: ~~9-19-87~~ & 9-20	
ELEVATION:	GWL: Depth 61.5' Date/Time 9-20/0900	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87	
DRILLING METHODS: Cable Tool		PAGE 6 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Total)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75'							
76'	S 07125	16 31 46	14"	Very dense grayish-brown gravel (Color: 2.5 Y, 5/2) and Coarse Sand See Remarks →	GP		Background levels (B.G.) (1140)
77'							Sand pump collecting large carbonate cobbles & gravel rocks with fossil Inclusions.
78'							
79'							
80'							
81'	S 07126	2 6 16	18"	Medium dense, gray, very coarse grain sand with some fine gravel 80.8 / Medium dense grayish-brown fine gravel with some coarse gravel	SW / GW		Background levels (1350)
82'							Drove 10" Temporary Casing to 90'
83'							Sand Pump bringing up fine to coarse gravel
84'							
85'							
86'	S 07127	20 50 (3"-50)	12"	Very dense, dark gray, sandy gravel with fine to coarse sand. (Color: 2.5 Y, N4/) & large cobbles i.e. 1" x 2" x 1½".	GP		Large rock jammed in Split Spoon. Actually a large gravel. Background levels (1600)
87'							
88'							
89'							
90'							

NOTES: Background levels 9-20-87 : β = 40-75 cpm. α = 0 , h_{max} = 0

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JCMC
100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:		DATE: 9-20 & 9/21/87
ELEVATION:	GWL: Depth 52'	Date/Time 9-20/1400	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 52'	Date/Time 9-21/0730	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool			PAGE 7 OF 11

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (")	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
90'							
91'		2 2 5 3 8 4	0"	Sand Pump collecting fine grain Sand	SW		Lost Sample both times even with Catcher In.
92'							End 9-20-87 Start 9-21-87
93'				93 ± ? ? ?	?		Approximate depth of material change.
94'							
95'				Very Dark Gray fine gravel with coarse sand (10YR 3/1)	GW		
96'	S 07128	18 29 36	24"	95.5 Dense gray fine to coarse gravel (2.5 Y N5) 95.5	GW		Background levels
				96.25 Very dense, grayish-brown silty sand moist. (Color: 2.5 Y, 5/2) 96.25	GM		1350
97'							
98'							Sand pump quit sucking up sand. Sample Taken.
99'							
100'	S 07129	17 ~~13~~ 20	18"	Very Stiff, dark gray clay moist (Color: 5 Y, 4/1)	CL	3.5	Background levels (1500)
101'							
102'				? ? ?	?		
103'							
104'							
105'							

NOTES: Background Levels 9-21-87 $\gamma\beta$ = 40-80 cpm, α = 0, hum = 0

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:	DATE: 9-22-87	
ELEVATION:	GWL: Depth 52' Date/Time 9-21/1700	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 64.5' Date/Time 9-22/1550	DATE COMPLETED: 10-3-87	
DRILLING METHODS: Cable Tool	92' 9-22/1715	PAGE 8 OF 11	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
105'							
106'	S 07130	6 7 14	6"	Medium dense, grayish-brown fine grain, well graded, silty Sand (Color: 2.5 Y, 5/2)	SM		Background levels (162C)
107'							End 9-21-87
108'							
109'							
110'							
111'	S 07131	6 10 11	12"				Background levels (103E)
				111.4' Soft, dark gray silty clay (Color: 5Y, 4/2) 111.4'	CL	~~.98~~ .5	
112'							
113'							Picking up clay on hammer 113'-115'
114'							
115'				Medium Stiff, Olive-Gray Clay (5Y, 4/2) 115.5' 115.5'			
116'	S 07132	9 14 18	18"	Very Stiff, olive gray clay (Color: 5Y, 4/2)	CL	.75 3.5	Background levels (133E)
117'							Casing Driven Down To 120'
118'							
119'							
120'							

NOTES: Background Levels 9-22-87: $\gamma\beta$ = 40-80 cpm, α = 0, hnu = 0

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FERNALD RI/FS

100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS		
BORING NUMBER: 324	COORDINATES:	DATE: 9/22 & 9/23/87	
ELEVATION:	GWL: Depth 64.5' Date/Time 9-22/1550	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 92' Date/Time 9-22/1715	DATE COMPLETED: 10-3-87	
DRILLING METHODS: Cable Tool	75' 9-23/1750	PAGE 9 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
120'							
121'	S 07133	2 3 6	18"	Medium Stiff, gray (5Y, 5/1) to Olive gray (5Y, 5/2) clay with some fine gravel wet	CL		Moderately gravelly Sand. Background levels (1650)
122'							End Day 9-22-87 Start Day 9-23-87
123'				123.5'			
124'							Noticed Sand & Gravel On Sticking On Hammer
125'							
126'	S 07134	27 17 10	6"	Medium Dense, Olive-~~Gray~~-Brown, fine to coarse gravel wet (Color: 2.5Y, 4/4)	GP		Seamed - Background Readings Only (1025)
127'							
128'							
129'							
130'							
131'	S 07135	18 33 19	5"	Very Dense, Olive-Brown Fine Gravel (Color: 2.5Y, 4/4) wet	GW		Background levels. Spoon Plugged with light Olive-brown carbonate rock fragment (2.5Y, 5/4) (1108)
132'							132' Drilling became more difficult Lithology Change
133'							
134'							Drilled Down To 135' & Sand blew In To 124'
135'							Drive 10" Cog to 140'

NOTES: Water Level checked at 1550, 9-22-87 when temporary Casing was at 121'.

Background Levels 9-23-87: $\gamma\beta$ = 40-120 cpm hnu = 0
α = 0

Smelled Some Brackish, Semi-Petroliferous odor observed at 125'
Hole Monitored with LLE & hnu. No Readings Detected.

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 324	COORDINATES:	DATE: 9-24-87 / 9-29-87
ELEVATION:	GWL: Depth 66.4' Date/Time 9-24/1245	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 58.5 Date/Time 9/29/0900	DATE COMPLETED: 10-3-87
DRILLING METHODS: CABLE TOOL		PAGE 10 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (In.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
135'							End Day 9-23-87
136'		#1 #2 11 5 13 7 14 10	0"				Start Day 9-24-87 Attempted twice to obtain sample.
137'							Sand Pump indicates Fine Sand
138'							
139'							Drilled Down to 140', but sand blew in to 135'. Drive Csg to 145'
140'		#1					
141'	S 07136	50-(4") #2 45 (3")-50	12"	Very Dense, very dark grayish-brown sand & fine gravel wet (Color: 2.5 Y, 3/2)	SW		B.G. Felt we hit a rock (1115)
142'							
143'							
144'							Hammer Driving Hard Feels like we were pounding a large rock.
145'							End Day 9/24
146'	S 07137	38 (3") 50	12"	Very Dense, very dark brownish-gray sand with fine gravel, generally as above (Color: 2.5 Y, 3/2) wet	SP		Start Day 9/29 Background - Scanned. (1050)
147'							
148'							
149'							
150'							

NOTES: Water level with Csg at 145' 9-24 @ 1245 = 66.4'
" " " " " " 9-29 @ 58.5' after well sitting 4 days

Background Levels 9/29/87: $\beta\beta$ = 60-120
α = 0
hmr = 0

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FERNALD RI/FS

100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 324	COORDINATES:	DATE: 9-29-87	
ELEVATION:	GWL: Depth 60.7 Date/Time 9-29/1615	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 58.6 Date/Time 9-30/1340	DATE COMPLETED: 10-3-87	
DRILLING METHODS: Cable Tool		PAGE 11 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
150							
151'	S 07138	20 37 (4")50	14"	Medium Dense, Gray Silty Sand grading downwards into: (Color 2.5 Y, N5/)	SM		Scanned - Background levels (1415)
152'				Very Dense, black fine gravel wet (Color: 2.5 Y, N2/)	GW		
153'							
154'							
155'							BOB.
156'	S 07139	7 22 45	18"	Very Dense, Dark gray coarse Sand w/ some fine gravel wet (Color: 5 Y, 4/1)			Scanned - Background levels (1540)
157'				Bottom of Borehole (10") = 155' Bottom of 1st Split Spoon = 156.5'			
158'							
159'							
160'							

NOTES: Blow Sand coming into hole with Csg @ 150'. to a depth of 147'
10" Csg Driven to 155' to obtain 150-151.5' Split Spoon Sample.

Used a total of 500 gallons to Drill Entire Well.

402-11-86

35

FAC
100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 1202	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 184	COORDINATES:		DATE: 11-20-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 11-20-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 11-20-87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ( )	RECOVERY ( )	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				SEE SOIL DESCRIPTIONS FOR WELL 584.			
	SU						
10	S7-0652						
	4.5						
20							
30							
				TD 33.0 FT			
				BOTTOM OF BORING			

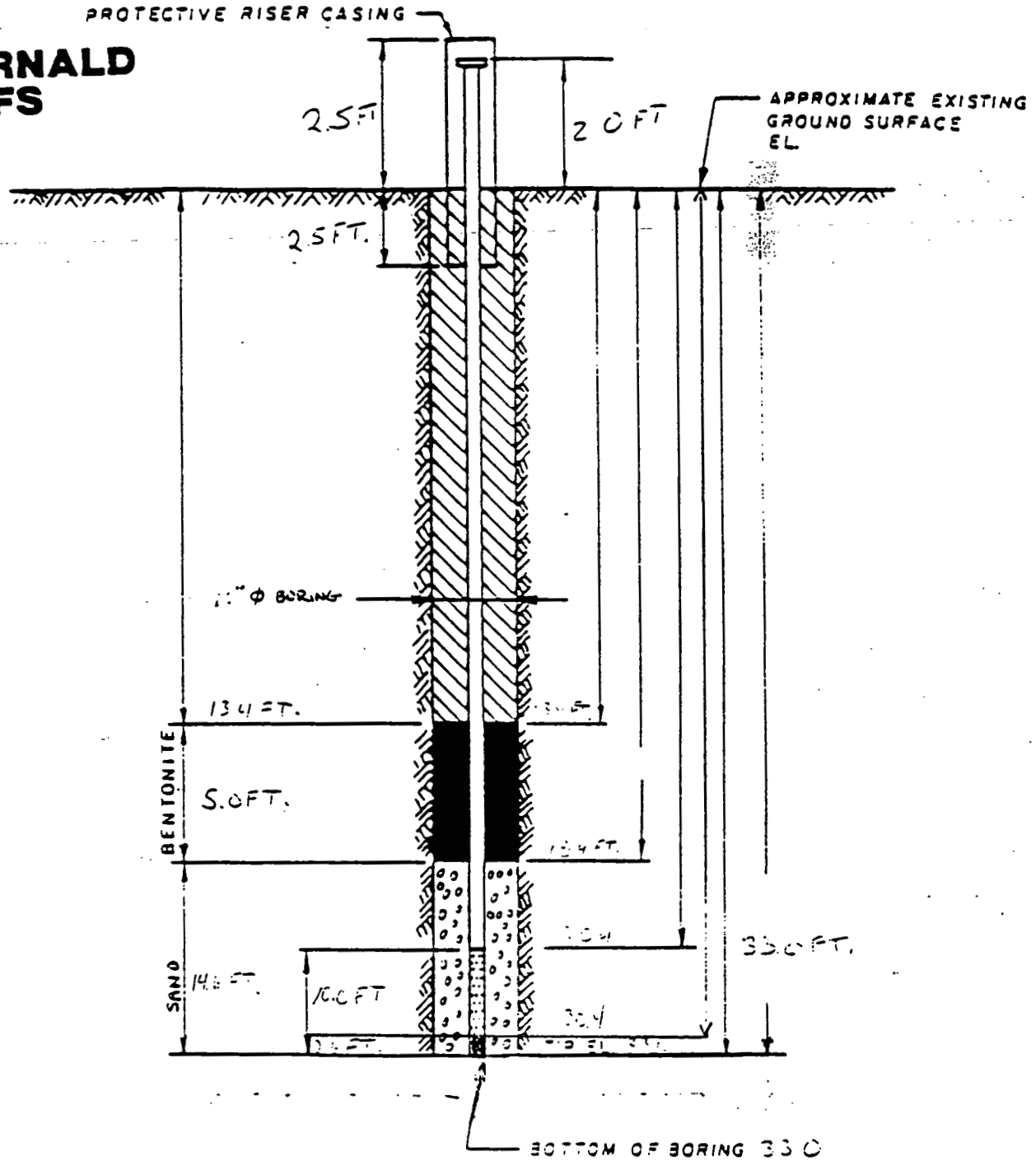
NOTES: CONTRACTOR: PENNWELL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOHN VANDIVIE

WATER ADDED TO HOLE - 1 TO 4-5 GALLONS
~~HH~~ ~~HH~~ ~~HH~~ I

WELL # 184

#100 27

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 184

PREPARED FOR

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

37

PAC
100

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D CARLISLE DATE 11-21-87
PROJECT NO. 602 CHECKED BY DATE
BORING NO. 184
PIEZOMETER NO. NA DATE OF INSTALLATION 11-21-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 4 TO 33 FT.
FLUID — FROM — TO —

TYPE OF BIT FLATHEAD
CASING SIZE (S) USED:
SIZE 10 IN FROM 0 TO 33 FT
SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE MONITORING - RCRA
DIAMETER OF PERFORATED SECTION 4 IN
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 INCH
TOTAL PERFORATED AREA 10 FT.

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8 IN I.D. 4 IN
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE O.D. 10 IN

OTHER PROTECTION LOCKABLE CAP WITH LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.5 FT.	BOTTOM 13.4 FT	TOP	BOTTOM
BENTONITE	TOP 13.4 FT.	BOTTOM 18.4 FT	TOP	BOTTOM
SAND	TOP 18.4 FT	BOTTOM 33.0 FT	TOP	BOTTOM
~~GRAVEL~~	TOP NA	BOTTOM	TOP	BOTTOM
PERFORATED SECTION	TOP 20.4 FT.	BOTTOM 30.4 FT.	TOP	BOTTOM
PIEZOMETER TIP	NA			
BOTTOM OF BOREHOLE	33.0 FT.			
GWL AFTER INSTALLATION	NA			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS

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409-11-86

FA
100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 284	COORDINATES:	DATE: 11-16-87
ELEVATION:	GWL: Depth 63.3 FT Date/Time 11-18-87/17:00	DATE STARTED: 11-16-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 11-18-87
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 1

DEPTH (3 FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ( )	RECOVERY ( )	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				SEE VISUAL CLASSIFICATION of soils FOR WELL # 384.			
15	17.0 FT / ST-0751 / 19.0 FT						
30							
45							
60							WATER LEVEL 63.3 FT.
75				WELL TD 77 FT. BOTTOM OF BORING			

NOTES: CONTRACTOR - PENNDRILL
DRILLER - HARRY DYKES
ASSISTANT - JOHN VANWINKLE
RIG: CYCLONE 42

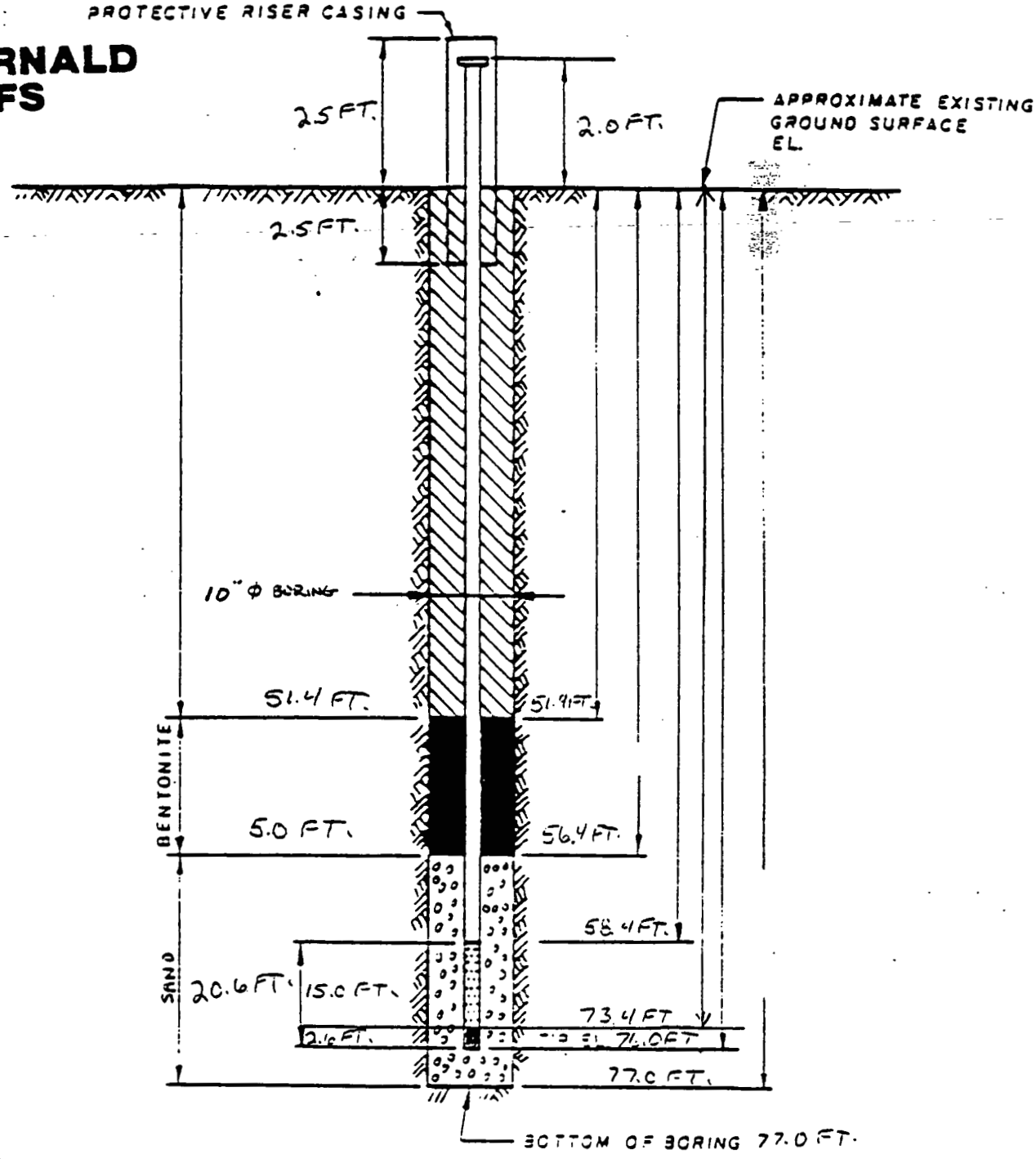
WATER ADDED TO HOLE - 1 TICK = 5 GALLONS
~~HHH HHH~~ HHH HHH HHH HHH ~~HHH HHH~~ ////

SCREEN - 58.4 - 73.4 FT.

402-11-86 39

WELL #284 100

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DATE

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 284

PREPARED FOR

40

PAL
100

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS
FIELD ENG./GEO. D OAKLEY
DATE 11-19-87
PROJECT NO. 602
CHECKED BY
DATE
BORING NO. ~~22~~ 284
PIEZOMETER NO. NA
DATE OF INSTALLATION 11-19-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 4 TO 77 FT.
FLUID NA FROM NA TO NA

TYPE OF BIT FLATHEAD
CASING SIZE (S) USED:
SIZE 10 IN FROM 0 TO 77 FT.
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING
DIAMETER OF PERFORATED SECTION 4 IN
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 INCH
TOTAL PERFORATED AREA 15 FT.

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4 IN
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE.
(FLUSH JOINT THREADS)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE O.D. 10 INCH

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 FT.	BOTTOM 51.4 FT.	TOP	BOTTOM
BENTONITE	TOP 51.4 FT.	BOTTOM 56.4 FT.	TOP	BOTTOM
SAND	TOP 58.4 FT	BOTTOM 77.0 FT	TOP	BOTTOM
NO GRAVEL USED	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 58.4	BOTTOM 73.4	TOP	BOTTOM
PIEZOMETER TIP	76.0 FT			
BOTTOM OF BOREHOLE	77.0 FT			
GWL AFTER INSTALLATION	63.3 FT.			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS

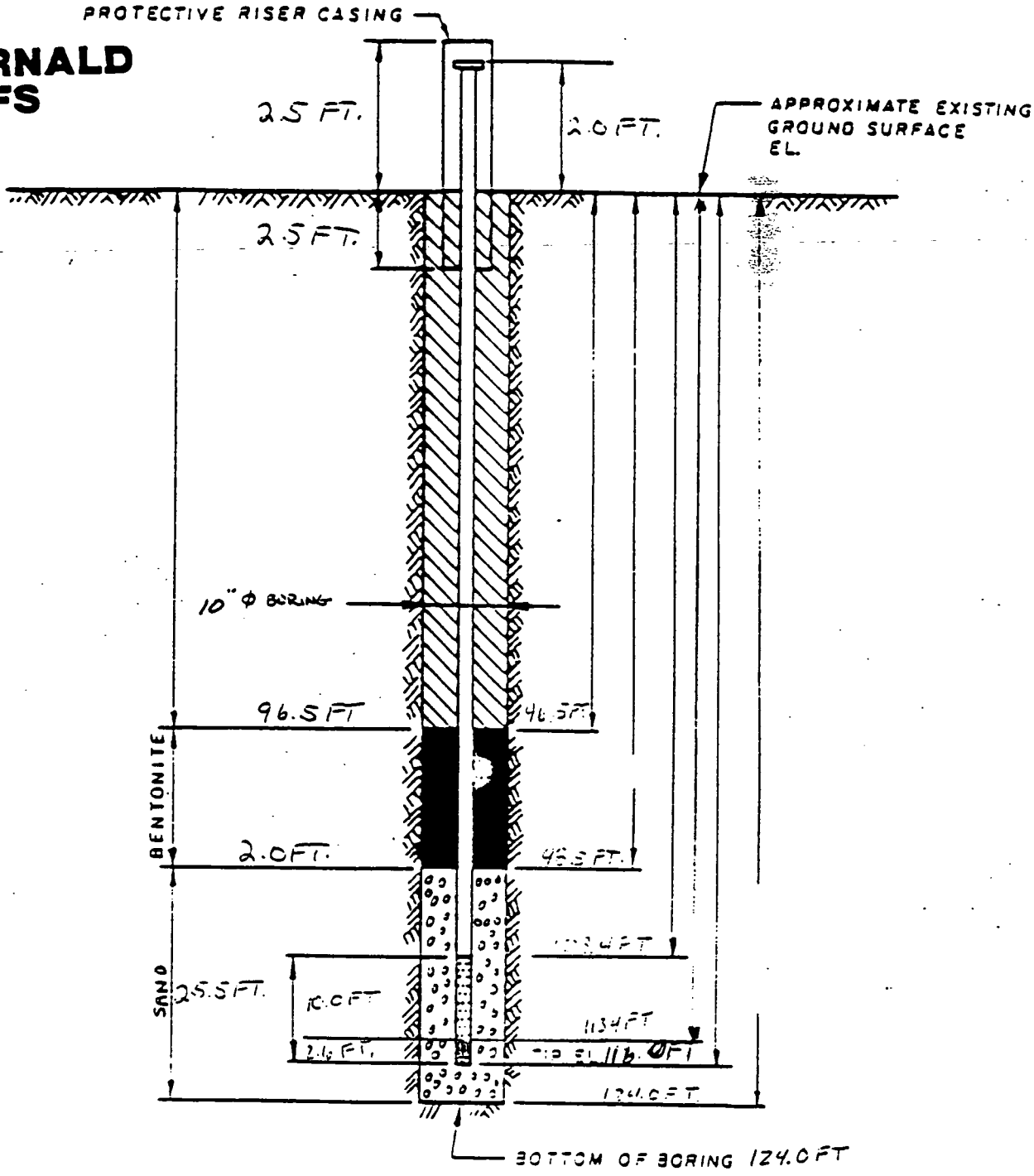
41

409-11-86

WELL # 384

100 #2

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 384

PREPARED FOR

DRAWING NUMBER	
CHECKED BY	
APPROVED BY	
DRAWN BY	DJS

47

100 PAL

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D. CARLSON DATE 11-18-87
PROJECT NO. 6.0.0 CHECKED BY DATE
BORING NO. 384
PIEZOMETER NO. NA DATE OF INSTALLATION 11-14-87, 11-15-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT FLATHEAD
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID WATER FROM 2 FT. TO 124 FT.	SIZE 10" FROM 0 FT. TO 124 FT.
FLUID — FROM — TO —	SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE MONITORING	RISER PIPE MATERIAL 316 STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4 IN.	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8" IN I.D. 4 IN
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 FT.
AVERAGE SIZE OF PERFORATIONS .010 INCH	JOINING METHOD THREAD AND
TOTAL PERFORATED AREA 10 FT.	COUPLE

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.	OTHER PROTECTION LOCKABLE CAP.
PROTECTIVE PIPE O.D. 10 IN	WITH LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 FT	BOTTOM 96.5 FT	TOP	BOTTOM
BENTONITE	TOP 96.5 FT.	BOTTOM 98.5 FT.	TOP	BOTTOM
SAND	TOP 98.5 FT.	BOTTOM 124.0 FT	TOP	BOTTOM
~~GRAVEL~~	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 103.4 FT.	BOTTOM 113.4 FT.	TOP	BOTTOM
PIEZOMETER TIP	116.			
BOTTOM OF BOREHOLE	124.0 FT.			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑
REMARKS

43

409-11-86

101.16 100 PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 384	COORDINATES:	DATE: 11-3-87	
ELEVATION: -	GWL: Depth Date/Time	DATE STARTED: 11-23-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87	
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 9	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6/N)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07512 8:00 07534 07535	3 12 12	12	VERY STIFF DARK BROWN (10YR, 3/3) SILT, TRACE CLAY, SAND AND GRAVEL - DRY	ML	2.0	HNU - 0PPM γ - 0CPM Bq - 1000 CPM
2 3	07513 8:10	9 10 12	15	VERY STIFF YELLOWISH BROWN (10YR, 5/4) SILT, SOME CLAY, TRACE SAND AND GRAVEL - DRY	ML	4.0	HNU - 0PPM γ - 0CPM Bq - 60CPM
4	07514 8:25	15 17 21	15	VERY STIFF GRAYISH BROWN (10YR, 5/2) 3.6 SILT, SOME CLAY TRACE SAND - DRY	ML	4.0	HNU - 0PPM γ - 0CPM Bq - 60 CPM
				HARD DARK BROWN (10YR, 4/3) CLAY, SOME SILT, TRACE SAND - DRY	CL	3.5	
5 6	07515 8:40	22 26 19	16	HARD DARK BROWN (10YR, 3/3) CLAY, 5.0 SOME SILT, TRACE SAND - DRY	CL	3.5	HNU - 0PPM γ - 0CPM Bq - 60 CPM
				HARD YELLOWISH BROWN (10YR, 5/4) CLAY, 6.0 SOME SILT, TRACE SAND - DRY	CL	3.5	
				STIFF GRAYISH BROWN (10YR 5/2) CLAY, 6.4 SOME SILT, TRACE SAND - MOIST.	CH	1.0	
7	07516 15:55	3 4 8	18	STIFF YELLOWISH BROWN (10YR, 5/6) CLAY, SOME SILT, TRACE SAND - DRY	CL	2.0	HNU - 0PPM γ - 0CPM Bq - 60 CPM
8 9	07517 16:10	2 2 6	15	MEDIUM STIFF BROWN (10YR, 5/3) CLAY, TRACE SAND AND SILT - MOIST.	CH	1.0	HNU - 0 PPM γ - 0 CPM Bq - 60 CPM
10	07518 7:50	3 4 7	13	STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME GRAVEL, TRACE ~~AND~~ SAND AND SILT - MOIST	CH	1.25	HNU - 0 PPM γ - 0 CPM Bq - 50 CPM
11 12	07519 8:05	6 8 12	16	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST.	CL	2.5	HNU - 0PPM γ - 0CPM Bq 60 CPM
13	07520 8:20	3 11 15	17	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SAND, TRACE GRAVEL AND SILT - DRY	CL	2.75	HNU - 0PPM γ - 0CPM Bq 50CPM
14 15	07521 8:35	4 11 15	18	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4 CLAY, SOME SAND, TRACE 14.6 FINE GRAVEL AND SILT - MOIST	CL	2.75	HNU - 0PPM γ - 0CPM Bq - 50 CPM
				VERY STIFF GRAY (5YR, 5/1) CLAY, SOME SAND, TRACE GRAVEL AND SILT - MOIST	CL	3.25	

NOTES: CONTRACTOR: PENMODULL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOHN VANDINE
WATER ADDED TO HOLE - 1 TICK = 5 GALLONS

ASTM STANDARD PENETRATION TEST USED FOR SPLIT SPOON SAMPLING
COLORS CHARACTERIZED USING MUNSELL COLOR CHARTS.

BACKGROUND
HNU - 0PPM
γ - 0CPM
LEL - 0 %
Bq - 300 CPM - GROUND

44

100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD	
BORING NUMBER: 384	COORDINATES:	DATE: 11-4-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D. DAHLE	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 9

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	07522 8:55	3 8 12	18	VERY STIFF GRAY (5Y, 5/1) CLAY, SOME SAND AND GRAVEL AND SILT - MOIST	CL	3.25	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
17 18	07523 10:00	3 6 9	12	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE GRAVEL AND SILT - MOIST.	CL	1.25	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
19	07524 10:20	3 4 9	8	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE GRAVEL AND SILT, MOIST.	CH	.75	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
20 21	07525 10:35	5 6 11	13	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE GRAVEL AND SILT - MOIST	CH	1.25	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
22	07526 10:50	5 6 12	15	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE FINE GRAVEL AND SILT - MOIST	CH	1.0	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
23 24	07527 11:10	2 6 7	13	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND AND GRAVEL, TRACE SILT, MOIST	CH	.75	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
25	07528 11:40	1 3 7	10	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME FINE GRAVEL, TRACE SAND AND SILT - WET	CH	.95	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
26 27	07529 15:20	4 5 7	12	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT, MOIST	CH	.95	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
28	07530 15:50	2 4 7	12	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST	CH	0.5	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
29 30	07531 16:10	6 6 7	6	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST	CH	1.0	HNU - 0 PPM Bα - 70 CPM γ - 0 CPM

NOTES:

BACKGROUND IN LEAD SHIELD - 40-70 CPM.

402-11-86

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 384	COORDINATES:	DATE: 11-4-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87	
ENGINEER/GEOLOGIST: D. OAKLEY/W. REGLEY	Depth Date/Time	DATE COMPLETED: 11-12-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 9	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (ft)	RECOVERY (ft)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	07538 1630	4 10 21	13	HARD OLIVE GRAY (5Y 5/2) CLAY, SOME GRAVEL AND SAND TRACE ~~OF~~ SILT, MOIST	CL	3.25	HNU - 0 PPM BZ - 70 CPM γ - 0 CPM
32	07539 1645	22 24 24	15	HARD OLIVE GRAY (5Y 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - DRY	CL	4.5	HNU - 0 (PPM) BZ - 50 CPM γ - 0 CPM END 11 4 87
33							
34	07536 0840	7 16 22	14	VERY STIFF OLIVE GRAY (5Y 5/2) CLAY SOME GRAVEL AND SILT - DRY	CL	2.5	BEGIN 11 5 87 HNU = 0 ppm BZ = 60 CPM γ = 0 CPM
35	07537 945	16 18 22	16	HARD GREY (5Y 5/1) CLAY ~~GRAVEL~~ SOME GRAVEL TRACE SAND	CL	4.5	HNU = 0 ppm BZ = 60 CPM γ = 0 CPM
36							
37	07538 1040	8 11 19	12	VERY STIFF GREY (5Y 5/1) CLAY SOME GRAVEL AND SAND TRACE OF SILT - MOIST	CL	2.5	HNU - 0 ppm BZ = 60 CPM γ 0 CPM
38	07539 1126	6 12 16	12	38.0 ~~LOOSE~~ MEDIUM DENSE ~~CLAY~~ ~~SAND~~ ~~AND~~ ~~SILT~~ SILT AND SAND REDDISH BROWN (7.5 YR 6/5) - MOIST	SM	1.0	HNU 0 ppm BZ 60 CPM γ 0 CPM
39							
40							
41	07540 07541 07542 1330	11 22 26	14	DENSE YELLOWISH BROWN (10YR 5/4) FINE SAND TRACE SILT - MOIST	SP ~~SM~~		HNU = 0 ppm BZ = 0 ppm γ = 0 CPM
42							
43							
44							
45							

NOTES:

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 - 3.2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~244~~ 394	COORDINATES:	DATE: 11 5 87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11 3 87
ENGINEER/GEOLOGIST: U KEGLEY/DCH	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6/6")	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	07543 1600	12 23 30	13	VERY DENSE DARK YELLOWISH BROWN (10YR 4/4) SAND TRACE OF GRAVEL - DRY	SP	—	HNU = 0ppm BZ = 60cpm γ = 0cpm
47							
48							
49							
50	07544 1440	16 36 37	12	VERY DENSE DARK YELLOWISH BROWN (10YR 4/3) SAND TRACE OF GRAVEL - DRY	SP	—	HNU 0ppm BZ 60-50cpm γ = 0cpm
51				VERY DENSE YELLOWISH BROWN 10YR 5/4 FINE SAND MOIST			
52							
53							
54							
55							7:15 11-6-87 TD CABLE
56	07545 0:30	17 27 50	16	VERY DENSE DARK YELLOWISH BROWN (10YR 4/3) FINE SAND - TRACE GRAVEL - MOIST	SP	—	HNU 0ppm BZ - 50 CPM γ - 0CPM
57							
58							
59							

NOTES:

FERNALD RI/FS

100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 384	COORDINATES:	DATE: 11-6-87	
ELEVATION:	GWL: Depth 62.75 Date/Time 11-10-87 8:00	DATE STARTED: 11-3-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87	
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 9	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	07546 9:00	10 21 30	16	VERY DENSE DARK YELLOWISH BROWN (10YR 4/4) SAND AND GRAVEL - MOIST 60.8	SW	—	HNU - 0 PPM γ - 0 CPM Bα - 60 CPM
				VERY DENSE DARK GRAY (10YR 4/1) FINE SAND, TRACE GRAVEL - DRY	SP	—	
62							
63							GWL 62.75 ✓
64							
65	07547 9:55	14 22 35	18	VERY DENSE DARK GRAY (10YR 4/1) FINE SAND, TRACE FINE GRAVEL - WET.	SP	—	HNU - 0 PPM γ - 0 CPM Bα - 70 CPM
66							
67							
68							
69							
70	07548 10:40	6 16 28	18	DENSE DARK GRAY (10YR 4/1) FINE SAND, TRACE FINE GRAVEL - WET. 70.6	SP	—	HNU - 0 PPM γ - 0 CPM Bα - 60 CPM
71				DENSE DARK YELLOWISH BROWN (10YR 4/4) FINE SAND, TRACE GRAVEL - WET	SP	—	11-10-87 7:50
72							
73							
74							
75							

NOTES:

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 384	COORDINATES:	DATE: 11-10-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D.OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 6 OF 9

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	07549 13:20	6 11 15	12	MEDIUM DENSE GRAYISH BROWN (10YR 5/2) VERY FINE SAND-WET	SP	—	HNU-0PPM γ-0CPM Bα-60CPM
				MEDIUM DENSE GRAY (5Y 4/1) SAND SOME FINE GRAVEL-WET.	SW	—	
77							
78							
79							
80							
81	07550 15:40	8 5 7	6	MEDIUM DENSE GRAYISH BROWN (10YR 5/2) SAND, SOME FINE GRAVEL-WET.	SW	—	HNU-0PPM γ-0CPM Bα-60CPM
82							
83							
84							
85							
86	07551 8:30	18 30 45	12	VERY DENSE GRAYISH BROWN (10YR 5/2) GRAVELLY SAND-WET	SW	—	HNU-0PPM γ-0CPM Bα-60CPM
87							
88							
89							
90							

NOTES:

402-11-86

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FERNALD RI/FS

PAC 100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 384	COORDINATES:	DATE: 11-11-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D O ARLEY	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 7 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	07552 10:15	6 8 10	13	MEDIUM DENSE GRAYISH BROWN (10YR, 5/2) SAND, SOME FINE GRAVEL - WET 90.8	SW	—	HNU - 0 PPM γ - 0 CPM β α - 70 CPM
				MEDIUM DENSE YELLOWISH BROWN (10YR, 5/6) FINE SAND - WET	SP	—	
92							
93							
94							
95							
96	07553 13:45	25 39 42	16	VERY DENSE GRAYISH BROWN (2.5Y, 5/2) MEDIUM SAND, TRACE FINE GRAVEL - WET. 95.9	SP	—	HNU - 0 PPM γ - 0 CPM β α - 60 CPM
				VERY DENSE DARK BROWN (10YR 4/3) MEDIUM SAND, TRACE FINE GRAVEL - WET 97.0	SP	—	DRILLERS ESTIMATE
97							
98							
99							
100							
101	07554 16:25	11 7 7	8	MEDIUM DENSE GRAYISH BROWN (2.5Y, 5/2) SAND AND GRAVEL - WET.	SW	—	HNU - 0 PPM γ - 0 CPM β α - 60 CPM
102							
103							
104							
105							

NOTES:

PAL
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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 384	COORDINATES:	DATE: 11-11-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87	
ENGINEER/GEOLOGIST: D OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87	
DRILLING METHODS: CABLE TOOL		PAGE 8 OF 9	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106	02555 16:55	17 31 42	18	VERY DENSE GRAYISH BROWN (2.5Y, 5/2) SAND AND FINE GRAVEL - WET. 105.8	SW	–	HNU - 0 PPM γ - 0 CPM Bα - 60 CPM
				VERY DENSE DARK GRAYISH BROWN (2.5Y, 4/2) VERY FINE SAND - WET	SP	–	
107							
108							
109							
110	02556 9:40	3 5 8	14	MEDIUM DENSE DARK GRAYISH BROWN (2.5Y, 4/2) VERY FINE SAND - WET	SP	–	HNU - 0 PPM γ - 0 CPM Sα - 40 CPM
111							
112							
113							
114							
115	02557 10:45	3 7 16	18	MEDIUM DENSE DARK GRAYISH BROWN (2.5Y, 4/2) VERY FINE SAND - WET	SP	–	HNU - 0 PPM γ - 0 CPM Bα - 40 CPM
116							
117							
118							
119				119.0 "BLUE CLAY"			DRILLERS CONTACT.
120					CL	–	

NOTES:

402-11-86

FERNALD RI/FS

PAC 100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 384	COORDINATES:	DATE: 11-12-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11.3.87
ENGINEER/GEOLOGIST: D OAKLEY	Depth Date/Time	DATE COMPLETED: 11.12.87
DRILLING METHODS: CABLE TOOL		PAGE 9 OF 9

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121	07558 13.45	9 16 25	15	HARD OLIVE GRAY (5Y, 4/2) CLAY, TRACE SILT - MOIST	CL	2.5	HNU - 0 PPM 8 - 0 CPM 3d - 50 CPM *
122							* MUNSELL COLOR NOT ACCURATE. MORE OF A SILVER-BLUE COLOR - NOT FOUND IN CHIPS
123	51 07559	NA	24				
124				WELL TO 124.0 FT.			

NOTES:

58

402-11-86

FERNALD RI/FS

100

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 216	COORDINATES:		DATE: 8/25/87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 8/25/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 8/31/87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 5

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1.5	7000	6 6 5	13"	STIFF BROWN SILT, TRACE FINE SAND.	ML		SAMPLE SCANNED - BACKGROUND READINGS
3.0	7001	6 6 6	14"	STIFF BROWN SILTY CLAY, TRACE FINE SAND.	CL		SAMPLE SCANNED - BACKGROUND READINGS
4.5	7002	1 2 3	14"	MEDIUM STIFF REDDISH YELLOW CLAY - TRACE SILT	CL		SAMPLE SCANNED - BACKGROUND READINGS
				MEDIUM STIFF LIGHT GRAY CLAY TRACE SAND AND SILT	CL		
6.0	7003	1 2 3	17"	MEDIUM STIFF LIGHT GRAY CLAY, TRACE SAND AND SILT.	CL		SAMPLE SCANNED - BACKGROUND READINGS
7.5	7004	1 1 2	14"	SOFT LIGHT YELLOWISH BROWN CLAY	CL		SAMPLE SCANNED - BACKGROUND READINGS 745 8-26-87
				SOFT LIGHT GRAY SILT, TRACE FINE SAND AND CLAY	ML		
9.0	7005	1 3 2	14"	LIGHT YELLOWISH BROWN SILT, SOME CLAY.	ML		SAMPLE SCANNED - BACKGROUND READINGS
				SOFT LIGHT GRAY CLAY, TRACE SILT.	CL		
				MEDIUM STIFF YELLOWISH BROWN CLAY, SOME SILT, TRACE SAND.	CL		
10.5	7006	6 7 10	13"	MEDIUM DENSE YELLOWISH BROWN ~~COARSE~~ SAND, TRACE GRAVEL AND SILT.	SP		SAMPLES SCANNED - BACKGROUND READINGS
12.0	7007	6 7 11	8"				SAMPLE SCANNED - BACKGROUND READINGS
				VERY STIFF YELLOWISH RED SILT, SOME SAND TRACE CLAY	ML		
				REDDISH BROWN ~~COARSE~~ SAND, ~~MEDIUM~~ DENSE TRACE ~~MEDIUM~~ GRAVEL ~~AND~~ SILT	SP		
13.5	7008	4 16 17	17"	~~SANDY~~ HARD ~~SO~~ GRAY SANDY SILT, TRACE GRAVEL	ML		PANCAKE - 100 - 120 COUNTS PER MINUTE. OTHER METER READINGS AT BACKGROUND.
				LENS REDDISH BROWN MEDIUM SAND, TRACE GRAVEL AND SILT.	SP		
15.0	7009	2 5 6	9"	STIFF GRAY SILT, TRACE CLAY	ML		SAMPLE SCANNED - BACKGROUND READINGS
				STIFF DARK GRAY MEDIUM SAND SOME SILT, TR. GRAVEL	SM		

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
RIG - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" O.D.

53

402-11-86

100
PA

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 26b	COORDINATES:		DATE: 8-26-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL			PAGE 2 OF 5

DEPTH (6")	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16.5	7010	3 6 7	9"	STIFF GRAY CLAY, SOME SILT, TRACE SAND AND GRAVEL.	CL		SAMPLE SCANNED - BACKGROUND READINGS.
18.0	7011	5 7 8	13"				SAMPLE SCANNED - BACKGROUND READINGS
19.5	7012	4 5 9	9"	STIFF GRAY SILT, SOME CLAY, TRACE GRAVEL	ML		SAMPLE SCANNED BACKGROUND READINGS
21.0	7013 7014	11 13 22	15"	HARD GRAY & CLAY AND SILT, TRACE GRAVEL.	CL		SAMPLE SCANNED BACKGROUND READINGS
22.5	7015	8 12 20	13"	HARD GRAY SILTY CLAY, TRACE GRAVEL AND SAND.	CL		SAMPLE SCANNED, BACKGROUND READINGS
24.0	7016 7017	20 15 25	12"				8-27-87 8:00 SAMPLE SCANNED- BACKGROUND READINGS
25.5	7018	9 19 26	13"				SAMPLE SCANNED - BACKGROUND READINGS
27.0	7019	5 26 REF. 50	10"				SAMPLE SCANNED- BACKGROUND READINGS
28.5	7020 7021	7 10 50	16"				SAMPLE SCANNED- BACKGROUND READINGS
30.0	7022 7023	17 27 40	14"				SAMPLE SCANNED- BACKGROUND READINGS

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
RIG - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" OD

54

402-11-86

100
PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 266	COORDINATES:	DATE: 8-27-87
ELEVATION:	GWL: Depth 19.5' Date/Time 8-28-87 8:00	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 5

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31.5	7024	13 17 37	13	HARD GRAY CLAY, SOME SILT AND GRAVEL, TRACE ~~ee~~ SAND.	CL		SAMPLE SCANNED - BACKGROUND READINGS.
				HARD GRAY SILTY CLAY, TRACE GRAVEL AND SAND.	CL		
33.0	7025	5 7 10	10	VERY STIFF GRAY SILTY CLAY, TRACE SAND AND GRAVEL.	CL		SAMPLE SCANNED - BACKGROUND READINGS
34.5	7026	13 16 40	16	VERY DENSE STRONG BROWN SAND, TRACE GRAVEL AND SILT.	SP		SAMPLE SCANNED - BACKGROUND READINGS,
36.6	7027	14 51 REF 20	12	VERY DENSE STRONG BROWN SAND, TRACE GRAVEL.	SP		8-28-87 8:00 SAMPLE SCANNED - BACKGROUND READINGS
40.0							
41.5	7028	30 50 REF	9"	VERY DENSE STRONG BROWN SANDY GRAVEL, TRACE CLAY.	GP		SAMPLE SCANNED, BACKGROUND READINGS
45.0				HARD GRAY SILT, TRACE CLAY AND SAND.	ML		

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
R/G - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" O.D.

55

402-11-86

100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 266	COORDINATES:	DATE: 8-31-87
ELEVATION:	GWL: Depth 39.45 Date/Time 8:10 8-31-87	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time 13:00 8-31-87	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 5

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46.5	7029	18 25 17	17	HARD GRAY SILT, TRACE CLAY AND SAND, LENS GRAY CLAY.	ML		8-31-87 8:10 SAMPLES SCANNED - BACKGROUND READINGS.
50.0							ADDED ~15 GAL. OF WATER TO HOLE.
51.5	7030	4 20 18	16	HARD GRAY CLAY, TRACE SILT	CL		SAMPLE SCANNED - BACKGROUND READINGS IN WATER 2.
				HARD GRAY SILT, SOME SAND, TRACE CLAY.	ML		
55.0							
56.5	7031 7032		18"	VERY STIFF GRAY SILT. SOME SAND TRACE CLAY.	ML		SAMPLE SCANNED - BACKGROUND READINGS.
				VERY STIFF GRAY CLAY SOME SAND, TRACE SILT.	CH		
				MEDIUM DENSE ~~SOME~~ GRAY ~~SAND~~, TRACE CLAY, SOME SILT.	SM		WET SAND
60.0							

NOTES:

DRILLER - HARRY DYKES

ASSISTANT - TIM HARRIS

RIG - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" O.D.

50

402-11-86

100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 266	COORDINATES:	DATE: 8-31-87	
ELEVATION:	GWL: Depth 52.5 Date/Time 8/31/87 14:25	DATE STARTED: 8-25-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth 51.65 Date/Time 8/31/87 14:45	DATE COMPLETED: 8-31-87	
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 5	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	7033	6	18	MEDIUM DENSE GRAY SAND, SOME SILT, TRACE CLAY			
	7034	6					
61.5		10		VERY STIFF GRAY CLAY, TRACE SAND AND SILT.			
62.0							
63.0				63.0' TD			NEW TD 9-9-87

NOTES:

DRILLER- HARRY DYKES
ASSISTANT - TIM HARRIS
RIG - CYCLONE 42

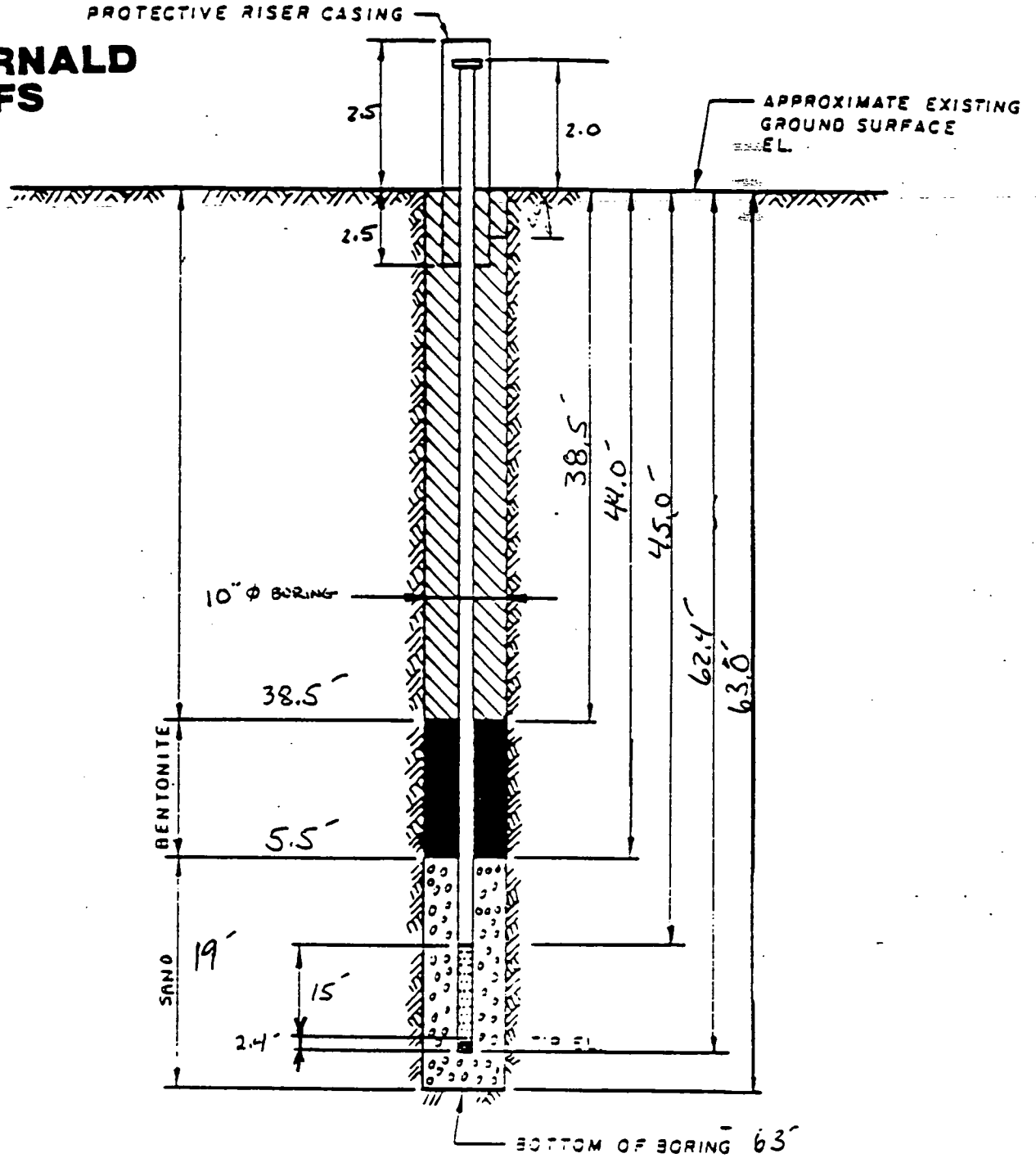
SPLIT SPOON SAMPLES TAKEN WITH STANDARD TUBE - 2.0" OD

57

402-11-86

WELL #266

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 266

PREPARED FOR

FMPC RI/FS

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

100

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D. OAKLEY DATE 9-23-87
PROJECT NO. 607 CHECKED BY _____ DATE _____
BORING NO. 266
PIEZOMETER NO. 266 DATE OF INSTALLATION 8-31-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 5 TO 62'
FLUID ~~NA~~ FROM NA TO NA

TYPE OF BIT FLAT HEAD HAMMER
CASING SIZE (S) USED: TEMPORARY
SIZE 12" FROM 0 TO 60'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE STAINLESS STEEL (316)
DIAMETER OF PERFORATED SECTION 4" ID
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .01 INCH
TOTAL PERFORATED AREA 15'

RISER PIPE MATERIAL STAINLESS STEEL (316)
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE (FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE O.D. 10 INCHES

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY (NOCLAY)	TOP 2'	BOTTOM 38.5'	TOP	BOTTOM
BENTONITE PELLETS	TOP 38.5	BOTTOM 44.0'	TOP	BOTTOM
SAND	TOP 44.0	BOTTOM 63'	TOP	BOTTOM
NO ~~GRAVEL~~ USED	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 45'	BOTTOM 60'	TOP	BOTTOM
PIEZOMETER TIP	62.4' (SILT TRAP)			
BOTTOM OF BOREHOLE	63'			
GWL AFTER INSTALLATION	39'			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS WELL TO BE DEVELOPED LATER

59

409-11-86

100 PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 366	COORDINATES:		DATE: 9-16-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 7

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
65				FOR DESCRIPTION OF SOILS FROM 0 – 62.0 ft SEE VISUAL CLASSIFICATION OF SOILS FROM WELL 266.			
63.5	ST 7041	NA	24	62.0			SHELBY TUBE.
65							
66.5	7035 7036	6 ~~[illegible]~~ 23 ~~[illegible]~~ 50	14	HARD, GRAY SILT, SOME CLAY, - MOIST	ML		SAMPLE SCANNED – BACKGROUND READINGS.
70				68.5			ADDED 20 GALLONS WATER.
71.5	7037 7038	15 25 40	15	HARD GRAY SILTY CLAY - DRY	CL	2.25 TONS/FT²	SAMPLE SCANNED – BACKGROUND READINGS

NOTES: SEE LOG FROM WELL # 266 FOR DESCRIPTION OF FIRST 62'.

RIG - CYCLONE #2

DRILLER - HARRY LYTOS

ASSISTANT - TIM HARRIS

BACKGROUND READINGS

HNU - ZERO

ALPHA - 0 COUNTS/MIN.

BETA/GAMMA - 40-80 COUNTS/MIN.

60

402-11-86

100
PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 3606	COORDINATES:	DATE: 9-16-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 7

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76.5	7039 7040	8 15 19	16	HARD GRAY SILTY CLAY - MOIST	CL	1.5	SAMPLE SCANNED - BACKGROUND READINGS.
80				79.5			ADDED 25 GALLONS WATER.
81.5	7042 7043	11 22 31	18	HARD GRAY CLAY, TRACE SILT, - DRY	CL	3.0	SAMPLE SCANNED - BACKGROUND READINGS.
85				84.0			
87.5							
89	7044 7045	6 15 14	18	MEDIUM DENSE GRAY FINE SAND - WET 88.5	SP	.20	SAMPLE SCANNED - BACKGROUND READINGS.
				GRAY CLAY, SOME SAND, TRACE SILT 89.3	CL		

NOTES: SEE LOG FROM WELL #2606 FOR DESCRIPTION OF FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY CYRUS
ASSISTANT - TIM HARRIS

BACKGROUND READINGS

HIPIJ - ZERO
ALPHA - 0 COUNT/MIN.
BETA/GAMMA - 40-80 COUNT/MIN

61

402-11-86

100 PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6052	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 3166	COORDINATES:	DATE: 9-17-87	
ELEVATION:	GWL: Depth / Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth / Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 7	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS 7:30 9-17-87
91.5	7046 7047	7 9 11	18	MEDIUM DENSE DARK GRAY FINE GRAINED SAND, TRACE CLAY AND SILT - WET. 91.4	SP	.20	SAMPLE SCANNED - BACKGROUND READINGS.
				GRAY CLAY, TRACE SAND AND SILT 92	CL		ADDED 25 GALLONS WATER.
95				DARK GRAY FINE GRAINE SAND. 94.5	SP		
96.5	7048	30 50REF	8	~~DEN~~ HARD GRAY CLAY, SOME SILT, TRACE SAND - DRY	CL	2.5	SAMPLE SCANNED - BACKGROUND READINGS.
100				99			ADDED 20 GALLONS WATER.
101.5	7049	9 14 25	13	HARD GRAY SILT, SOME CLAY, TRACE SAND - DRY	ML	.75	SAMPLE SCANNED - BACKGROUND READINGS
							ADDED 20 GALLONS WATER.

NOTES: SEE LOG FROM WELL A366 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYMES
ASSISTANT - TIM HARRIS

BACKGROUND READINGS

HNU - @ ZERO
ALPHA - 0 COUNTS/MIN
BETA/GAMMA - 40-80 COUNTS/MIN.

62

402-11-86

100
DA

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 366	COORDINATES:		DATE: 9-17-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL			PAGE 4 OF 7

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106.5	7050 7051	27 50 REF. 50	16	HARD GRAY SILTY CLAY, TRACE SAND - DRY	CL	3	SAMPLE SCANNED - BACKGROUND READINGS
110							ADDED 25 GALLONS WATER.
111.5	7052 7053	11 24 43	18	HARD DRY SILTY CLAY	CL	2.5	SAMPLE SCANNED - BACKGROUND READINGS
113.5	ST 7054	NA	23				SHELBY TUBE
115							ADDED 20 GALLONS WATER.
116.5	7055	11 16 23	12	HARD GRAY SILTY CLAY - DRY	CL	2.5	SAMPLE SCANNED - BACKGROUND READINGS
							7:30 9-18-87

NOTES: SEE LOG FROM WELL #266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY SYKES
ASSISTANT - TIM HARRIS

BACKGROUND READINGS
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

63

402-11-86

100
PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 366	COORDINATES:	DATE: 9-12-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 7	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121.5	7056 7057	12 1 0 2 0	18	HARD GRAY CLAY, TRACE SILT - MOIST	CL	2.0	SAMPLE SCANNED - BACKGROUND READINGS
				DENSE GRAY SAND, SOME CLAY - MOIST	SP	1.0	
				DENSE DARK GRAY SAND, SOME CLAY, TRACE GRAVEL - MOIST	SW	0.5	
125							
126.5	7058 7059	16 25 50	18	VERY DENSE GRAY SAND, TRACE GRAVEL, TRACE CLAY - WET, MEDIUM GRAIN SIZE.	SW	0.2	SAMPLE SCANNED - BACKGROUND READINGS
130							WELL MAKING LARGE AMOUNTS OF WATER - 55' WATER IN CASING.
131.5	7060 7061	17 38 46	18	VERY DENSE GRAY COARSE SAND, SOME GRAVEL - WET	SW	0.3	SAMPLE SCANNED - BACKGROUND READINGS
							ADDED 25 GALLONS WATER.

NOTES: SEE LOG FROM WELL # 266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
SCREEN SET FROM 125-135'.

BACKGROUND
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

402-11-86

100
PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 366	COORDINATES:	DATE: 9-18-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. CAHLEY	Depth Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 6 OF 7	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136.5	7062	11 17 31	8	VERY DENSE GRAY SAND-WET MEDIUM GRAIN SIZE	SP	0.2	FIRST SPLIT SPOON EMPTY - PUT IN TRAP. SAMPLE SCANNED - BACKGROUND READINGS.
140				139			
141.5	7063 7064	9 18 19	18	HARD ~~GRAY~~ DARK GRAY SANDY CLAY, TRACE SILT - MOIST	CL	1.0	SAMPLE SCANNED - BACKGROUND READINGS
145							
146.5	—	17 50 50	0				~~AS~~ TWO ATTEMPTED SPLIT SPOONS WERE EMPTY.
149							
149.5	7065 7066	21 31 35	15	GRAY SANDY CLAY - MOIST 149.5 HARD, GRAY CLAY, SOME SILT - MOIST	CL	.75	SAMPLE SCANNED - BACKGROUND READINGS

NOTES: SEE LOG FROM WELL #266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS

BACKGROUND
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

65

402-11-86

100

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 366	COORDINATES:	DATE: 9-19-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 7 OF 7	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
150							
152	ST-7067	NA	20	HARD, GRAY SILTY CLAY, MOIST. SAMPLE TD 152 ft.			SHELBY TUBE DESCRIPTION based on previous sample and classification of soils observed at ends of tube

NOTES: SEE LOG FROM WELL # 266 FOR FIRST 62'.

RIG - CYCLONE 42

DRILLER - HARRY DYKES

ASSISTANT - TIM HARRIS

~~[illegible]~~ ID

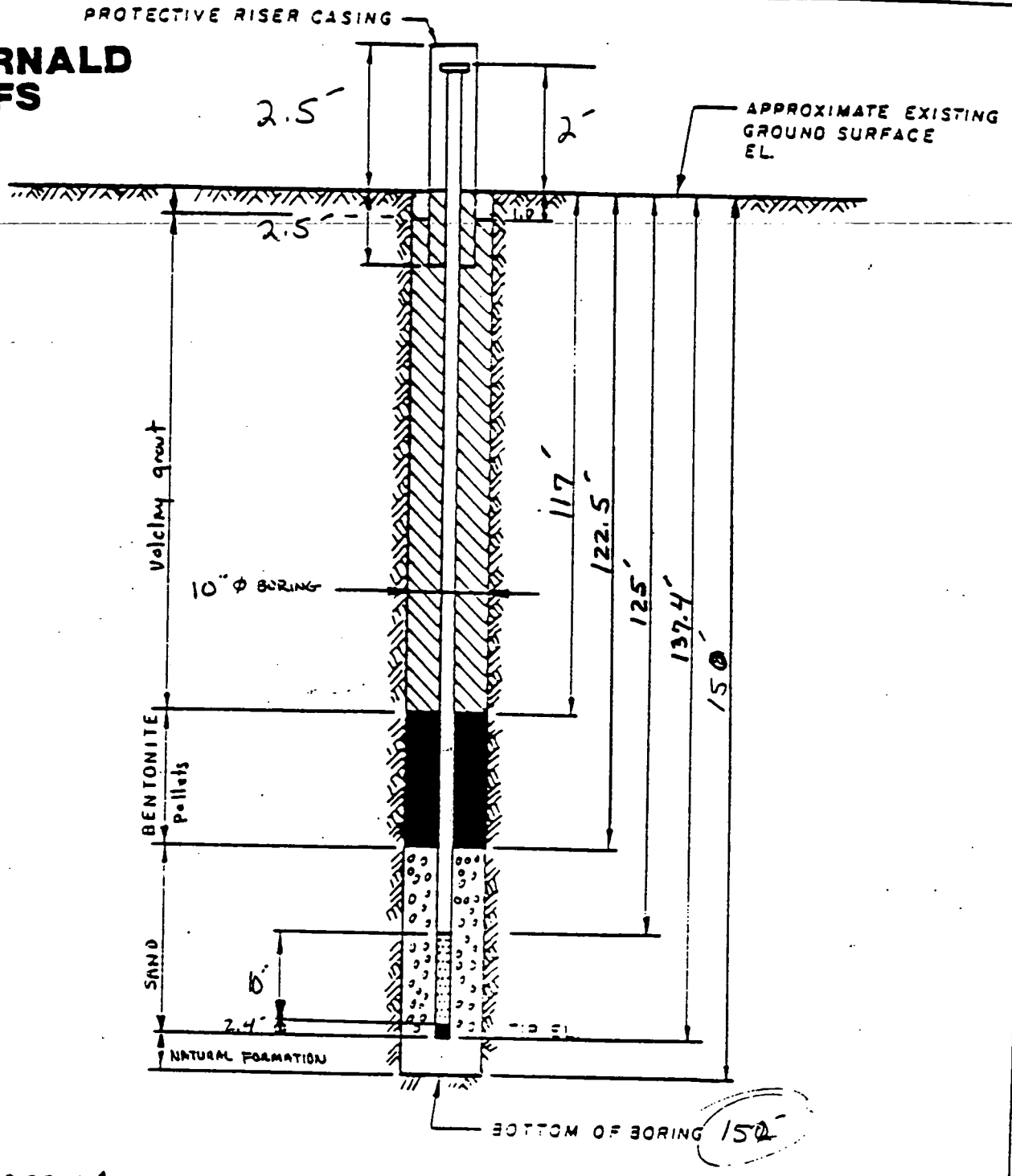
HOLE TD 150' - SHELBY TAKEN FROM 150 TO 152' - APPARENTLY IN SILT AND CLAY.

66

402-11-86

WELL # 366

FERNALD RI/FS



DRAWN BY	DRAWING NUMBER
DBO	
CHECKED BY	
APPROVED BY	

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. S.S. PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 366

PREPARED FOR

FMPC RI/FS

100

PRC

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D. CAHLEY DATE 9-22-87
PROJECT NO. 602 CHECKED BY _____ DATE _____
BORING NO. 366
PIEZOMETER NO. 366 DATE OF INSTALLATION 9-22-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT FLAT HEAD HAMMER
DRILLING FLUID (S) USED:	CASING SIZE (S) USED: TEMPORARY
FLUID WATER FROM 5' TO 132'	SIZE 10" FROM 0 TO 150'
FLUID — FROM — TO —	SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE 316 STAINLESS STEEL MONITORING WELL	RISER PIPE MATERIAL 316 STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4" ID	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8" I.D. 4"
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 FT.
AVERAGE SIZE OF PERFORATIONS —	JOINING METHOD THREAD AND COUPLE
TOTAL PERFORATED AREA 15'	(FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.	OTHER PROTECTION LOCKABLE CAP
PROTECTIVE PIPE O.D. 10 INCHES	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY VOLCLAY	TOP 1'	BOTTOM 117'	TOP	BOTTOM
BENTONITE PELLETS	TOP 117'	BOTTOM 122.5'	TOP	BOTTOM
SAND	TOP 122.5'	BOTTOM 137.4'	TOP	BOTTOM
FORMATION	TOP 137.4'	BOTTOM 152	TOP	BOTTOM
PERFORATED SECTION	TOP 125'	BOTTOM 135'	TOP	BOTTOM
PIEZOMETER TIP	137.4			
BOTTOM OF BOREHOLE	152'			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS SHELBY TUBE TAKEN FROM 150' - 152'

WELL TO BE DEVELOPED LATER

68

APPENDIX B

ASTM METHOD D 1586-84

Designation: D 1586 - 84

Standard Method for PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 *number of rope turns*—the total contact angle between the rope and the cathead at the

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 - 58 T. Last previous edition D 1586 - 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly:*

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance", or the "*N*-value". If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb

(63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

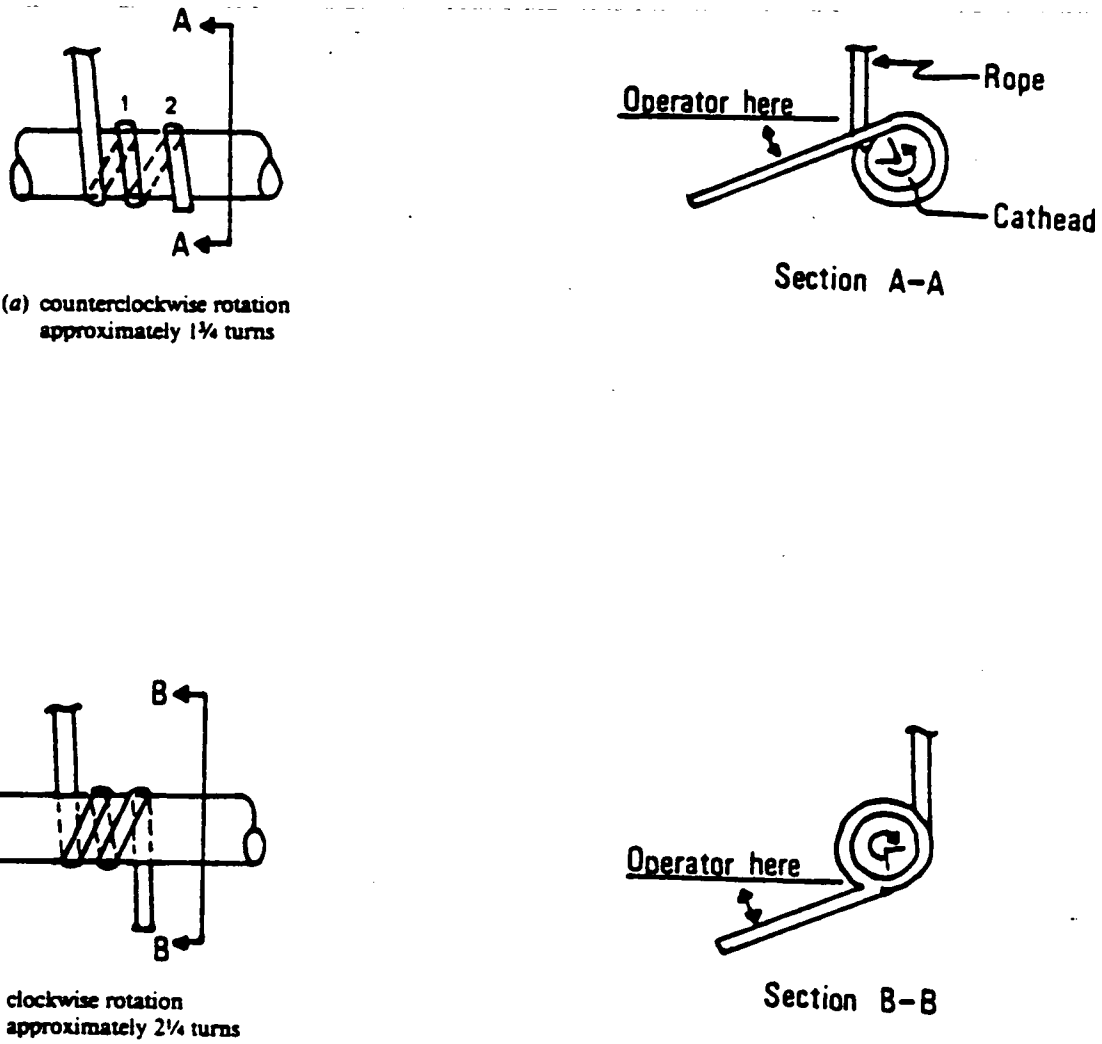
9. Precision and Bias

9.1 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values

obtained between operator-drill rig systems.

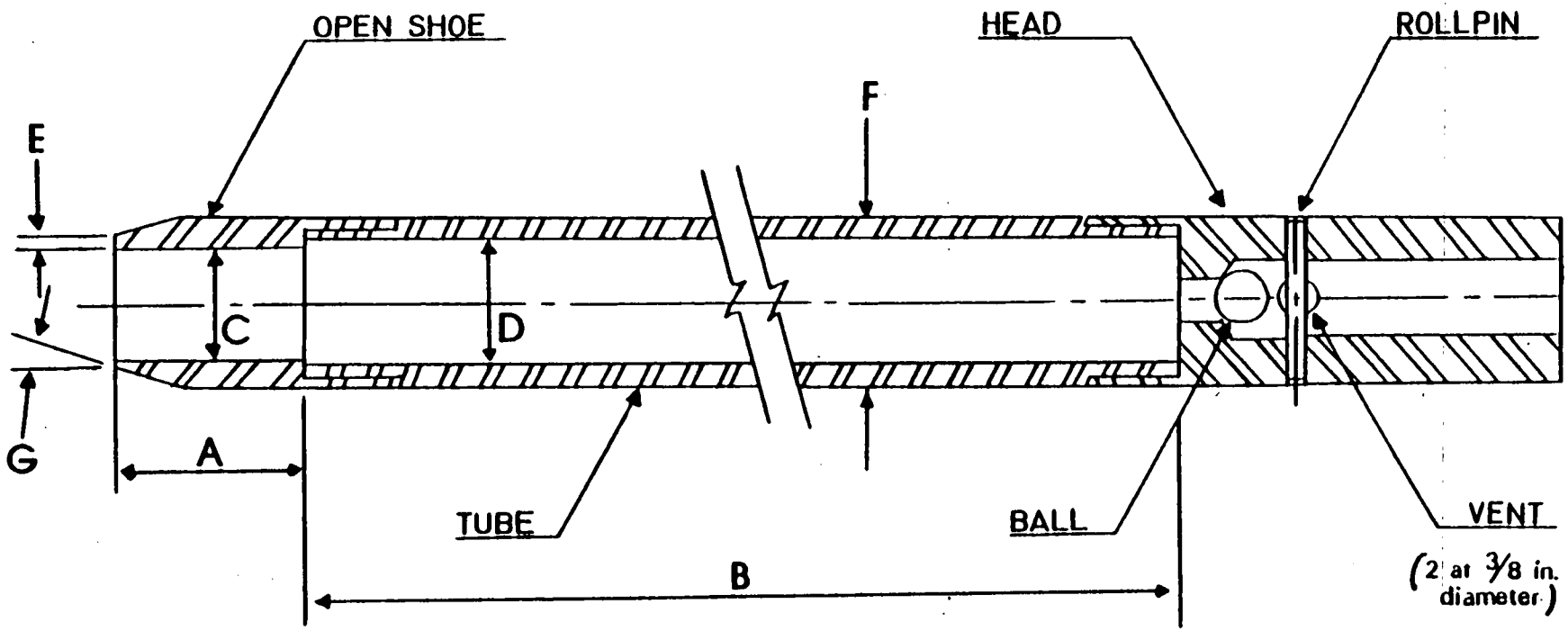
9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.



(*a*) counterclockwise rotation approximately 1¾ turns

(*b*) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

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