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Summary Report For Camp Fogarty Firing Range

Naval Construction Battalion Center Davisville, Rhode Island

Northern Division Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 127

September 1994

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Halliburton NUS CORPORATION

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SUMMARY REPORT
FOR
CAMP FOGARTY FIRING RANGE

NAVAL CONSTRUCTION BATTALION CENTER
DAVISVILLE, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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TABLE OF CONTENTS

SECTION			PAGE
1.0	INTRODUCTION		1-1
	1.1	SITE LOCATION	1-1
	1.2	SITE DESCRIPTION	1-1
2.0	FIELD INVESTIGATION		2-1
3.0	FINDINGS		3-1
	3.1	SITE GEOLOGY	3-1
	3.2	HYDROGEOLOGY	3-1
	3.3	ANALYTICAL RESULTS	3-1
	3.3.1	Soil	3-1
	3.3.2	Groundwater	3-7
4.0	SUMMARY AND CONCLUSIONS		4-1

REFERENCES

APPENDICES

A	Analytical Results
B	Boring and Well Construction Logs
C	Slug Test Calculation Table

TABLES

NUMBER		PAGE
3-1	Summary of Rising Head Slug Test Results For Five Overburden Monitoring Wells	3-2
3-2	June 1993 Analytical Results, 15 Soil Samples From Five Soil Borings	3-4
3-3	February 1994 Analytical Results, 10 Soil Samples from Three Soil Borings	3-6
3-4	July 1993 Analytical Results For Unfiltered Groundwater Samples Collected From Seven Monitoring Wells Using a Bailer Method	3-8
3-5	February 1994 Analytical Results For Unfiltered Groundwater Samples Collected From Seven Monitoring Wells Using a "Low-Flow" Method	3-9

TABLE OF CONTENTS (Continued)

FIGURES

NUMBER		PAGE
1-1	Location Map	1-2
1-2	Study Area Locus Plan	1-3
1-3	Site Map	1-4

1.0 INTRODUCTION

This Final Summary Report was prepared to summarize activities at the Camp Fogarty Firing Range in East Greenwich, Rhode Island, associated with Contract Task Order (CTO) 127, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. Pursuant to the CTO, Halliburton NUS Corporation (HNUS) accomplished the tasks specified in a memo dated April 15, 1993, re: Lead Investigation at Camp Fogarty Firing Range. The objectives of this study were to determine the vertical distribution of lead in the upper six feet of soils in proximity to impact areas, determine the groundwater quality beneath the firing range, and provide data for future fate analyses.

1.1 SITE LOCATION

The Camp Fogarty Firing Range site is located in East Greenwich, Rhode Island (Figures 1-1 and 1-2). Camp Fogarty is a 350-acre base which includes support facilities, a motor pool area, and small arms firing ranges. Camp Fogarty currently has three active firing ranges denoted as Ranges A, B, and C. Figure 1-3 presents the developed portion of Camp Fogarty and indicates the locations of the Firing Ranges.

1.2 SITE DESCRIPTION

Range A is a two hundred yard long rifle range, with targets located at two intervals, 25 meters and 200 yards. The range is bordered to the north, south, and west by earthen berms, with the firing positions along the east perimeter. Rounds impact sandbags behind the 25 meter targets. The berm on the west side of the range is the impact area for the 200-yard targets. There are 25 firing points and impact areas for both the 25 meter and 200 yard distances. These firing points/impact areas are rotated by the Range Control Officer to evenly distribute the impacting rounds. This Range was investigated with two monitoring wells.

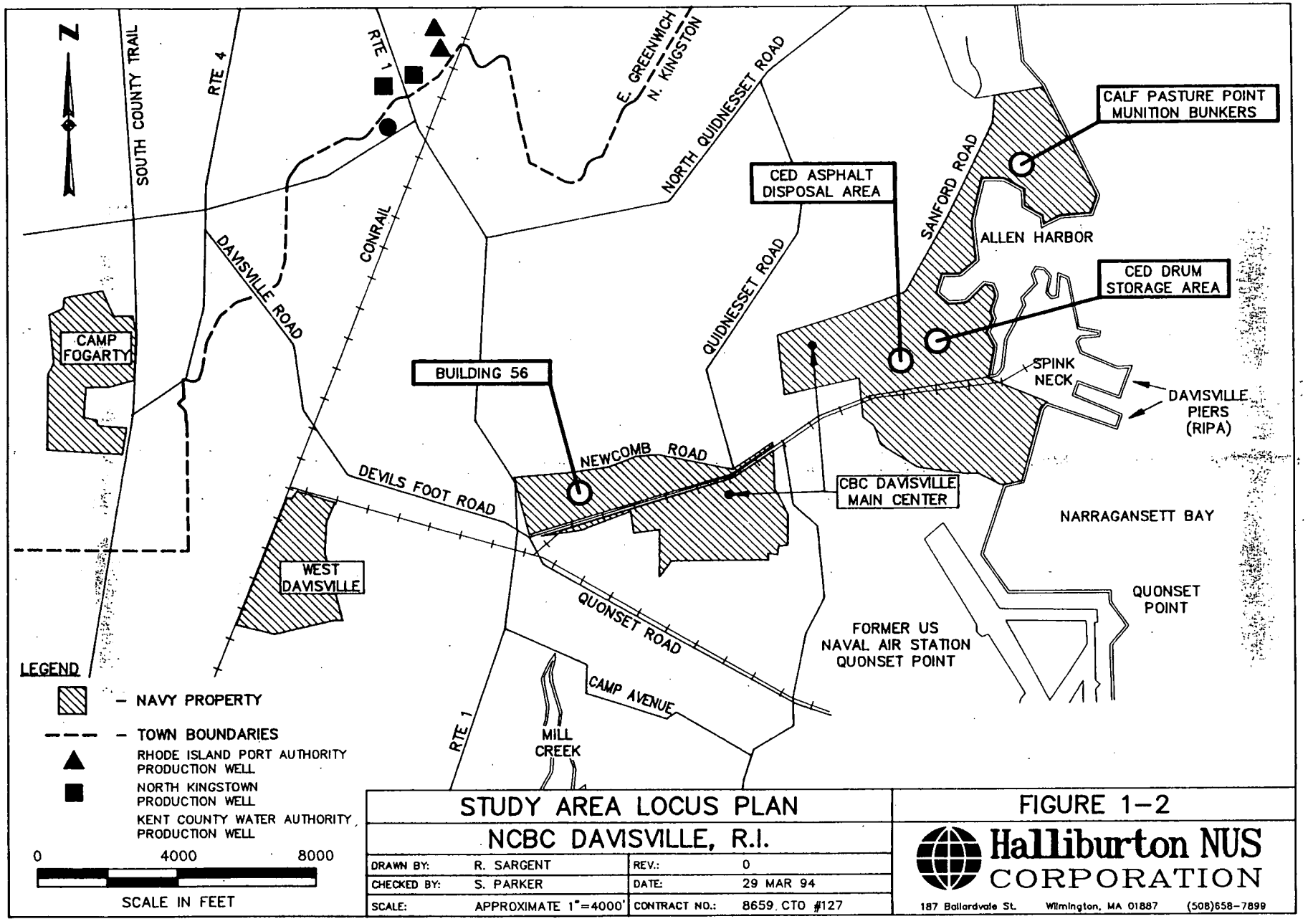
Range B is a pistol range, bordered to the north, south, and west by earthen berms, with the firing positions along the east perimeter. Rounds impact the berm on the west side of the range. This range was not investigated.

Range C is a shotgun/machine gun firing range bordered to the north, south, and west by earthen berms, with the firing positions along the east perimeter. As a safety precaution, the machine guns are mounted so that the movement of the barrels during firing is restricted. As a result, most of the rounds impact small segments of the west berm. This range was investigated with one monitoring well.

The order of frequency of use for the ranges/targets from most utilized to least utilized is as follows: Range A 25-meter, Range A 200-yard, Range B, Range C.

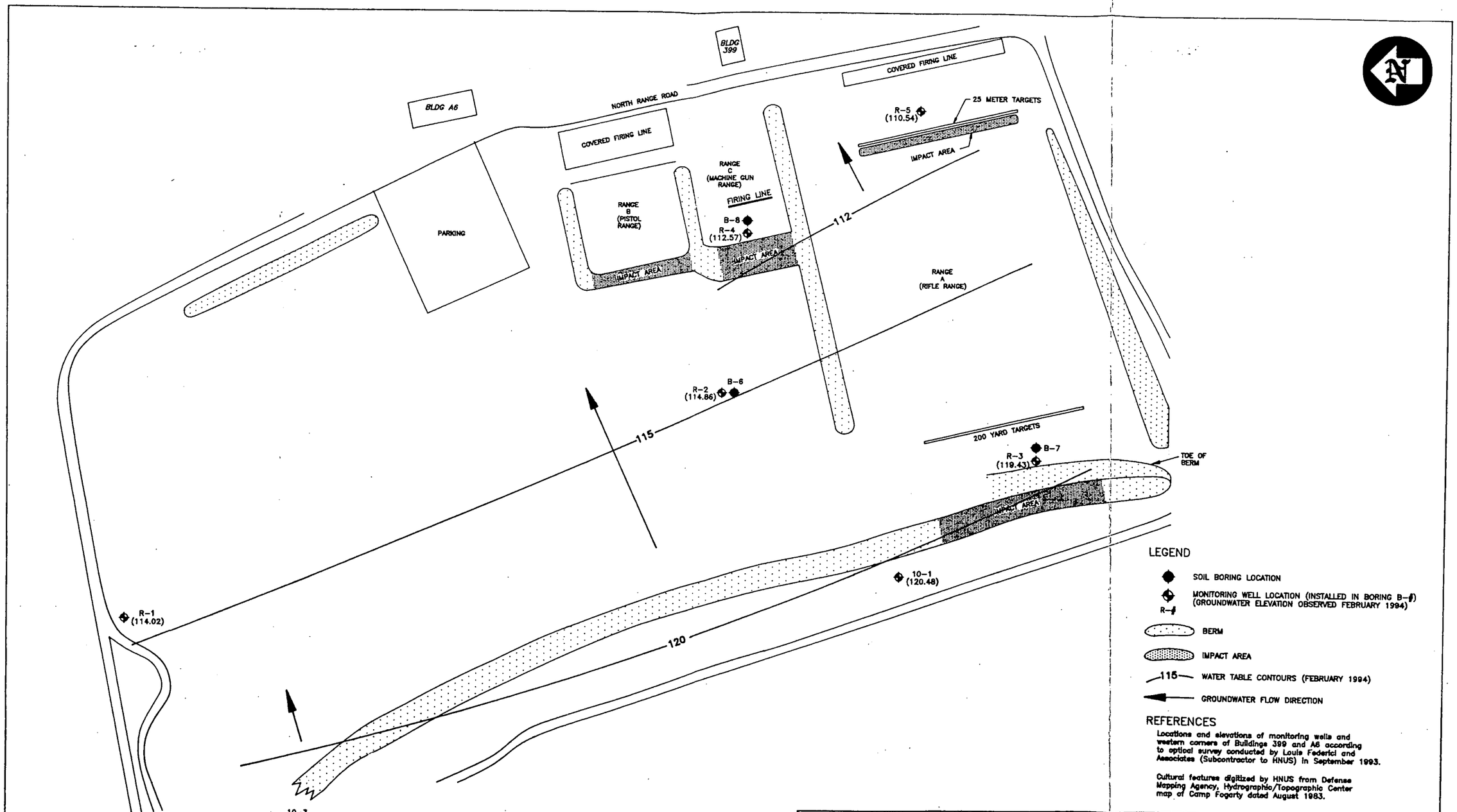
According to a site map, the ranges have been in their current locations since at least 1945. The use of the property prior to 1945 is unknown. Reportedly, material has not been removed from the berms since their construction; however, fresh soil was recently added to the impact areas at Range A to decrease the frequency of ricochets caused by soil erosion. Redistribution and grading of soils at the site is not documented, and the possibility of lead-bearing soils being placed at depth in the vicinity of the berm areas must be considered in evaluating the results of this study. Shooting at Camp Fogarty has always been toward the west.

LOCATION MAP			FIGURE 1–1
CAMP FOGARTY FIRING RANGE			Halliburton NUS CORPORATION
US NAVY – NCBC DAVISVILLE, RI			
DRAWN BY: P. SARGENT	REV.: 0		
CHECKED BY: N. MARTIN	DATE: 3 NOV 93		187 Ballardvale St. Wilmington, MA 01887 (508)658-7899
SCALE: AS SHOWN	PROJECT NO.: 9659 CTO #127		



STUDY AREA LOCUS PLAN			FIGURE 1–2
NCBC DAVISVILLE, R.I.			Halliburton NUS CORPORATION
DRAWN BY:	R. SARGENT	REV.:	0
CHECKED BY:	S. PARKER	DATE:	29 MAR 94
SCALE:	APPROXIMATE 1"=4000'	CONTRACT NO.:	8659 CTO #127

187 Ballardvale St. Wilmington, MA 01887 (508)658-7899



SITE MAP			
CAMP FOGARTY FIRING RANGES			
NCBC DAVISVILLE, R.I.			
DRAWN BY:	R. SARGENT	REV.:	0
CHECKED BY:	G. GLENNON	DATE:	22 APR 94
SCALE:	1" = 150'	CONTRACT NO.:	N62472-90-D-1298

FIGURE 1-3

Halliburton NUS CORPORATION

187 Ballardvale St. Wilmington, MA 01887 (508)658-7899

2.0 FIELD INVESTIGATION

Between June 16 and 17, 1993, Environmental Drilling, Inc. advanced five soil borings at Camp Fogarty using hollow-stem augers. Groundwater monitoring wells were installed at the completion of each boring. The borings were designated B-1 through B-5. Monitoring wells R-1 through R-5 were installed in borings B1 through B5. The boring and well locations are presented on Figure 1-3. Complete boring and well construction logs are provided in Appendix B.

Split-barrel samples were taken in accordance with ASTM D-1586-84. Samples were logged by an HNUS geologist during the drilling process using the Unified Soil Classification System. Notes were also made regarding the physical appearance of the samples, including bedding features and thickness of layers, as shown in Appendix B.

Samples were collected for laboratory analysis from each split-barrel at the following depths: 0-2 feet (S-1); 2-4 feet (S-2); and 4-6 feet (S-3). The soil was transferred to the sample jars using disposable plastic scoops. After each sample was collected, the split-barrel samplers were decontaminated prior to re-use. Samples were shipped via overnight carrier to Southwest Laboratory of Oklahoma where they were analyzed for total lead and Toxicity Characteristic Leaching Procedure (TCLP) lead concentrations. A second set of samples was shipped to Halliburton NUS Environmental Corporation, Environmental Laboratories, where they were tested to determine their cation exchange capacity and grain size distribution.

The monitoring wells were constructed through the hollow-stem augers. The augers were withdrawn from the hole in increments during the placement of the filter sand pack (No. 20 - 30 U.S. Standard Sieve size) and bentonite seals to ensure that these materials were properly placed. The monitoring wells were constructed of nominal two-inch inside diameter, flush joint, threaded Schedule 40 PVC pipe and factory-slotted nominal 0.010-inch well screens.

A bentonite pellet seal was placed immediately above the sand pack. A one-foot thick layer of clean quartz sand (No. 20-30 U.S. Standard Sieve size) was then placed above the grout or bentonite seal, if space was available, to act as a drainage layer for the protective casing. The complete monitoring well construction logs are presented in Appendix B.

Five-foot long, four-inch inner diameter, steel protective casings were installed over monitoring wells R-1 and R-2. Flush-mounted protective casings were installed over monitoring wells R-3, R-4, and R-5.

After the wells were installed and the grout had set, the wells were developed. Development included surging and pumping the wells to remove fine-grained material which was disturbed during the drilling process to create a good hydraulic connection between the well and the aquifer.

The back-end of the drilling rig, and all downhole drilling, sampling, and testing equipment were high-pressure steam cleaned onsite prior to the beginning of drilling operations to ensure that they were free of paint or any petroleum-based greases/lubricants. Well development water, drilling fluids, and drilling cuttings were containerized in DOT Specification 17, 55-gallon steel drums.

On July 8, 1993, HNUS personnel performed rising head slug tests on the five newly-installed wells. The tests were performed using a method presented by Bouwer and Rice (Bouwer and Rice, 1967). Water was removed from the well with a disposable Teflon bailer. The well response was then recorded (with an electronic pressure transducer) as a function of time as the well recovered. These data were used to calculate the hydraulic conductivity of the aquifer at the monitoring well locations.

On July 14, 1993, HNUS personnel collected groundwater samples for total lead analysis (unfiltered) from the five newly-installed monitoring wells (R-1 through R-5) and two existing wells (MW-10-1 and MW-10-3). The static water level was measured and the volume of water standing in the well was calculated. Each well was purged by removing three well volumes with a disposable Teflon bailer prior to sampling. The pH, temperature, specific conductance, and dissolved oxygen concentration of each well volume was measured and recorded.

The samples were poured directly from the bailer into one-liter polyethylene bottles. Each sample was preserved with laboratory-grade nitric acid to a pH of less than 2. The samples were shipped via overnight carrier to Southwest Laboratory of Oklahoma for analysis.

The location and elevation of each well was determined by optical survey by Louis Federici and Associates in September 1993. The locations of the northwest and southwest corners of Buildings 399 and A6 were also surveyed for control purposes. These data were combined with existing plans of Camp Fogarty to prepare a site figure for the presentation and analysis of the data gathered during the study (Figure 1-3).

On February 14, 1994, HNUS and subcontractor personnel collected split-barrel samples from three locations: B-6 (adjacent to B-2), B-7 (adjacent to B-3), and B-8 (adjacent to B-4). The samples were collected to confirm analyses conducted during the June 1993 sample round. The samples were collected with split-barrel samplers in stable, open boreholes to a depth of six feet. Samples were collected for laboratory analysis from each split-barrel at the following depths: 0-2 feet (S1); 2-4 feet (S2); and 4-6 feet (S3). The soil was placed in a stainless-steel mixing bowl, homogenized by mixing with a stainless-steel scoop, and transferred to the sample jars. After each sample was collected, the split-barrel samplers were decontaminated. Samples were shipped via overnight carrier to Southwest Laboratory of Oklahoma where they were analyzed for total lead, TCLP lead, and soil pH.

On February 16 - 18, 1994, HNUS personnel collected groundwater samples from monitoring wells R-1 through R-5, MW-10-1, and MW-10-3 in accordance with a EPA Region 1 accepted "low-flow" sampling method provided by the Navy. The depth to water was measured from the top of PVC at each monitoring well with a decontaminated electric water sensing device. Dedicated polyethylene tubing was inserted into the well to a depth equivalent to the center of the well screen interval and connected to a peristaltic pump fitted with silicone pump-head tubing. The well was purged using the peristaltic pump at a rate between 100 and 300 ml/minute. Groundwater quality parameters, including temperature, pH, specific conductance, Eh, turbidity, dissolved oxygen, and salinity were monitored and recorded every three minutes.

Well purging was completed and groundwater samples were collected from the well after readings were stabilized to ±5% for three successive monitoring intervals. Groundwater samples were collected directly from the silicone tubing into pre-preserved (when appropriate) sample containers. Samples were collected for the following analyses in the following order: total lead, pH, and hardness. In addition, filtered groundwater samples were collected from monitoring wells R-2 and R-3 for total lead analysis. These samples were collected through an in-line 0.45 μm filter directly into the appropriate sample bottle.

3.0 FINDINGS

This section presents the results of the study conducted at Camp Fogarty, and includes discussions of the site geology, hydrogeology, and analytical data.

3.1 SITE GEOLOGY

The overburden geologic unit encountered in this study was a thick sequence of silt and silty sand layers varying in thickness from a few inches to a few feet. These layers could not be traced between boring locations. Locally, the overburden unit contains minor amounts of gravel.

Drilling refusals were encountered in the overburden at depths ranging from 13 to 22 feet below ground surface. Bedrock was not confirmed. The boring logs for each boring, which provide details of the depth and type of material encountered, are presented in Appendix B.

The results of the study are consistent with the surficial geologic map of the area prepared by Schafer (1961).

3.2 HYDROGEOLOGY

The site overlies a water table aquifer comprised of layers of silt and silty sand. Based on groundwater elevations observed in February 1994, groundwater flow is to the east-northeast (Figure 1-3). The hydraulic conductivity of the aquifer at monitoring wells R-1 through R-5 is presented in Table 3-1. The slug test data and parameters used in the calculation of the hydraulic conductivity are presented in Appendix C. The hydraulic conductivities range from a low of 1.05 feet per day (3.71E-04 centimeters per second, cm/sec) at R-2 to a high of 42.71 feet per day (1.51E-02 cm/sec) at R-4. These hydraulic conductivities assume that the bottom of the aquifer is 10 feet below the well screen; the actual location of the bottom of the aquifer is unknown. The range of hydraulic conductivities observed indicates that the water table aquifer is heterogeneous.

The silt and silty sand layers observed in the soil boring samples indicate that the aquifer is also anisotropic. Anisotropic aquifers have hydraulic conductivities which vary depending on the direction of measurement. The slug test measured the hydraulic conductivity in the horizontal direction. If the hydraulic conductivity were measured in the vertical direction, it would be expected to be lower, due to the presence of lower permeability silt layers. The silt layers impede groundwater movement more in the vertical direction than in the horizontal direction.

Well R-3 is located at the toe of the slope of the large berm which serves as the impact area for the 200-yard targets at Range A. During field work conducted under this study, observation of the surface soils at R-3 indicated that surface water flowed into this area during precipitation events. This could result in a higher rate of groundwater recharge at this location compared to other portions of the site.

3.3 ANALYTICAL RESULTS

3.3.1 Soil

In June 1993, fifteen soil samples were collected from five soil borings (B-1 through B-5) advanced at the site. These samples were analyzed for grain size, cation exchange capacity, total lead, and TCLP lead. In February 1994, soil borings B-6, B-7, and B-8, were advanced adjacent to borings B-2, B-3, and B-4, respectively, to collect ten additional soil samples. These additional soil samples were

TABLE 3-1
SUMMARY OF RISING HEAD SLUG TEST RESULTS
FOR FIVE OVERBURDEN WELLS
CAMP FOGARTY FIRING RANGE
EAST GREENWICH, RHODE ISLAND

Well No.	Hydraulic Conductivity[1]	
	(ft/day)	(cm/sec)
R-1	26.49	9.34E-03
R-2	1.05	3.71E-04
R-3	6.22	2.19E-03
R-4	42.71	1.51E-02
R-5	1.62	5.72E-04

(1) Assumes bottom of aquifer is 10 feet below well screen.

collected to resolve questions arising from inconsistencies observed in the June 1993 analytical results; they were analyzed for soil pH, total lead, and TCLP lead. The analytical results for the soil samples collected in June 1993 and February 1994 are discussed in Sections 3.3.1.1 and 3.3.1.2, respectively. Refer to Figure 1-3 for the locations of the soil borings.

A maximum background concentration of 53.8 mg/kg is used in the evaluation of the total lead results. This is the maximum total lead concentration detected in background samples collected by TRC Environmental Corporation at NCBC and Camp Fogarty during preparation of the NCBC Draft Remedial Investigation Report (TRC, 1993b). The background samples were collected from 7 unimpacted areas located as close as possible to NCBC and Camp Fogarty study areas. Identification of unimpacted areas was made on the basis of aerial photographs and the review of organic analytical data.

The TCLP analyses were conducted to provide an estimation of the leachability of the lead in the soil. The TCLP extraction fluid has a pH of 5.0, which approximates the pH of acid precipitation in the northeastern U.S. It should be noted that the TCLP extraction fluid contains acetic acid, which is a lead chelant; the TCLP procedure is therefore felt to provide a conservative measure of potential leaching of lead in soils. TCLP theoretical maximum concentrations were used in the evaluation of the TCLP lead results. TCLP theoretical maximum concentrations were calculated using the following equation:

Total lead concentration (mg/kg)
x 1,000 μg/mg
x 0.1 kg soil/2.0 l leachate
= TCLP lead theoretical maximum concentration (μg/l leachate)

3.3.1.1 June 1993 Results

The analytical results for the soil samples collected in June 1993 are presented in Table 3-2.

The results of the grain size analysis were used to assign Unified Soil Classification System (USCS) classifications to each of the samples. Nine of the 15 soil samples were classified as silt; the remaining six soil samples were classified as silty sand.

The cation exchange capacity (CEC) of a soil represents the total number of sites where cations, such as Pb^{+2}, can be adsorbed (Hem, 1992). Therefore, low CECs favor cation migration through the soil, and high CECs favor cation immobilization by the soil. Soil CECs typically range from 2 meq/100 g (sand) to greater than 200 meq/100 g (soil organic matter) (Dragun, 1988). The CECs of the soil samples collected in June 1993 ranged from 3.8 to 25.0 meq/100 g.

Total lead was detected at concentrations above the maximum background concentration of 53.8 mg/kg in samples from two of the five soil borings (B-3 and B-4). Borings B-3 and B-4 were located within 10 feet of the berms at Range A (200 yard impact area) and Range C. At both locations, total lead concentrations were above the maximum background concentration at the surface, but decreased with depth to concentrations below the maximum background concentration. In boring B-3, the total lead concentration decreased from 1,380 mg/kg in sample S1, collected from 0'-2', to 53.5 mg/kg in sample S3, collected from 4'-6'. In boring B-4, the total lead concentration decreased from 1,760 mg/kg in sample S1 to 7.0 mg/kg in sample S3.

TCLP lead was detected at elevated concentrations in samples B2-S3, B3-S2, and B4-S3. However, the TCLP lead concentration detected in each of these samples was higher than the TCLP theoretical maximum concentration, indicating that the total lead and TCLP lead results for these samples were inconsistent. The raw data from the TCLP and total lead analyses were reviewed and all calculations

TABLE 3-2
JUNE 1993 ANALYTICAL RESULTS
15 SOIL SAMPLES FROM FIVE SOIL BORINGS
CAMP FOGARTY FIRING RANGE
EAST GREENWICH, RHODE ISLAND

SAMPLE LOCATION	SAMPLE DEPTH	USCS SOIL CLASSIFICATION (FROM RESULTS OF GRAIN SIZE ANALYSIS)	CATION EXCHANGE CAPACITY (meq/100 g)	TOTAL LEAD DETECTED CONCENTRATION (mg/kg)	TOTAL LEAD DETECTED CONCENTRATION > MAXIMUM BACKGROUND CONCENTRATION (53.8 mg/kg)?	TCLP LEAD DETECTED CONCENTRATION (µg/l)	TCLP LEAD THEORETICAL MAXIMUM CONCENTRATION (µg/l)	TCLP LEAD DETECTED CONCENTRATION > THEORETICAL MAXIMUM CONCENTRATION?
B1-S1	0'-2'	silty sand	5.1	7.7	No	ND	385	No
B1-S2	2'-4'	silty sand	14.0	11.0	No	ND	550	No
B1-S3	4'-6'	silt	11.0	52.6	No	ND	2,630	No
B2-S1	0'-2'	silt	4.9	20.4	No	ND	1,020	No
B2-S2	2'-4'	silt	25.0	4.4	No	169	220	No
B2-S3	4'-6'	silt	24.0	8.3	No	145,000	415	Yes
B3-S1	0'-2'	silty sand	7.3	1,380	Yes	304	69,000	No
B3-S2	2'-4'	silt	6.3	773	Yes	174,000	38,650	Yes
B3-S3	4'-6'	silt	3.8	53.5	No	2,860	2,680	Yes
B4-S1	0'-2'	silt	15.0	1,760	Yes	2,490	88,000	No
B4-S2	2'-4'	silt	10.0	166	Yes	1,190	8,300	No
B4-S3	4'-6'	silty sand	5.7	7.0	No	6,270	350	Yes
B5-S1	0'-2'	silty sand	6.8	29.7	No	72.5 J	1,485	No
B5-S2	2'-4'	silt	17.0	8.2	No	ND	410	No
B5-S3	4'-6'	silty sand	13.0	8.6	No	ND	430	No

ND Not Detected.

from the raw data up to the reported result were checked to determine if the reported results were affected by transcription or math errors. No transcription or math errors were found. In order to resolve the inconsistency in the data, additional soil samples were collected in February 1994 from soil borings B-6, B-7, and B-8, advanced adjacent to soil borings B-2, B-3, and B-4. The analytical results for the February 1994 soil samples are discussed in Section 3.3.1.2.

3.3.1.2 February 1994 Results

The analytical results for the soil samples collected in February 1994 are presented in Table 3-3.

The soil was acidic at boring B6 (pH 4.71 to 4.89), neutral at boring B7 (pH 6.62 - 7.2), and weakly acidic to neutral at boring B8 (pH 6.44 to 7.22). Generally, low pH favors cation migration through the soil, and high pH favors immobilization of cations in the soil.

Total lead was detected at concentrations above the maximum background concentration of 53.8 mg/kg in the upper sample intervals from two of the three soil borings (B-7 and B-8). Borings B-7 and B-8 were located within 10 feet of the berms at Range A (200 yard impact area) and Range C, respectively.

At both locations, total lead concentrations were above the maximum background concentration at the surface, but decreased with depth to concentrations below the maximum background concentration. In boring B-7, the total lead concentration decreased from 762 mg/kg in sample S1, collected from 0'-2', to 7.1 mg/kg in sample S3, collected from 4'-6'. In boring B-8, the total lead concentration decreased from an average of 466 mg/kg in duplicate pair S1/S1A to 6.0 mg/kg in sample S3.

TCLP lead was detected at elevated concentrations in samples from two of the three soil borings (B-7 and B-8). At both locations, TCLP lead concentrations decreased rapidly with depth. In boring B-7, the TCLP lead concentration decreased from 12,500 μg/l in sample S1, collected from 0'-2', to less than 14 μg/l in sample S3, collected from 4'-6'. In boring B-8, the TCLP lead concentration decreased from an average of 11,700 μg/l in duplicate pair S1/S1A to less than 14 μg/l in sample S3. In contrast to the June 1993 results, all of the TCLP lead detected concentrations were below the TCLP lead theoretical maximum concentrations.

Transport processes which may have contributed to the total lead concentrations detected in the subsurface soil samples include grading and leaching. Grading is the physical redistribution of soil using mechanical earth-moving equipment. Leaching is the percolation of rainwater through soil. The grading operations at the firing range have not been documented; therefore, the relative contributions of the grading and leaching processes to the total lead concentrations detected in the subsurface soil samples are unknown.

Based on a comparison of total lead concentrations detected in soil at the firing range to the maximum background concentration, it appears that lead deposited at the surface of the Range A 200-yard impact area has been graded into, or has leached through, the soil to a depth of four feet over the 49-year active life of the firing range. Also, it appears that lead deposited at the surface of the Range C impact area has been graded into, or has leached through, the soil to a depth of two feet over the same period. Assuming that leaching is the dominant transport process, lead may have migrated to a greater depth at the Range A 200-yard impact area than at the Range C impact area because the pH and CEC of the surface soil are lower and the rate of groundwater recharge is higher at the Range A 200-yard impact area. Lead has apparently not been graded into, or has not leached into, the subsurface at the Range C 25-yard impact area.

TABLE 3-3
FEBRUARY 1994 ANALYTICAL RESULTS
10 SOIL SAMPLES FROM THREE SOIL BORINGS
CAMP FOGARTY FIRING RANGE
EAST GREENWICH, RHODE ISLAND

SAMPLE LOCATION	ADJACENT JUNE 1993 SAMPLE LOCATION	SAMPLE DEPTH	SOIL pH	TOTAL LEAD DETECTED CONCENTRATION (mg/kg)	TOTAL LEAD DETECTED CONCENTRATION > MAXIMUM BACKGROUND CONCENTRATION (53.8 mg/kg)?	TCLP LEAD DETECTED CONCENTRATION (μg/l)	TCLP LEAD THEORETICAL MAXIMUM CONCENTRATION (μg/l)	TCLP LEAD DETECTED CONCENTRATION > THEORETICAL MAXIMUM CONCENTRATION?
B6A-S1	B2-S1	0'-2'	4.77	25.9	No	18.9	1,295	No
B6A-S2	B2-S2	2'-4'	4.89	7.6	No	ND	380	No
B6A-S3	B2-S3	4'-6'	4.71	5.6	No	ND	280	No
B7A-S1	B3-S1	0'-2'	6.62	762	Yes	12,500	38,100	No
B7A-S2	B3-S2	2'-4'	6.69	492	Yes	4,960	24,600	No
B7A-S3	B3-S3	4'-6'	7.2	7.1	No	ND	355	No
B8A-S1 B8A-S1A Average[1]	B4-S1	0'-2'	7.15 7.12	576 355 466	Yes	10,100 13,300 11,700	505,000 665,000 585,000	No
B8A-S2	B4-S2	2'-4'	7.22	6.3	No	ND	315	No
B8A-S3	B4-S3	4'-6'	6.44	6.0	No	ND	300	No

ND Not Detected.
(1) Average of results from duplicate samples B8A-S1 and B8A-S2.

3.3.2 Gr undwater

Groundwater samples were collected from the five monitoring wells installed as part of this study (R-1 through R-5) and two existing monitoring wells (MW10-1 and MW10-3). Sample rounds were conducted in July 1993 and February 1994. Refer to Figure 1-3 for the locations of the monitoring wells.

The July 1993 samples were collected using a bailer method, and were analyzed for total lead. Water quality parameters measured in the field included temperature, specific conductance, pH, and dissolved oxygen.

The February 1994 samples were collected using an EPA Region 1 accepted "low-flow" method provided by the Navy. These groundwater samples were collected to resolve questions arising from the high turbidity observed in the July 1993 samples; they were analyzed for total lead, pH, and hardness. Water quality parameters measured in the field included temperature, specific conductance, pH, turbidity, dissolved oxygen, salinity, and redox potential (Eh).

The total lead results are compared to EPA's Maximum Contaminant Level (MCL) of 15 μg/l.

3.3.2.1 July 1993 Results

The analytical results from the groundwater samples collected in July 1993 are presented in Table 3-4. Lead was detected in groundwater samples from six of the seven wells at concentrations exceeding the Maximum Contaminant Level of 15 μg/l. The samples were very turbid; this high turbidity was apparently due to the presence of solids which were settled at the bottom of the well were resuspended by the motion of the bailer. Any lead adsorbed onto these suspended solids would have been brought into solution when the sample was preserved with nitric acid; therefore, the suspended solids may have contributed significantly to the lead concentrations detected in the groundwater samples.

3.3.2.2 February 1994 Results

The analytical results from the groundwater samples collected in February 1994 are presented in Table 3-5. These samples were collected using a "low-flow" method. This method uses a sample pumping rate which approximates well recharge rates to minimize resuspension of well sediments and to avoid stripping of otherwise immobile particles from aquifer materials. Groundwater samples collected using this method are therefore more representative of the ambient groundwater. All of the groundwater samples collected using the "low-flow" method had a measured turbidity of less than 3 NTUs.

Lead was detected in groundwater samples from two of the wells: R-3, located within 10 feet of the berm at the Range A 200-yard impact area; and R-4, located within 10 feet of the impact berm at Range C. The average total lead concentration detected in a pair of duplicate groundwater samples collected from R-3 was 1.8 μg/l. The total lead concentration detected in the groundwater sample collected from R-4 was 2.7 μg/l. The total lead concentrations detected at both locations were well below the Maximum Contaminant Level of 15 μg/l. These results indicate that it is likely that suspended solids contributed significantly to the high lead concentrations detected in the July 1993 groundwater samples.

TABLE 3-4
JULY 1993 ANALYTICAL RESULTS FOR UNFILTERED GROUNDWATER SAMPLES COLLECTED FROM SEVEN MONITORING WELLS USING A BAILER METHOD CAMP FOGARTY FIRING RANGE EAST GREENWICH, RHODE ISLAND

SAMPLE LOCATION	TEMPERATURE[1] (°C)	SPECIFIC CONDUCTANCE[1] (mmhos/cm)	pH[1]	DISSOLVED OXYGEN[1] (mg/l)	TOTAL LEAD DETECTED CONCENTRATION	TOTAL LEAD DETECTED CONCENTRATION > MCL (15.0 μg/l)?
R1-S1	19.5	160	6.86	5.0	165 J	Yes
R2-S1 R2-S2 Average[2]	17.0	90	7.04	8.4	310 J 544 J 427 J	Yes
R3-S1	16.7	76	7.00	7.2	3,690	Yes
R4-S1	15.3	100	6.77	8.2	90.7 J	Yes
R5-S1	15.8	86	6.72	8.6	11.4 J	No
MW10-1-S1	15.7	90	6.30	8.0	82.9 J	Yes
MW10-3-S1	14.0	56	6.06	8.4	31 J	Yes

J Quantitation is approximate.
(1) Reported value is a field measurement, recorded after purging of three well volumes and prior to sample collection.
(2) Average of results from duplicate samples R2-S1 and R2-S2.

TABLE 3-5
FEBRUARY 1994 ANALYTICAL RESULTS FOR UNFILTERED[1] GROUNDWATER SAMPLES COLLECTED FROM SEVEN MONITORING WELLS USING A "LOW-FLOW" METHOD CAMP FOGARTY FIRING RANGE EAST GREENWICH, RHODE ISLAND

SAMPLE LOCATION	TEMPERATURE[2] (°C)	SPECIFIC CONDUCTANCE[2] (mmhos/cm)	pH (FIELD)[2]	pH (LAB)	TURBIDITY[2] (NTU)	DISSOLVED OXYGEN[2] (mg/l)	SALINITY[2] (%)	REDOX POTENTIAL[2] (mV)	HARDNESS AS $CaCO_3$ (mg/l)	TOTAL LEAD DETECTED CONCENTRATION	TOTAL LEAD DETECTED CONCENTRATION > MCL (15.0 μg/l)?
R1A-S1	5.6	0.132	5.52	5.44	1.09	4.00	0.0	250	28	ND	No
R2A-S1 R2A-S2[3]	7.4	0.081	5.95	5.89	1.16	6.75	0.0	246	24	ND ND	No
R3A-S1 R3A-S2 Average[4] R3A-S3[3]	8.9	0.110	6.05	5.92	1.73	5.95	0.0	258	32	1.7 1.8 1.8 ND	No
R4A-S1	8.4	0.099	5.94	6.04	2.22	6.65	0.0	310	32	2.7	No
R5A-S1	8.0	0.087	5.68	5.96	0.69	9.00	0.0	230	24	ND	No
MW10-1A-S1	7.5	0.073	5.86	5.68	0.64	9.70	0.0	256	20	ND	No
MW10-3A-S1	7.1	0.064	5.75	5.46	0.26	8.60	0.0	252	16	ND	No

ND Not Detected.
(1) Unless otherwise noted.
(2) Reported values are field measurements recorded at stabilization, that is, after three successive measurements of all parameters are within ±5%. Stabilization indicates that the water being sampled is representative of ambient groundwater conditions.
(3) Filtered sample.
(4) Average of results from duplicate samples R3A-S1 and R3A-S2.

In addition, lead was not detected in a filtered "low-flow" groundwater sample collected from R-3. This result suggests that even the trace levels of lead detected in the "low-flow" groundwater samples may be due to the presence of suspended solids.

4.0 SUMMARY AND CONCLUSIONS

The objectives of this study at the Camp Fogarty Firing Range were to determine the vertical distribution of lead in the upper six feet of soils in proximity to impact areas, determine the groundwater quality beneath the firing range, and provide data for future fate analyses.

Based on a comparison of total lead concentrations detected in soil at the firing range to the maximum background concentration, it appears that lead deposited at the surface of the Range A 200-yard impact area has been graded into, or has leached through, the soil to a depth of four feet over the 49-year active life of the firing range. Also, it appears that lead deposited at the surface of the Range C impact area has been graded into, or has leached through, the soil to a depth of two feet over the same period. Lead has apparently not been graded into, or has not leached into, the subsurface at the Range C 25-yard impact area.

Total lead concentrations detected in groundwater samples collected from onsite monitoring wells using a "low-flow" sampling method were below the Maximum Contaminant Level of 15 μg/l.

REFERENCES

REFERENCES

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APPENDIX A

ANALYTICAL RESULTS

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY SOIL BORING RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			05-B1-S1-061793	05-B1-S2-061793	05-B1-S3-061793	05-B2-S1-061793	05-B2-S2-061793
LABORATORY ID:			14217.01	14217.02	14217.03	14217.04	14217.05
TAL LEAD SOILS (mg/Kg)	CRDL	IDL					
LEAD	0.6	0.4	7.7	11.0	52.6	20.4	4.4
% SOLIDS:			91.3	81.6	78.3	74.1	79.6

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY SOIL BORING RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			05-B2-S3-061793	05-B3-S1-061693	05-B3-S2-061693	05-B3-S3-061693	05-B4-S1-061793
LABORATORY ID:			14217.06	14217.07	14217.08	14217.09	14217.10
TAL LEAD SOILS (mg/Kg)	CRDL	IDL					
LEAD	0.6	0.4	8.3	1380	773	53.5	1760
% SOLIDS:			76.9	91.4	90.5	90.4	94.3

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY SOIL BORING RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			05-B4-S2-061793	05-B4-S3-061793	05-B5-S1-061693	05-B5-S2-061693	05-B5-S3-061693
LABORATORY ID:			14217.11	14217.12	14217.13	14217.14	14217.15
TAL LEAD SOILS (mg/Kg)	CRDL	IDL					
LEAD	0.6	0.4	166	7.0	29.7	8.2	8.6
% SOLIDS:			86.8	90.0	92.8	77.1	82.8

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY SOIL BORING RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			05-B1-S1-061793		05-B1-S2-061793		05-B1-S3-061793		05-B2-S1-061793		05-B2-S2-061793
LABORATORY ID:			14217.16		14217.17		14217.18		14217.19		14217.20
TCLP LEAD SOILS (ug/L)	CRDL	IDL									
LEAD	3.0	2.0	30	UJ	30	UJ	30	UJ	30	UJ	169

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY SOIL BORING RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			05-B2-S3-061793	05-B3-S1-061693	05-B3-S2-061693	05-B3-S3-061693	05-B4-S1-061793
LABORATORY ID:			14217.21	14217.22	14217.23	14217.24	14217.25
TCLP LEAD SOILS (ug/L)	CRDL	IDL					
LEAD	3.0	2.0	145000	304	174000	2860	2490

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY SOIL BORING RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			05-B4-S2-061793	05-B4-S3-061793	05-B5-S1-061693	05-B5-S2-061693	05-B5-S3-061693
LABORATORY ID:			14217.26	14217.27	14217.28	14217.29	14217.30
TCLP LEAD SOILS (ug/L)	CRDL	IDL					
LEAD	3.0	2.0	1190	6270	72.5 J	30 UJ	30 UJ

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY GROUNDWATER RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R1-S1-071493		5-R2-S1-071493		5-R2-S2-071493		5-R3-S1-071493	
LABORATORY ID:			14580.01		14580.02		14580.06		14580.03	
					FIELD DUPLICATE PAIR					
TAL LEAD WATERS (ug/L)	CRDL	IDL								
LEAD	3	2	165	J	310	J	544	J	3690	J

SITE: CTO #127, NCBC DAVISVILLE, RHODE ISLAND
CAMP FOGARTY GROUNDWATER RESULTS
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R4-S1-071493		5-R5-S1-071493		5-MW10-1-S1-071493		5-MW10-3-S1-071493	
LABORATORY ID:			14580.04		14580.05		14580.09		14580.08	
TAL LEAD WATERS (ug/L)	CRDL	IDL								
LEAD	3	2	90.7	J	11.4	J	82.9	J	31	J

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July 22, 1993
Report No.: 00016035
Section A Page 1

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B1-S1-061793
NUS SAMPLE NO: P0240012
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNIT
1	T45	Grain Size - Sieve & Hydrometer		
		c. 1.0 inch sieve	100.0	% Passed
		d. 3/4 inch sieve	96.8	% Passed
		e. 1/2 inch sieve	94.8	% Passed
		f. 3/8 inch sieve	91.2	% Passed
		g. Sieve No. 4	83.2	% Passed
		h. Sieve No. 10	70.0	% Passed
		i. Sieve No. 20	58.5	% Passed
		j. Sieve No. 40	50.0	% Passed
		k. Sieve No. 60	42.7	% Passed
		l. Sieve No. 140	32.2	% Passed
		m. Sieve No. 200	28.4	% Passed
		n. Particle Size .023mm	13.4	% Passed
		o. Particle Size .007mm	7.8	% Passed
		p. Particle Size .001mm	2.8	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	5.1	meq/100 g
4	I620S	Percent Solids at 103C	94.9	%

COMMENTS:

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July 22, 1993
Report No.: 00016035
Section A Page 2

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B1-S2-061793
NUS SAMPLE NO: P0240013
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		c. 1.0 inch sieve	100.0	% Passed
		d. 3/4 inch sieve	98.5	% Passed
		e. 1/2 inch sieve	94.4	% Passed
		f. 3/8 inch sieve	91.6	% Passed
		g. Sieve No. 4	84.4	% Passed
		h. Sieve No. 10	74.4	% Passed
		i. Sieve No. 20	65.0	% Passed
		j. Sieve No. 40	57.3	% Passed
		k. Sieve No. 60	50.7	% Passed
		l. Sieve No. 140	40.6	% Passed
		m. Sieve No. 200	36.5	% Passed
		n. Particle Size .022mm	15.6	% Passed
		o. Particle Size .007mm	8.2	% Passed
		p. Particle Size .001mm	3.0	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	14	meq/100 g
3	I620S	Percent Solids at 103C	87.5	%

COMMENTS:

CLIENT ORIGINAL

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July 22, 1993
Report No.: 00016035
Section A Page 3

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B1-S3-061793
NUS SAMPLE NO: P0240014
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		c. 1.0 inch sieve	100.0	% Passed
		d. 3/4 inch sieve	97.1	% Passed
		e. 1/2 inch sieve	95.7	% Passed
		f. 3/8 inch sieve	94.8	% Passed
		g. Sieve No. 4	92.6	% Passed
		h. Sieve No. 10	88.6	% Passed
		i. Sieve No. 20	84.7	% Passed
		j. Sieve No. 40	80.3	% Passed
		k. Sieve No. 60	76.9	% Passed
		l. Sieve No. 140	71.6	% Passed
		m. Sieve No. 200	67.3	% Passed
		n. Particle Size .022mm	25.7	% Passed
		o. Particle Size .007mm	13.3	% Passed
		p. Particle Size .001mm	7.1	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	11	meq/100 g
3	I620S	Percent Solids at 103C	83.5	%

COMMENTS:

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July 22, 1993
Report No.: 00016035
Section A Page 4

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B2-S1-061793
NUS SAMPLE NO: P0240015
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		g. Sieve No. 4	100.0	% Passed
		h. Sieve No. 10	99.9	% Passed
		i. Sieve No. 20	99.7	% Passed
		j. Sieve No. 40	99.5	% Passed
		k. Sieve No. 60	99.3	% Passed
		l. Sieve No. 140	97.7	% Passed
		m. Sieve No. 200	93.5	% Passed
		n. Particle Size .022mm	25.0	% Passed
		o. Particle Size .007mm	13.0	% Passed
		p. Particle Size .001mm	6.0	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	4.9	meq/100 g
3	I6205	Percent Solids at 103C	86.1	%

COMMENTS:

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July 22, 1993
Report No.: 00016035
Section A Page 5

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B2-S2-061793
NUS SAMPLE NO: P0240016
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		k. Sieve No. 60	100.0	% Passed
		l. Sieve No. 140	99.0	% Passed
		m. Sieve No. 200	93.0	% Passed
		n. Particle Size .022mm	12.9	% Passed
		o. Particle Size .007mm	5.0	% Passed
		p. Particle Size .001mm	2.0	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	25	meq/100 g
3	I620S	Percent Solids at 103C	79.6	%

COMMENTS:

CLIENT ORIGINAL

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July 22, 1993
Report No.: 00016035
Section A Page 6

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B2-S3-061793
NUS SAMPLE NO: P0240017
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		f. 3/8 inch sieve	100.0	% Passed
		g. Sieve No. 4	99.1	% Passed
		h. Sieve No. 10	98.7	% Passed
		i. Sieve No. 20	98.5	% Passed
		j. Sieve No. 40	98.3	% Passed
		k. Sieve No. 60	98.1	% Passed
		l. Sieve No. 140	96.7	% Passed
		m. Sieve No. 200	89.8	% Passed
		n. Particle Size .022mm	14.7	% Passed
		o. Particle Size .007mm	6.8	% Passed
		p. Particle Size .001mm	2.0	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	24	meq/100 g
3	I620S	Percent Solids at 103C	76.7	%

COMMENTS:

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July 22, 1993
Report No.: 00016035
Section A Page 7

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B3-S1-061693
NUS SAMPLE NO: P0240018
P.O. NO.:

DATE SAMPLED: 16-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		d. 3/4 inch sieve	100.0	% Passed
		e. 1/2 inch sieve	95.9	% Passed
		f. 3/8 inch sieve	93.2	% Passed
		g. Sieve No. 4	86.9	% Passed
		h. Sieve No. 10	78.0	% Passed
		i. Sieve No. 20	68.5	% Passed
		j. Sieve No. 40	61.2	% Passed
		k. Sieve No. 60	54.6	% Passed
		l. Sieve No. 140	42.7	% Passed
		m. Sieve No. 200	36.3	% Passed
		n. Particle Size .022mm	17.8	% Passed
		o. Particle Size .006mm	10.1	% Passed
		p. Particle Size .001mm	3.0	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	7.3	meq/100 g
3	I620S	Percent Solids at 103C	92.4	%

COMMENTS:

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July 22, 1993
Report No.: 00016035
Section A Page 8

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B3-S2-061693
NUS SAMPLE NO: P0240019
P.O. NO.:

DATE SAMPLED: 16-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		e. 1/2 inch sieve	100.0	% Passed
		f. 3/8 inch sieve	99.8	% Passed
		g. Sieve No. 4	99.3	% Passed
		h. Sieve No. 10	97.5	% Passed
		i. Sieve No. 20	92.0	% Passed
		j. Sieve No. 40	86.0	% Passed
		k. Sieve No. 60	80.1	% Passed
		l. Sieve No. 140	62.9	% Passed
		m. Sieve No. 200	51.7	% Passed
		n. Particle Size .021mm	23.7	% Passed
		o. Particle Size .006mm	14.2	% Passed
		p. Particle Size .001mm	5.7	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	6.3	meq/100 g
3	I620S	Percent Solids at 103C	93.1	%

COMMENTS:

CLIENT ORIGINAL

REMIT TO:

HALLIBURTON NUS
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July 22, 1993
Report No.: 00016035
Section A Page 9

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B3-S3-061693
NUS SAMPLE NO: P0240020
P.O. NO.:

DATE SAMPLED: 16-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		e. 1/2 inch sieve	100.0	% Passed
		f. 3/8 inch sieve	99.6	% Passed
		g. Sieve No. 4	98.4	% Passed
		h. Sieve No. 10	96.1	% Passed
		i. Sieve No. 20	90.9	% Passed
		j. Sieve No. 40	85.9	% Passed
		k. Sieve No. 60	80.7	% Passed
		l. Sieve No. 140	65.3	% Passed
		m. Sieve No. 200	55.4	% Passed
		n. Particle Size .021mm	25.2	% Passed
		o. Particle Size .006mm	15.9	% Passed
		p. Particle Size .001mm	6.5	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	3.8	meq/100 g
3	I620S	Percent Solids at 103C	89.7	%

COMMENTS:

LIGHT ORIGINAL

HALLIBURTON NUS
Environmental Corporation
Environmental Laboratories

July 22, 1993
Report No.: 00016035
Section A Page 10

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B4-S1-061793
NUS SAMPLE NO: P0240021
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		e. 1/2 inch sieve	100.0	% Passed
		f. 3/8 inch sieve	99.5	% Passed
		g. Sieve No. 4	98.8	% Passed
		h. Sieve No. 10	98.1	% Passed
		i. Sieve No. 20	96.7	% Passed
		j. Sieve No. 40	95.0	% Passed
		k. Sieve No. 60	91.6	% Passed
		l. Sieve No. 140	85.5	% Passed
		m. Sieve No. 200	82.0	% Passed
		n. Particle Size .022mm	24.3	% Passed
		o. Particle Size .006mm	10.7	% Passed
		p. Particle Size .001mm	2.9	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	15	meq/100 g
3	I620S	Percent Solids at 103C	83.4	%

COMMENTS:

CLIENT ORIGINAL

REMIT TO:

HALLIBURTON NUS
Environmental Corporation
Environmental Laboratories

July 22, 1993
Report No.: 00016035
Section A Page 11

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B4-S2-061793
NUS SAMPLE NO: P0240022
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		e. 1/2 inch sieve	100.0	% Passed
		f. 3/8 inch sieve	99.7	% Passed
		g. Sieve No. 4	99.6	% Passed
		h. Sieve No. 10	99.5	% Passed
		i. Sieve No. 20	99.1	% Passed
		j. Sieve No. 40	98.7	% Passed
		k. Sieve No. 60	97.9	% Passed
		l. Sieve No. 140	95.7	% Passed
		m. Sieve No. 200	90.9	% Passed
		n. Particle Size .022mm	24.7	% Passed
		o. Particle Size .007mm	6.9	% Passed
		p. Particle Size .001mm	3.0	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	10	meq/100 g
3	I620S	Percent Solids at 103C	80.4	%

COMMENTS:

HALLIBURTON NUS
Environmental Corporation

July 22, 1993
Report No.: 00016035
Section A Page 12

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B4-S3-061793
NUS SAMPLE NO: P0240023
P.O. NO.:

DATE SAMPLED: 17-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		c. 1.0 inch sieve	100.0	% Passed
		d. 3/4 inch sieve	99.2	% Passed
		e. 1/2 inch sieve	91.2	% Passed
		f. 3/8 inch sieve	88.5	% Passed
		g. Sieve No. 4	82.6	% Passed
		h. Sieve No. 10	74.8	% Passed
		i. Sieve No. 20	65.3	% Passed
		j. Sieve No. 40	56.5	% Passed
		k. Sieve No. 60	47.3	% Passed
		l. Sieve No. 140	27.8	% Passed
		m. Sieve No. 200	20.5	% Passed
		n. Particle Size .022mm	5.5	% Passed
		o. Particle Size .006mm	2.5	% Passed
		p. Particle Size .001mm	1.1	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	5.7	meq/100 g
3	I620S	Percent Solids at 103C	81.2	%

COMMENTS:

REMIT TO:

HALLIBURTON NUS
Environmental Corporation
Environmental Labor...

July 22, 1993
Report No.: 00016035
Section A Page 13

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8659
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B5-S1-061693
NUS SAMPLE NO: P0240024
P.O. NO.:

DATE SAMPLED: 16-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		d. 3/4 inch sieve	100.0	% Passed
		e. 1/2 inch sieve	94.5	% Passed
		f. 3/8 inch sieve	92.7	% Passed
		g. Sieve No. 4	85.0	% Passed
		h. Sieve No. 10	73.9	% Passed
		i. Sieve No. 20	62.1	% Passed
		j. Sieve No. 40	55.1	% Passed
		k. Sieve No. 60	49.8	% Passed
		l. Sieve No. 140	40.5	% Passed
		m. Sieve No. 200	36.2	% Passed
		n. Particle Size .022mm	15.4	% Passed
		o. Particle Size .006mm	8.1	% Passed
		p. Particle Size .001mm	3.7	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	6.8	meq/100 g
3	I620S	Percent Solids at 103C	87.1	%

COMMENTS:

CLIENT ORIGINAL

REMIT TO:

HALLIBURTON NUS
Environmental Corporation
Environmental Laboratories

July 22, 1993
Report No.: 00016035
Section A Page 14

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8859
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B5-S2-061693
NUS SAMPLE NO: P0240025
P.O. NO.:

DATE SAMPLED: 16-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		c. 1.0 inch sieve	100.0	% Passed
		d. 3/4 inch sieve	87.8	% Passed
		e. 1/2 inch sieve	82.3	% Passed
		f. 3/8 inch sieve	82.3	% Passed
		g. Sieve No. 4	79.3	% Passed
		h. Sieve No. 10	74.3	% Passed
		i. Sieve No. 20	67.6	% Passed
		j. Sieve No. 40	62.9	% Passed
		k. Sieve No. 60	58.8	% Passed
		l. Sieve No. 140	51.3	% Passed
		m. Sieve No. 200	47.4	% Passed
		n. Particle Size .022mm	18.4	% Passed
		o. Particle Size .006mm	9.6	% Passed
		p. Particle Size .001mm	5.1	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	17	meq/100 g
3	I620S	Percent Solids at 103C	69.1	%

COMMENTS:

CLIENT ORIGINAL

REMIT TO:

HALLIBURTON NUS
Environmental Corporation
Environmental Laboratories

July 22, 1993
Report No.: 00016035
Section A Page 15

LABORATORY ANALYSIS REPORT

CLIENT NAME: NAVY CLEAN - C/O HALLIBURTON NUS
ADDRESS: 187 BALLARDVALE STREET/SUITE A-1
WILMINGTON, MA 01887-
ATTENTION: MR. CHUCK MARTIN

NUS CLIENT NO: 1495 0015
WORK ORDER NO: 8859
VENDOR NO:

Carbon Copy:

SAMPLE ID: 05-B5-S3-061693
NUS SAMPLE NO: P0240026
P.O. NO.:

DATE SAMPLED: 16-JUN-93
DATE RECEIVED: 24-JUN-93
APPROVED BY: Chuck Kieda

LN	TEST CODE	DETERMINATION	RESULT	UNITS
1	T45	Grain Size - Sieve & Hydrometer		
		b. 1.5 inch sieve	100.0	% Passed
		c. 1.0 inch sieve	73.8	% Passed
		d. 3/4 inch sieve	60.1	% Passed
		e. 1/2 inch sieve	56.5	% Passed
		f. 3/8 inch sieve	53.4	% Passed
		g. Sieve No. 4	50.1	% Passed
		h. Sieve No. 10	47.4	% Passed
		i. Sieve No. 20	44.9	% Passed
		j. Sieve No. 40	43.5	% Passed
		k. Sieve No. 60	42.6	% Passed
		l. Sieve No. 140	40.8	% Passed
		m. Sieve No. 200	39.2	% Passed
		n. Particle Size .022mm	11.8	% Passed
		o. Particle Size .007mm	4.2	% Passed
		p. Particle Size .001mm	2.4	% Passed
2	ACECS	Cation Exchange Capacity (CEC)	13	meq/100 g
3	I620S	Percent Solids at 103C	80.2	%

COMMENTS:

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-B6A-S1-021494	5-B6A-S2-021494	5-B6A-S3-021494
LABORATORY ID:			17590.01	17590.02	17590.03
% SOLIDS:			70	78	81
TAL METAL SOILS (MG/KG)	CRQL	MDL			
LEAD	0.3	0.1	25.9	7.6	5.6

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-B7A-S1-021494	5-B7A-S2-021494	5-B7A-S3-021494
LABORATORY ID:			17590.04	17590.05	17590.06
% SOLIDS:			86	92	93
TAL METAL SOILS (MG/KG)	CRQL	MDL			
LEAD	0.3	0.1	762	492	7.1

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-B8A-S1-021494	5-B8A-S1A-021494	5-B8A-S2-021494	5-B8A-S3-02149
LABORATORY ID:			17590.07	17590.27	17590.08	17590.09
			FIELD DUPLICATE PAIR			
% SOLIDS:			78	78	90	88
TAL METAL SOILS (MG/KG)	CRQL	MDL				
LEAD	0.3	0.1	576	355	6.3	6

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-B6A-S1-021494	5-B6A-S2-021494	5-B6A-S3-021494
LABORATORY ID:			17590.13	17590.14	17590.15
TCLP METALS (UG/L)	CRQL	MDL			
LEAD	14	NA	18.9	14 U	14 U

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-B7A-S1-021494	5-B7A-S2-021494	5-B7A-S3-021494	
LABORATORY ID:			17590.16	17590.17	17590.18	
TCLP METALS (UG/L)	CRQL	MDL				
LEAD	14	NA	12500	4960	14	U

5A_SB_TP.WK3

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-B8A-S1-021494	5-B8A-S1A-021494	5-B8A-S2-021494	5-B8A-S3-021494
LABORATORY ID:			17590.19	17590.25	17590.20	17590.21
				FIELD DUPLICATE PAIR		
TCLP METALS (UG/L)	CRQL	MDL				
LEAD	14	NA	10100	13300	14 U	14 U

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE AREA SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:	5-B6A-S1-021494	5-B6A-S2-021494	5-B6A-S3-021494
LABORATORY ID:	17590.01	17590.02	17590.03
pH	4.77	4.89	4.71

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE AREA SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:	5-B7A-S1-021494	5-B7A-S2-021494	5-B7A-S3-021494
LABORATORY ID:	17590.04	17590.05	17590.06
pH	6.62	6.69	7.2

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE AREA SOIL BORING RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:	5B8A-S1-021494	5-B8A-S1A-021494	5-B8A-S2-021494	5-B8A-S3-02149
LABORATORY ID:	17590.07	17590.25	17590.08	17590.09
	FIELD DUPLICATE PAIR			
pH	7.15	7.12	7.22	6.44

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE GROUNDWATER RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R1A-S1-021894		5-R2A-S1-021694		5-R2A-S2-021694	
LABORATORY ID:			17640.03		17640.07		17640.16 FILTERED	
CLP METALS (µG/KG)	CRQL	MDL						
LEAD	3	1	1	U	1	U	1	U

5A_GW_PB.WK4

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE GROUNDWATER RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R3A-S1-021794	5-R3A-S2-021794	5-R3A-S3-021794	5-R4A-S1-021694
LABORATORY ID:			17640.04	17640.11	17640.12	17640.05
				FIELD DUPLICATE PAIR	FILTERED	
CLP METALS (µG/KG)	CRQL	MDL				
LEAD	3	1	1.7	1.8	1 U	2.7

5A_GW_PB.WK4

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE GROUNDWATER RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R5A-S1-021794		5-MW10-1A-S1-021794		5-MW10-3A-S1-021794	
LABORATORY ID:			17640.06		17640.01		17640.02	
CLP METALS (µG/KG)	CRQL	MDL						
LEAD	3	1	1	U	1	U	1	U

5A_GW_PB.WK4

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE GROUNDWATER RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R1A-S1-021894	5-R2A-S1-021694	5-R3A-S1-021794	5-P4A-S1-021694
LABORATORY ID:			17640.03	17640.07	17640.04	17640.05
MISCELLANEOUS	CRQL	MDL				
HARDNESS as CaCO3 (mg/l)	1	N/A	28	24	32	32
pH			5.44	5.89	5.92	6.04

SITE: CTO 127, NCBC DAVISVILLE, RI
CAMP FOGARTY FIRING RANGE GROUNDWATER RESULTS - ROUND 2
LABORATORY: SOUTHWEST LABORATORY OF OKLAHOMA

CLIENT ID:			5-R5A-S1-021794	5-MW10-1A-S1-021794	5-MW10-3A-S1-021794
LABORATORY ID:			17640.06	17640.01	17640.02
MISCELLANEOUS	CRQL	MDL			
HARDNESS as CaCO3 (mg/l)	1	N/A	24	20	16
pH			5.96	5.68	5.46

APPENDIX B

BORING AND WELL CONSTRUCTION LOGS

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127	LOCATION: Camp Fogarty	DRILLED BY: C. Stamas/EDI	BORING NO.: R-1
DATE STARTED: 6/17/93	INCLINATION: Vertical	LOGGED BY: P. Young	GROUND ELEV.: Not surveyed
DATE COMPLETED: 6/17/93	BEARING: N/A	CHECKED BY:	TOTAL DEPTH: 13 feet

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
0	0	S-1	6 - 36 36 - 63	24	24	< 1 ppm on sample		S-1 (0 ft. to 2 ft.) SILTY SAND, fine - coarse sand with gravel up to 0.5 in., tan. (SM)
	2	S-2	11 - 4 20 - 60	24	22	0 ppm on sample		S-2 (2 ft. to 3 ft. 10 in.) SILTY SAND, similar to S-1 but siltier, 0.5 in. gravel, piece of altered rock, tan/brown; 14 in. layer of loose silty sand. (SM)
	4	S-3	11 - 33 52 - 39	24	24	0 ppm on sample		S-3A (4 ft. to 4 ft. 7 in.) SILTY SAND, similar to S-2, brown. (SM) S-3B (4 ft. 7 in. to 4 ft. 9 in.) 2 in. rounded gravel between S-3A and S-3C.
	6					∇ @ 6 ft. on 6/17/93.		S-3C (4 ft. 9 in. to 5 ft. 2 in.) SILT, with small root hairs, dark brown. (ML) S-3D (5 ft. 2 in. to 5 ft. 4 in.) SILT, black, piece of altered rock (ML)
	8							S-3E (5 ft. 4 in. to 6 ft.) SAND, fine sand seams of oxide discoloration, gray. (SP)
	10	S-4	25 - 22 29 - 46	24	17	< 1 ppm on sample Auger grinding @ 13 ft.		S-4 (10 ft. to 11 ft. 5 in.) SILTY GRAVELLY SAND, fine - coarse sand with angular to subangular gravel up to 0.5 in., grades from brown to tan, a 7 in. layer then grades to red/brown then back to brown. (SM-SW)
	12							
	14							END OF BORING. MONITORING WELL R-1 INSTALLED.
	16							
	18							
	20							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
∇ - Natural ground water table

NOTES:

Borehole advanced by rotating 8-inch outside diameter hollow stem augers to 13 ft. Continuous 2 in. split barrel samples collected until water table (WT) intersected (∇ @ 6 ft. on 6/17/93). Additional samples collected at 5 foot intervals to approximately 10 ft. below the WT or to a point of refusal. Monitoring well installed in R-1.

DATE: 10/07/93 PROJECT NO.: 8659
PAGE: 1 OF 1 BORING NO.: R-1

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127	LOCATION: Camp Fogarty	DRILLED BY: Geosearch	BORING NO.: R-2
DATE STARTED: 6-17-93	INCLINATION: Vertical	LOGGED BY: K. Jalkut	GROUND ELEV.: Not surveyed
DATE COMPLETED: 6-17-93	BEARING: N/A	CHECKED BY:	TOTAL DEPTH: 17 ft.

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
0	0	S-1	3 - 3 5 - 5	24	21	0ppm on sample		S-1 (0 to 21 in.) SILTY SAND. Tan to brown; fine grained sand; poorly graded; >12% silt; grass roots present; (SM)
	2	S-2	6 - 7 9 - 7	24	18	0ppm on sample; Grinding against boulders		S-2 (2 ft. - 3 ft. 6 in.) SILTY SAND. Tan to brown with an orange discoloration; similar to S-1; (SM)
	4	S-3	6 - 10 12 - 23	24	19	0ppm on sample; Grinding against boulders; ▽ @ 6 feet on 6-17-93		S-3A (4 ft. - 4 ft. 3 in.) HIGHLY ORGANIC SOIL - PEAT/LOAM. Dark brown; fine grained soil; poorly graded; twigs; no apparent odor; (PT) S-3B (4 ft. 3 in. - 5 ft. 7 in.) SILTY SAND with gravel. Tan to brown; fine grained sand; poorly graded; >12% silt; some subrounded fine gravel (0.25 in. to 0.50 in.) present; (SM)
	6							
	8							
	10	S-4	8 - 14 17 - 13	24	10	0ppm on sample; Grinding against boulders; sample saturated		S-4 (10 ft.- 10 ft. 10 in.) SAND, with gravel, trace of silt. Brown; fine to medium grained sand with trace of coarse grained sand; well graded; 1 piece of angular, fine gravel (0.5 in.) present; <5% silt; (SW)
	12							
	14							
		S-5	7 - 10 18 - 21	24	16	0ppm on sample; Grinding against boulders		S-5 (15 ft. - 16 ft. 4 in.) SAND, with gravel, trace of silt, interbedded with a single layer of organic material. Brown; fine to coarse grained sand; widely graded; 2 pieces of angular, fine gravel (0.5 in) and 1 piece of angular, coarse gravel (1.5 in.) present; <5% silt; (SW); 1-inch interbed of highly organic soil present - dark brown loam; similar to S-3A; (PT)
	16							
	18					Refusal; No sample collected; End of boring		END OF BORING @ 18 FT. ON 6-17-93; ON 6-18-93, BOREHOLE COLLAPSED TO 17 FT.; GROUNDWATER MONITORING WELL R-2 INSTALLED TO A DEPTH OF 17 FT.
	20							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
▽ - Natural ground water table

NOTES:
Borehole advanced by rotating 8-inch outside diameter hollow stem augers to 18 ft. Continuous split barrel samples collected until water table (WT) intersected (▽ @ 6 ft. on 6-17-93). Additional samples collected at 5 foot intervals to roughly 10 ft. below the WT. Refusal at 18 ft. Borehole collapsed to 17 ft. on 6-18-93. Collapsed material could not be removed; well set at 17 ft.

DATE: 10/07/93 PROJECT NO.: 8659
PAGE: 1 OF 1 BORING NO.: R-2

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127 LOCATION: Camp Fogarty/Range A DRILLED BY: C. Stamas/EDI BORING NO.: R-3

DATE STARTED: 6/16/93 INCLINATION: Vertical LOGGED BY: P. Young GROUND ELEV.: Not surveyed

DATE COMPLETED: 6/16/93 BEARING: N/A CHECKED BY: TOTAL DEPTH: 18 feet

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
0	0	S-1	4 - 14 20 - 18	24	21	0 ppm on sample		S-1A (0 to 1 ft. 3 in.) SILTY SAND, fine - coarse sand, 6 in. layer, brown and a 9 in. layer, gray; pulverized rock at end of split barrel sampler; (SM)4 in. layer topsoil. (SM) S-1B (1 ft. 3 in. to 1 ft. 7 in.) 4 in. layer of topsoil. (SM)
	2	S-2	32 - 20 30 - 40	24	17	0 ppm on sample		S-2 (2 ft. to 3 ft. 5 in.) SILTY SAND, fine - coarse sand, brown; 2 in. layer of coarse gravel at top of sample. (SM)
	4	S-3	2 - 4 4 - 5	24	10	0 ppm on sample		S-3A (4 ft. to 4 ft. 8 in.) SAND, fine - coarse sand, few pieces of fine gravel, trace of silt, 8 in. layer, brown. (SW) 2 in. layer of S-3B (4 ft. 8 in. to 4 ft. 10 in.) SILTY SAND, 2 in. layer with piece of fine gravel, dark brown. (SM)
	6					▽ @ 6 ft. on 6/16/93.		
	8							
	10	S-4	22 - 15 59 - 120/0"	18	18	0 ppm on sample. Tough drilling, boulders to 15'.		S-4 (10 ft. to 11 ft. 6 in.) SILTY SAND, fine - coarse sand with pieces of fine gravel, brown. (SM)
	12							
	14							
	16	S-5	120/1"	1	18	Split barrel refusal @ 16.1'. 17" wash. Boulders to 18'.		S-5 (16 ft. to 16 ft. 1 in.) SILT (ML)
	18							END OF BORING @ 18 FT. MONITORING WELL INSTALLED IN R-3.
	20							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
▽ - Natural ground water table

NOTES:
Borehole advanced by rotating 8-inch outside diameter hollow stem augers to 18 ft. Continuous 2 in. split barrel samples collected until water table (WT) intersected (▽ @ 6 ft. on 6/16/93). Additional samples collected at 5 foot intervals to approximately 10 ft. below the WT or to a point of refusal. Monitoring well installed in R-3.

DATE: 10/08/93 PROJECT NO.: 8659
PAGE: 1 OF 1 BORING NO.: R-3

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127	LOCATION: Camp Fogarty	DRILLED BY: T. Belsky/Geosearch	BORING NO.: R-4
DATE STARTED: 6-17-93	INCLINATION: Vertical	LOGGED BY: K. Jalkut	GROUND ELEV.: Not surveyed
DATE COMPLETED: 6-17-93	BEARING: N/A	CHECKED BY:	TOTAL DEPTH: 22 ft.

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
0	0	S-1	2 - 3 8 - 10	24	18	0ppm on sample		S-1 (0 to 18 in.) SAND, trace of silt. Light grey to tan; fine grained sand with trace percentages of medium grained sand; mostly well graded; <5% silt; grass roots present 0 to 2 inches; (SP)
	2	S-2	11 - 13 13 - 18	24	22	0ppm on sample		S-2A (2 ft. to 3 ft) SAND, trace of silt. Light grey; fine grained sand with trace percentages of medium and coarse grained sand; mostly well uniformly graded; <5% silt; (SP)
	4	S-3	9 - 12 18 - 35	24	24	0ppm on sample; Grinding against rock material		S-2B (3 ft. to 3 ft. 10 in.) SAND, with trace to some silt. Light brown; fine grained sand; poorly graded; <5% silt; (SP) S-3A (4 ft. to 5 ft.) SAND, with trace to some silt. Similar to S-2B. (SP)
	6	S-4	23 - 27 17 - 17	24	18	0ppm on sample; Grinding against rock material		S-3B (5 ft. to 6 ft.) SAND, trace to some silt, with gravel. Brown; fine to medium grained sand with trace percentage of coarse grained sand; well graded; 5% to 12% silt; 2 pieces of angular, coarse gravel (1 in.); gravel pieces appear to be a schist; (SW)
	8	S-5	12 - 16 13 - 11	24	15	0ppm on sample; Grinding against rock material		S-4 (6 ft. to 7 ft. 6 in.) SILTY SAND with gravel. Brown; fine to medium grained sand with trace percentage of coarse grained sand; well graded; >12% silt; 1 piece of subangular, fine gravel (0.5 in.) (SM)
	10	S-6	22 - 26 13 - 8	24	6	0ppm on sample; Pushed rock ahead of split barrel sampler - little recovery; ∇ @ 10 ft. on 6-17-93		S-5 (8 ft. to 9 ft. 3 in.) SILTY SAND with gravel. Dark brown; fine to medium grained sand with trace percentage of coarse grained sand; well graded; >12% silt; 1 piece of angular, coarse gravel (2 in.) that appears to be a schist; (SM)
	12							
	14							S-6 (10 ft. to 10 ft. 6 in.) SAND, trace to some silt, with gravel. Brown; fine to coarse grained sand; well graded; <5% silt; pieces of subangular to subrounded, fine gravel; (SW)
		S-7	63 - 100/4	10	10	0ppm on sample; Blowing sand; Grinding - temporary refusal due to a boulder		S-7 (15 ft. to 15 ft. 10 in.) SAND, trace to some silt. Brown; fine to medium grained sand with trace percentage of coarse grained sand; well graded; <5% silt; (SW)
	16							
	18							
	20							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
∇ - Natural ground water table

NOTES:
Borehole advanced by rotating 8-inch diameter hollow stem augers to 22 ft. Continuous split barrel samples collected until water table (WT) intersected (∇ @ 10 ft. on 6-17-93). Additional samples collected at 5 foot intervals to roughly 10 ft. below the WT or to refusal.

DATE: 10/08/93 PROJECT NO.: 8659
PAGE: 1 OF 2 BORING NO.: R-4

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127	LOCATION: Camp Fogarty	DRILLED BY: T. Belsky/Geosearch	BORING NO.: R-4
DATE STARTED: 6-17-93	INCLINATION: Vertical	LOGGED BY: K. Jalkut	GROUND ELEV.: Not surveyed
DATE COMPLETED: 6-17-93	BEARING: N/A	CHECKED BY:	TOTAL DEPTH: 22 ft.

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
	20	S-8	21 - 17 16 - 32	24	15	Oppm on sample Grinding against a boulder		S-8 (20 ft. to 21 ft., 3 in.) SAND, trace of silt, with gravel. Brown; fine to medium grained sand with trace percentage of coarse grained sand; well graded; 5% silt; fine gravel; (SW)
	22							END OF BORING @ 22 FT.; GROUNDWATER MONITORING WELL R-4 INSTALLED
	24							
	26							
	28							
	30							
	32							
	34							
	36							
	38							
	40							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
∇ - Natural ground water table

NOTES:
Borehole advanced by rotating 8-inch diameter hollow stem augers to 22 ft. Continuous split barrel samples collected until water table (WT) intersected (∇ @ 10 ft. on 6-17-93). Additional samples collected at 5 foot intervals to roughly 10 ft. below the WT or to refusal.

DATE: 10/08/93 PROJECT NO.: 8659
PAGE: 2 OF 2 BORING NO.: R-4

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127	LOCATION: Camp Fogarty	DRILLED BY: T. Belsky/Geosearch	BORING NO.: R-5A
DATE STARTED: 6-16-93	INCLINATION: Vertical	LOGGED BY: K. Jalkut.	GROUND ELEV.: Not surveyed
DATE COMPLETED: 6-16-93	BEARING: N/A	CHECKED BY:	TOTAL DEPTH: 16 ft

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
0	0	S-1	6 - 13 13 - 10	24	20	0ppm on sample		S-1 (0 to 20 in.) SAND, trace to some silt, with gravel. Tan; fine sand with traces of medium and coarse sand; mostly well graded; <5% silt; several pieces of subangular, fine and coarse gravel; quartz pebble present; (SW)
	2	S-2	7 - 6 4 - 5	24	19	0ppm on sample		S-2 (2 ft. to 3 ft. 7 in.) SILTY SAND with gravel. Tan; fine sand with traces of medium and coarse sand; mostly well graded; >12% silt; subrounded, fine gravel; (SM)
	4	S-3	2 - 1 3 - 5	24	19	0ppm on sample		S-3 (4 ft. to 5 ft. 7 in.) SAND, trace of silt, with gravel. Tan; fine sand with traces of medium sand; well graded; <5% silt; fine gravel; (SP)
	6	S-4	6 - 10 22 - 31	24	17	0ppm on sample; Auger grinding through boulder; perched ∇ @ 6.5 ft. on 6-16-93		S-4A (6 ft. to 6 ft. 11 in.) SAND, trace of silt. Tan-Grey; fine sand; poorly graded; <5% silt; (SP) S-4B (6 ft. 11 in. to 7 ft. 5 in.) SAND, trace of silt. Dark brown; fine sand with traces of medium and coarse sand; mostly well graded; <5% silt; (SP)
	8	S-5	10 - 18 13 - 15	24	17	0ppm on sample; Auger grinding through boulder;		S-5 (8 ft. to 9 ft. 5 in.) SAND, trace of silt, with gravel. Light brown to tan; fine sand with traces of medium sand; well graded; <5% silt; pieces of angular, fine gravel (quartz pebble), and angular coarse gravel present; (SP)
	10	S-6	10 - 16 13 - 18	24	19	0ppm on sample; Damp sediment - ∇ @ 10.5 ft. on 6-16-93		S-6 (10 ft. to 11 ft. 7 in.) SAND, trace to some silt, with gravel. Brown; fine sand with traces of medium and coarse sand; well graded; <5% silt; pieces of angular, coarse (1.5 in.) gravel (quartz pebble) present; (SP)
	12							
	14							
	16	S-7	12 - 100/2	24	13	0ppm on sample; Sediment saturated Refusal @ 16 ft.; End of boring		S-7 (15 ft. to 15 ft. 8 in.) SAND, trace to some silt. Brown; fine and medium sand with traces of coarse sand; well graded; <5% silt; (SW) END OF BORING @ 16 FT. - REFUSAL; BOREHOLE BACKFILLED AND ABANDONED; NO GROUNDWATER MONITORING WELL INSTALLED IN R-5A
	18							
	20							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
∇ - Natural ground water table

NOTES:

Borehole advanced by rotating 8-inch diameter hollow stem augers to 16 ft. Continuous split barrel samples collected until water table (WT) intersected (∇ @ 10.5 ft. on 6-16-93; perched WT @ 6.5 ft.). Additional samples collected at 5 foot intervals to roughly 10 ft. below the WT or to a point of refusal. Refusal at 16 ft. R-5A boring backfilled and abandoned. Monitoring well set @ R-5B, adjacent to R-5A.

DATE: 10/08/93 PROJECT NO.: 8659
PAGE: 1 OF 1 BORING NO.: R-5A

BORING LOG **HALLIBURTON NUS ENVIRONMENTAL CORPORATION**

PROJECT: NCBC - CTO 127	LOCATION: Camp Fogarty	DRILLED BY: T. Betsky/Geosearch	BORING NO.: R-5B
DATE STARTED: 6-16-93	INCLINATION: Vertical	LOGGED BY: K. Jalkut	GROUND ELEV.:
DATE COMPLETED: 6-16-93	BEARING: N/A	CHECKED BY:	TOTAL DEPTH: 16

ELEV. feet	DEPTH feet	SAMPLE TYPE-NO.	SAMPLE BLOWS PER 6"	SAMPLE PEN. in.	SAMPLE REC. in.	REMARKS ON ADVANCE OF BORING	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
	0							NO SOIL SAMPLES COLLECTED. SEE BORING LOG R-5A FOR ALL SOIL AND ROCK DESCRIPTIONS
	2							
	4							
	6							
	8							
	10							
	12							
	14							
	16							REFUSAL @ 16 FT.
								END OF BORING - INSTALLED GROUNDWATER MONITORING WELL R-5B
	18							
	20							

LEGEND:
TYPE-NO. - Type of sample
C - Rock core sample
S - Split barrel sample
BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
PEN - Penetration length of sampler
REC - Length of sample recovered
▽ - Natural ground water table

NOTES:
Borehole advanced by rotating 8-inch outside diameter hollow stem augers to 16 ft. Refusal @ 16 ft. No soil samples were collected. All soils descriptions for boring R-5A applicable to boring R-5B, located less than 5 feet away. R-5B was drilled because refusal was encountered in R-5A @ 16 ft. Because refusal was also encountered in R-5B at same depth, monitoring well R-5B was installed.

DATE: 10/08/93 PROJECT NO.: 8659
PAGE: 1 OF 1 BORING NO.: R-5B

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

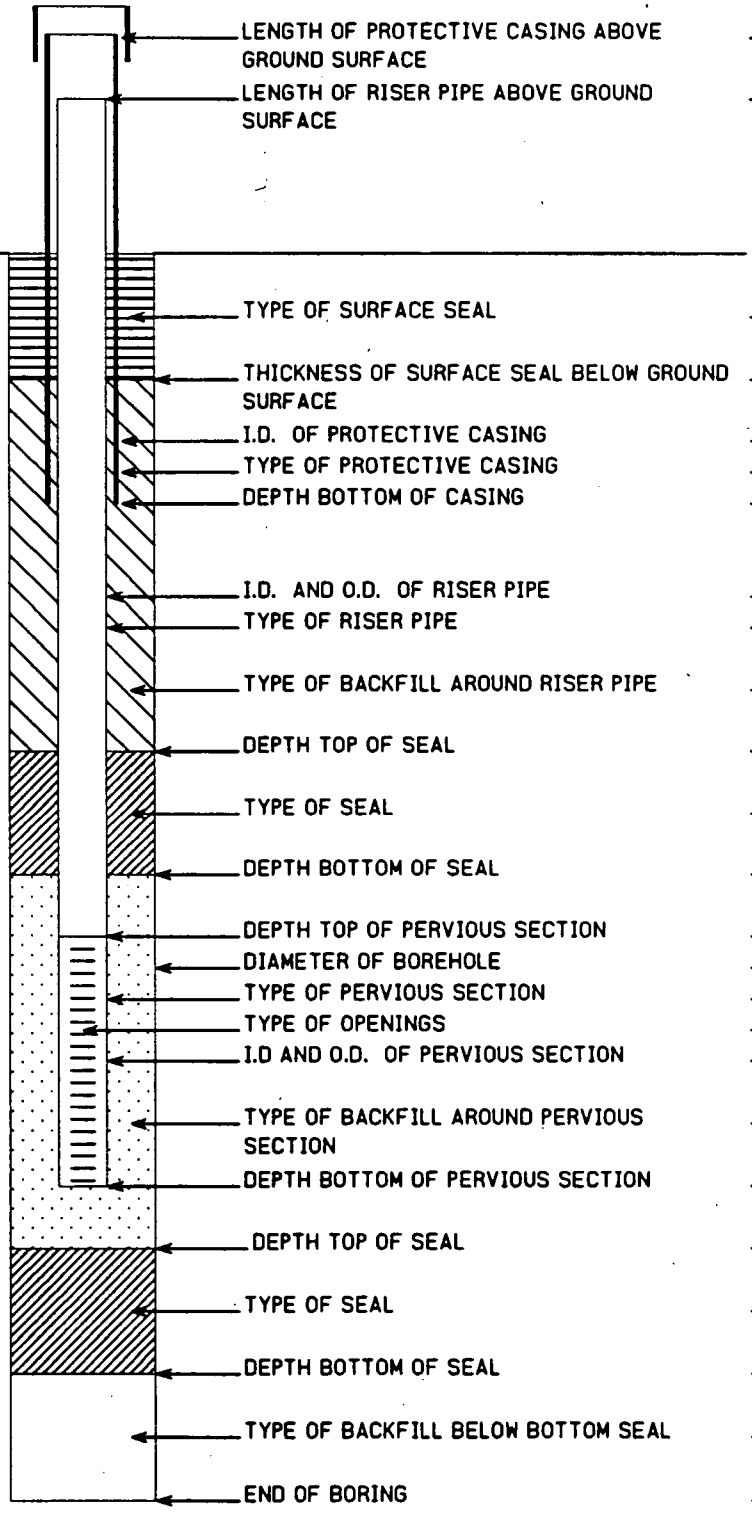
PROJECT: NCBC - CTO 127		PAGE: 1 OF 1	
PROJECT LOCATION: Davisville, RI		R-1	
CLIENT: U.S. Navy		BORING NO.: R-1	
CONTRACTOR: Environmental Drilling Inc.	DRILLER: C. Stamas	BORING LOCATION: Camp Fogarty	
LOGGED BY: P. Young	DATE: 6/17/93	PROJECT NO.: 8659	
CHECKED BY:	DATE:		

ELEVATION TOP OF PROTECTIVE CASING MSL

ELEVATION TOP OF RISER PIPE MSL

GROUND ELEVATION Not surveyed MSL

Water Table Aquifer



General soil conditions (not to scale)

LENGTH OF PROTECTIVE CASING ABOVE GROUND SURFACE	2.9'
LENGTH OF RISER PIPE ABOVE GROUND SURFACE	2.5'
TYPE OF SURFACE SEAL	Cement
THICKNESS OF SURFACE SEAL BELOW GROUND SURFACE	1'
I.D. OF PROTECTIVE CASING	6"
TYPE OF PROTECTIVE CASING	Steel
DEPTH BOTTOM OF CASING	1'
I.D. AND O.D. OF RISER PIPE	2" & 2 3/8"
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Silica sand
DEPTH TOP OF SEAL	3'
TYPE OF SEAL	Bentonite chips
DEPTH BOTTOM OF SEAL	7'
DEPTH TOP OF PERVIOUS SECTION	8'
DIAMETER OF BOREHOLE	4"
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
TYPE OF OPENINGS	0.010 slotted
I.D AND O.D. OF PERVIOUS SECTION	2" & 2 3/8"
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Silica sand
DEPTH BOTTOM OF PERVIOUS SECTION	12.5'
DEPTH TOP OF SEAL	N/A
TYPE OF SEAL	Silica sand
DEPTH BOTTOM OF SEAL	N/A
TYPE OF BACKFILL BELOW BOTTOM SEAL	N/A
END OF BORING	13 feet

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

PROJECT: NCBC - CTO 127 PAGE: 1 OF 1

PROJECT LOCATION: E. Greenwich, RI R-2

CLIENT: NAVFAC BORING NO.: R-2

CONTRACTOR: Geosearch DRILLER: T. Belsky BORING LOCATION: Camp Fogarty

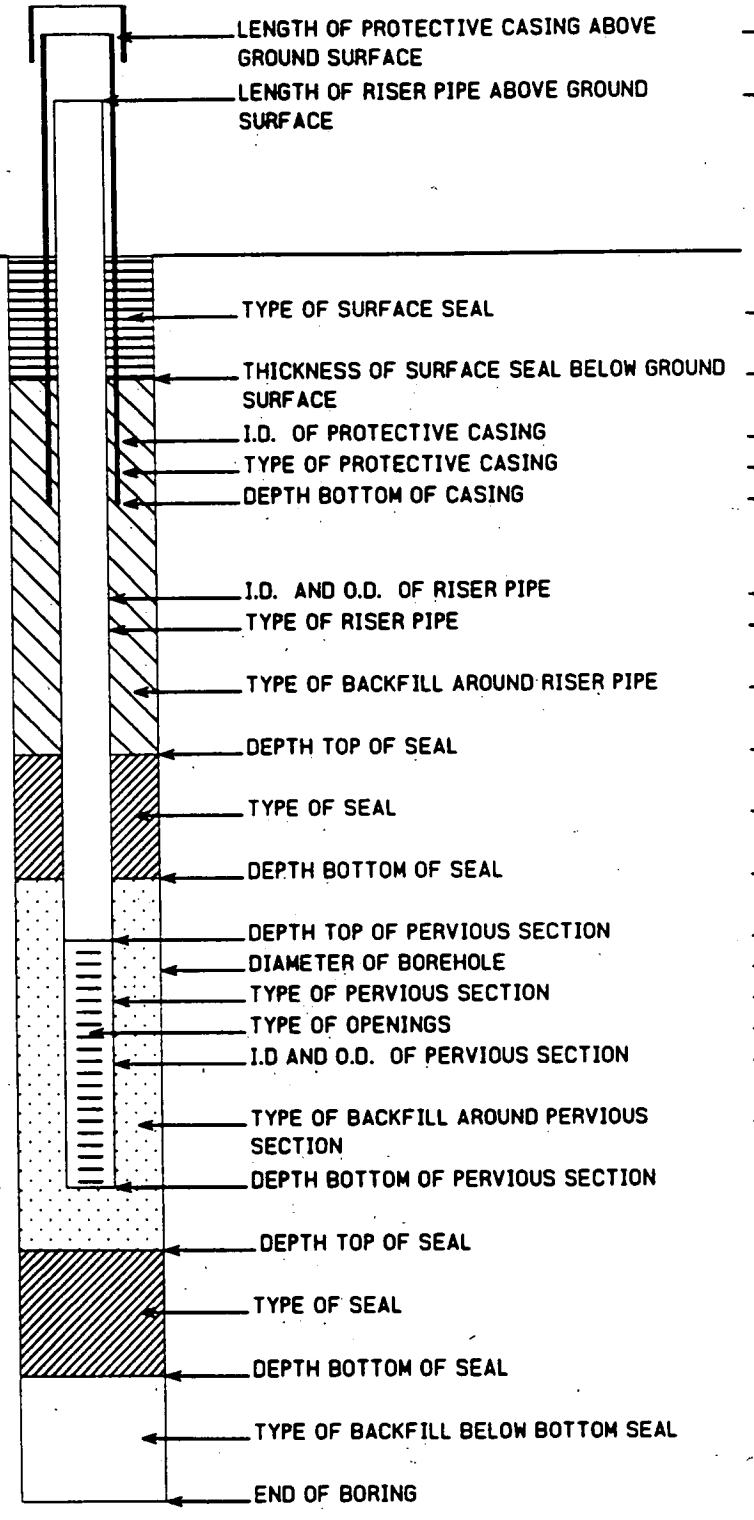
LOGGED BY: K. Jalkut DATE: 6-18-93 PROJECT NO.: 8659

CHECKED BY: W.J. Martin DATE: 10-25-93

ELEVATION TOP OF PROTECTIVE CASING Not surveyed MSL

ELEVATION TOP OF RISER PIPE Not surveyed MSL

GROUND ELEVATION Not surveyed MSL



LENGTH OF PROTECTIVE CASING ABOVE GROUND SURFACE	2 ft.
LENGTH OF RISER PIPE ABOVE GROUND SURFACE	11 in.
TYPE OF SURFACE SEAL	Cement
THICKNESS OF SURFACE SEAL BELOW GROUND SURFACE	6 in.
I.D. OF PROTECTIVE CASING	8 in.
TYPE OF PROTECTIVE CASING	Steel
DEPTH BOTTOM OF CASING	3 ft.
I.D. AND O.D. OF RISER PIPE	2 in./2.5 in.
TYPE OF RISER PIPE	PVC
TYPE OF BACKFILL AROUND RISER PIPE	Bentonite Grout
DEPTH TOP OF SEAL	5 ft.
TYPE OF SEAL	Bentonite chips
DEPTH BOTTOM OF SEAL	8 ft.
DEPTH TOP OF PERVIOUS SECTION	10 ft.
DIAMETER OF BOREHOLE	8 in.
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
TYPE OF OPENINGS	0.010 slots
I.D AND O.D. OF PERVIOUS SECTION	2 in./2.5 in.
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Silica Sand
DEPTH BOTTOM OF PERVIOUS SECTION	17 ft.
DEPTH TOP OF SEAL	NA
TYPE OF SEAL	Not Installed
DEPTH BOTTOM OF SEAL	NA
TYPE OF BACKFILL BELOW BOTTOM SEAL	Not Installed
END OF BORING	17 ft.

General soil conditions (not to scale)

1 ft.

SILTY SAND

3 ft.

4 ft.

ORGANIC MATERIAL, SILTY SAND WITH GRAVEL

5 ft.

6 ft.

TOP OF WATER TABLE AT 6 FT. ON 6-17-93

8 ft.

10 ft.

SAND WITH GRAVEL, TRACE OF SILT

17 ft.

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

PROJECT: NCBC - CTO 127 PAGE: 1 OF 1

PROJECT LOCATION: Davisville, RI R-3

CLIENT: U.S. Navy BORING NO.: R-3

CONTRACTOR: Environmental Drilling, Inc. DRILLER: C. Stamas BORING LOCATION: Camp Fogarty/Range A

LOGGED BY: P. Young DATE: 6/16/93 PROJECT NO.: 8659

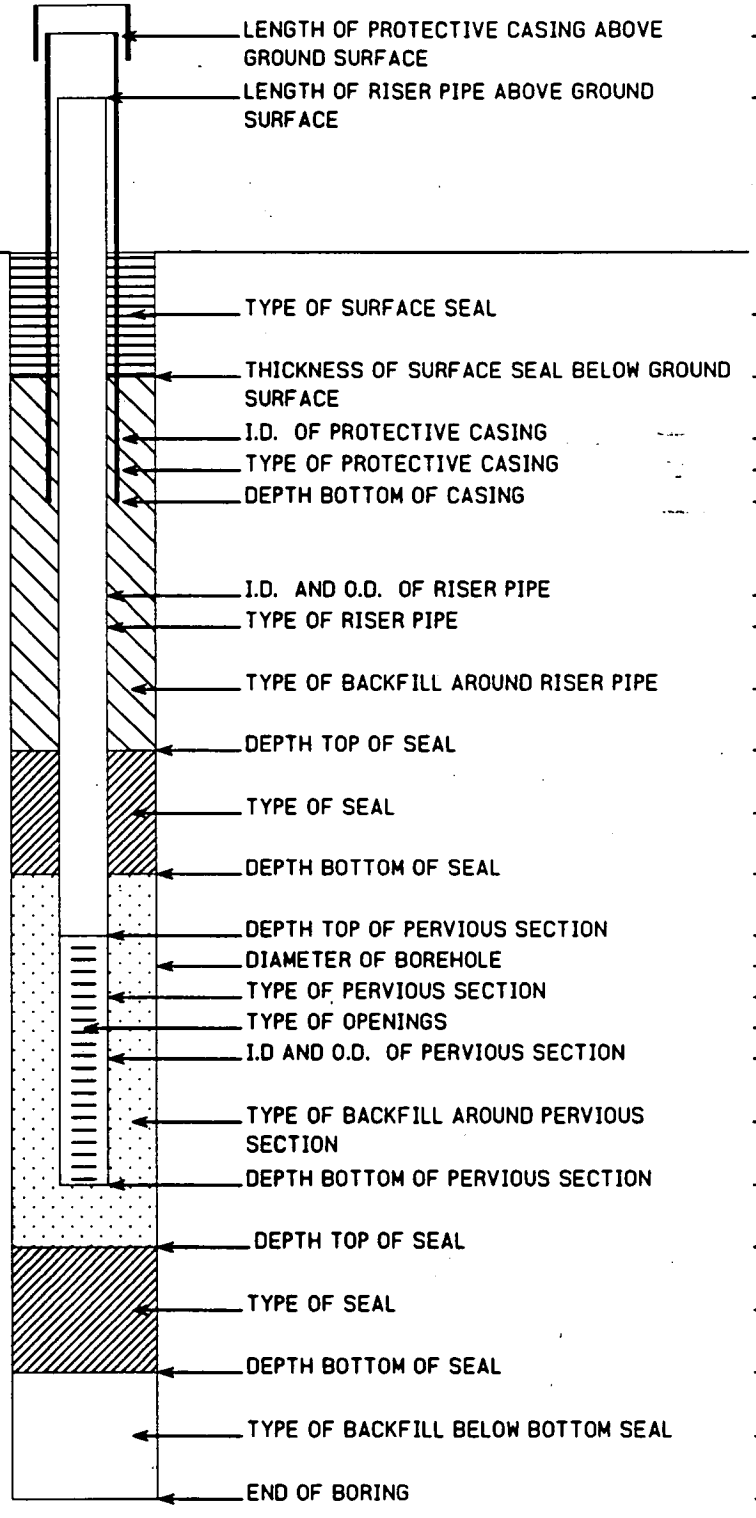
CHECKED BY: DATE:

ELEVATION TOP OF PROTECTIVE CASING MSL

ELEVATION TOP OF RISER PIPE MSL

GROUND ELEVATION Not surveyed MSL

Water Table Aquifer



LENGTH OF PROTECTIVE CASING ABOVE GROUND SURFACE	None/Roadbox
LENGTH OF RISER PIPE ABOVE GROUND SURFACE	None/Ground surface
TYPE OF SURFACE SEAL	Cement
THICKNESS OF SURFACE SEAL BELOW GROUND SURFACE	< 1' Flush mount
I.D. OF PROTECTIVE CASING	6"
TYPE OF PROTECTIVE CASING	Steel
DEPTH BOTTOM OF CASING	< 1' Flush mount
I.D. AND O.D. OF RISER PIPE	2" & 2 3/8"
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Sand to 3'/Grout to 2'
DEPTH TOP OF SEAL	6'
TYPE OF SEAL	Bentonite chips
DEPTH BOTTOM OF SEAL	8'
DEPTH TOP OF PERVIOUS SECTION	10'
DIAMETER OF BOREHOLE	4"
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
TYPE OF OPENINGS	0.010 slotted
I.D AND O.D. OF PERVIOUS SECTION	2" & 2 3/8"
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Silica sand
DEPTH BOTTOM OF PERVIOUS SECTION	17.5'
DEPTH TOP OF SEAL	N/A
TYPE OF SEAL	Silica sand
DEPTH BOTTOM OF SEAL	N/A
TYPE OF BACKFILL BELOW BOTTOM SEAL	N/A
END OF BORING	18 feet

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

PROJECT: NCBC - CTO 127 PAGE: 1 OF 1

PROJECT LOCATION: E. Greenwich, RI R-4

CLIENT: NAVFAC BORING NO.: R-4

CONTRACTOR: Geosearch DRILLER: T. Belsky BORING LOCATION: Camp Fogarty

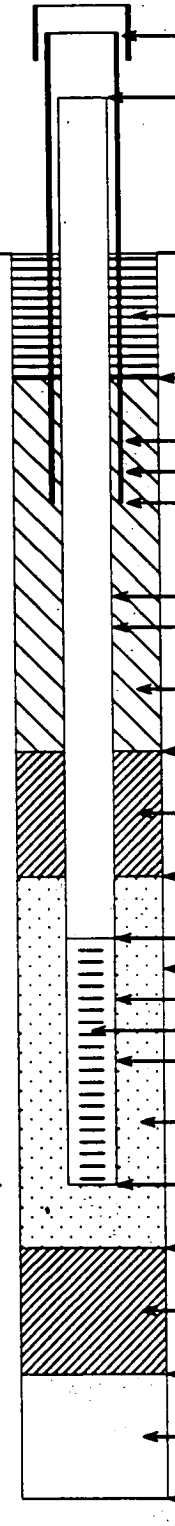
LOGGED BY: K. Jalkut DATE: 6-17-93 PROJECT NO.: 8659

CHECKED BY: W.J. Martin DATE: 10-25-93

ELEVATION TOP OF PROTECTIVE CASING Not surveyed MSL

ELEVATION TOP OF RISER PIPE Not surveyed MSL

GROUND ELEVATION Not surveyed MSL



LENGTH OF PROTECTIVE CASING ABOVE GROUND SURFACE	None/Roadbox
LENGTH OF RISER PIPE ABOVE GROUND SURFACE	None/Ground surface
TYPE OF SURFACE SEAL	Cement
THICKNESS OF SURFACE SEAL BELOW GROUND SURFACE	6 in.
I.D. OF PROTECTIVE CASING	8 in.
TYPE OF PROTECTIVE CASING	Steel
DEPTH BOTTOM OF CASING	1 foot
I.D. AND O.D. OF RISER PIPE	2 in./2.5 in.
TYPE OF RISER PIPE	PVC
TYPE OF BACKFILL AROUND RISER PIPE	Bentonite Grout
DEPTH TOP OF SEAL	6 ft.
TYPE OF SEAL	Bentonite chips
DEPTH BOTTOM OF SEAL	10 ft.
DEPTH TOP OF PERVIOUS SECTION	12 ft.
DIAMETER OF BOREHOLE	8 in.
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
TYPE OF OPENINGS	0.010 slots
I.D AND O.D. OF PERVIOUS SECTION	2 in./2.5 in.
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Silica Sand
DEPTH BOTTOM OF PERVIOUS SECTION	22 ft.
DEPTH TOP OF SEAL	NA
TYPE OF SEAL	Not Installed
DEPTH BOTTOM OF SEAL	NA
TYPE OF BACKFILL BELOW BOTTOM SEAL	Not Installed
END OF BORING	22 ft.

General soil conditions (not to scale)

0 ft.

SAND, TRACE OF SILT

1 ft.

3 ft.

SAND, SOME SILT, WITH GRAVEL

6 ft.

6 ft.

SILTY SAND WITH GRAVEL

10 ft. / ▽ (6-17-93)

12 ft.

SAND, TRACE TO SOME SILT, SOME GRAVEL

22 ft.

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

PROJECT: NCBC - CTO 127 PAGE: 1 OF 1

PROJECT LOCATION: E. Greenwich, RI R-5B

CLIENT: NAVFAC BORING NO.: R-5B

CONTRACTOR: Geosearch DRILLER: T. Belsky BORING LOCATION: Camp Fogarty

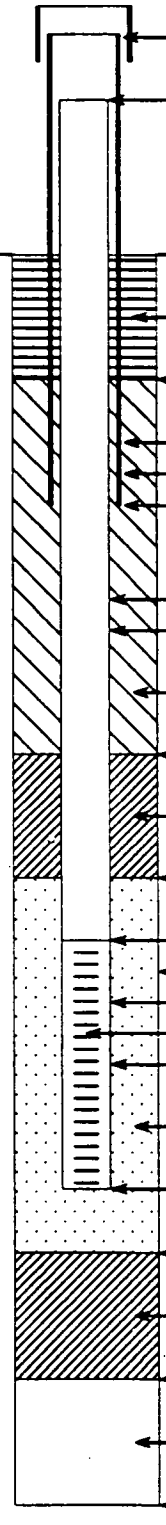
LOGGED BY: K. Jalkut DATE: 6-16-93 PROJECT NO.: 8659

CHECKED BY: W.J. Martin DATE: 10-25-93

ELEVATION TOP OF PROTECTIVE CASING Not surveyed MSL

ELEVATION TOP OF RISER PIPE Not surveyed MSL

GROUND ELEVATION Not surveyed MSL



LENGTH OF PROTECTIVE CASING ABOVE GROUND SURFACE	None/Roadbox
LENGTH OF RISER PIPE ABOVE GROUND SURFACE	None/Ground surface
TYPE OF SURFACE SEAL	Cement
THICKNESS OF SURFACE SEAL BELOW GROUND SURFACE	6 in.
I.D. OF PROTECTIVE CASING	8 in.
TYPE OF PROTECTIVE CASING	Steel
DEPTH BOTTOM OF CASING	1 foot
I.D. AND O.D. OF RISER PIPE	2 in./2.5 in.
TYPE OF RISER PIPE	PVC
TYPE OF BACKFILL AROUND RISER PIPE	Bentonite Grout
DEPTH TOP OF SEAL	7 ft.
TYPE OF SEAL	Bentonite chips
DEPTH BOTTOM OF SEAL	11 ft.
DEPTH TOP OF PERVIOUS SECTION	12 ft.
DIAMETER OF BOREHOLE	8 in.
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
TYPE OF OPENINGS	0.010 slots
I.D AND O.D. OF PERVIOUS SECTION	2 in./2.5 in.
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Silica Sand
DEPTH BOTTOM OF PERVIOUS SECTION	16 ft.
DEPTH TOP OF SEAL	NA
TYPE OF SEAL	Not Installed
DEPTH BOTTOM OF SEAL	NA
TYPE OF BACKFILL BELOW BOTTOM SEAL	Not Installed
END OF BORING	16 ft

General soil conditions (not to scale)

0 ft.

SAND WITH SILT & GRAVEL

1 ft.

1 ft.

SAND WITH TRACES OF SILT & GRAVEL; PERCHED ▽ @ 6.5 FT.

7 ft.

12 ft.

SAND WITH SILT & GRAVEL; ▽ @ 10.5 FT. ON 6-16-93

16 ft.

SAND WITH TRACE OF SILT

APPENDIX C

SLUG TEST CALCULATION TABLE

SLUG TEST CALCULATION TABLE
CAMP FOGARTY FIRING RANGE

WELL NO.	SCREEN IN	TYPE OF TEST	NOTES		DEPTH OF WATER LEVEL (in)	LOWER AQUIFER BOUN-DARY (in)	THICK-NESS OF AQUIFER D (in)	DEPTH TO SCREEN BOTTOM (in)	HEIGHT OF WATER IN WELL H (in)	LENGTH OF SCREEN L (in)	INNER WELL RADIUS (in)	WELL RADIUS rc (in)	RADIUS TO ORIGINAL AQUIFER rw (in)
R-1	Over-burden	Ri-sing head test	Bottom of aquifer uncertain, measured recovery.	Aquifer bottom at screen bottom	118.00	150	32.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 5' below screen	118.00	210	92.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 10' below screen	118.00	270	152.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 15' below screen	118.00	330	212.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 20' below screen	118.00	390	272.0	150.0	32.0	32.0	1.00	1.32	2.00
			Bottom of aquifer uncertain, adjusted recovery.	Aquifer bottom at screen bottom	118.00	150	32.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 5' below screen	118.00	210	92.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 10' below screen	118.00	270	152.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 15' below screen	118.00	330	212.0	150.0	32.0	32.0	1.00	1.32	2.00
				Bottom of aquifer 20' below screen	118.00	390	272.0	150.0	32.0	32.0	1.00	1.32	2.00
R-2	Over-burden	Ri-sing head test	Bottom of aquifer uncertain, measured recovery.	Aquifer bottom at screen bottom	82.50	204	121.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 5' below screen	82.50	264	181.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 10' below screen	82.50	324	241.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 15' below screen	82.50	384	301.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 20' below screen	82.50	444	361.5	204.0	121.5	84.0	1.00	1.00	4.00
			Bottom of aquifer uncertain, adjusted recovery.	Aquifer bottom at screen bottom	82.50	204	121.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 5' below screen	82.50	264	181.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 10' below screen	82.50	324	241.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 15' below screen	82.50	384	301.5	204.0	121.5	84.0	1.00	1.00	4.00
				Bottom of aquifer 20' below screen	82.50	444	361.5	204.0	121.5	84.0	1.00	1.00	4.00
R-3	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at screen bottom	110.00	210	100.0	210.0	100.0	90.0	1.00	1.00	2.00
				Bottom of aquifer 5' below screen	110.00	270	160.0	210.0	100.0	90.0	1.00	1.00	2.00
				Bottom of aquifer 10' below screen	110.00	330	220.0	210.0	100.0	90.0	1.00	1.00	2.00
				Bottom of aquifer 15' below screen	110.00	390	280.0	210.0	100.0	90.0	1.00	1.00	2.00
				Bottom of aquifer 20' below screen	110.00	450	340.0	210.0	100.0	90.0	1.00	1.00	2.00
R-4	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at screen bottom	209.00	264	55.0	264.0	55.0	55.0	1.00	2.18	4.00
				Bottom of aquifer 5' below screen	209.00	324	115.0	264.0	55.0	55.0	1.00	2.18	4.00
				Bottom of aquifer 10' below screen	209.00	384	175.0	264.0	55.0	55.0	1.00	2.18	4.00
				Bottom of aquifer 15' below screen	209.00	444	235.0	264.0	55.0	55.0	1.00	2.18	4.00
				Bottom of aquifer 20' below screen	209.00	504	295.0	264.0	55.0	55.0	1.00	2.18	4.00
R-5	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at refusal	162.00	198	36.0	192.0	30.0	30.0	1.00	2.18	4.00
				Bottom of aquifer 5' below refusal	162.00	258	96.0	192.0	30.0	30.0	1.00	2.18	4.00
				Bottom of aquifer 10' below refusal	162.00	318	156.0	192.0	30.0	30.0	1.00	2.18	4.00
				Bottom of aquifer 15' below refusal	162.00	378	216.0	192.0	30.0	30.0	1.00	2.18	4.00
				Bottom of aquifer 20' below refusal	162.00	438	276.0	192.0	30.0	30.0	1.00	2.18	4.00

SLUG TEST CALCULATION TABLE
CAMP FOGARTY FIRING RANGE

WELL NO.	SCREEN IN	TYPE OF TEST	NOTES		START TIME OF TEST to (min)	START RE-COVERY READING yo (ft)	TIME OF TEST POINT t (min)	RECOVERY AT TEST POINT yt (ft)	RATIO L/rw	PARAMETERS A	B	C	VALUE OF ln(Re/rw)	EFFEC-TIVE RADIUS Re (in)
R-1	Over-burden	Ri-sing head test	Bottom of aquifer uncertain, measured recovery.	Aquifer bottom at screen bottom	0	0.21	0.50	0.02	16.0	--	--	1.50	2.039	15.362
				Bottom of aquifer 5' below screen	0	0.21	0.50	0.02	16.0	2.00	0.30	--	1.708	11.035
				Bottom of aquifer 10' below screen	0	0.21	0.50	0.02	16.0	2.00	0.30	--	1.671	10.633
				Bottom of aquifer 15' below screen	0	0.21	0.50	0.02	16.0	2.00	0.30	--	1.650	10.412
				Bottom of aquifer 20' below screen	0	0.21	0.50	0.02	16.0	2.00	0.30	--	1.635	10.262
			Bottom of aquifer uncertain, adjusted recovery.	Aquifer bottom at screen bottom	0	0.112	0.50	0.01	16.0	--	--	1.50	2.039	15.362
				Bottom of aquifer 5' below screen	0	0.112	0.50	0.01	16.0	2.00	0.30	--	1.708	11.035
				Bottom of aquifer 10' below screen	0	0.112	0.50	0.01	16.0	2.00	0.30	--	1.671	10.633
				Bottom of aquifer 15' below screen	0	0.112	0.50	0.01	16.0	2.00	0.30	--	1.650	10.412
				Bottom of aquifer 20' below screen	0	0.112	0.50	0.01	16.0	2.00	0.30	--	1.635	10.262
R-2	Over-burden	Ri-sing head test	Bottom of aquifer uncertain, measured recovery.	Aquifer bottom at screen bottom	0	1.20	3.00	0.27	21.0	--	--	1.70	2.480	47.775
				Bottom of aquifer 5' below screen	0	1.20	3.00	0.27	21.0	2.15	0.30	--	2.158	34.629
				Bottom of aquifer 10' below screen	0	1.20	3.00	0.27	21.0	2.15	0.30	--	2.113	33.100
				Bottom of aquifer 15' below screen	0	1.20	3.00	0.27	21.0	2.15	0.30	--	2.088	32.265
				Bottom of aquifer 20' below screen	0	1.20	3.00	0.27	21.0	2.15	0.30	--	2.070	31.697
			Bottom of aquifer uncertain, adjusted recovery.	Aquifer bottom at screen bottom	0	1.28	4.00	0.08	21.0	--	--	1.70	2.480	47.775
				Bottom of aquifer 5' below screen	0	1.28	4.00	0.08	21.0	2.15	0.30	--	2.158	34.629
				Bottom of aquifer 10' below screen	0	1.28	4.00	0.08	21.0	2.15	0.30	--	2.113	33.100
				Bottom of aquifer 15' below screen	0	1.28	4.00	0.08	21.0	2.15	0.30	--	2.088	32.265
				Bottom of aquifer 20' below screen	0	1.28	4.00	0.08	21.0	2.15	0.30	--	2.070	31.697
R-3	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at screen bottom	0	0.85	0.20	0.41	45.0	--	--	2.50	2.970	38.970
				Bottom of aquifer 5' below screen	0	0.85	0.20	0.41	45.0	2.80	0.55	--	2.598	26.862
				Bottom of aquifer 10' below screen	0	0.85	0.20	0.41	45.0	2.80	0.55	--	2.542	25.401
				Bottom of aquifer 15' below screen	0	0.85	0.20	0.41	45.0	2.80	0.55	--	2.510	24.610
				Bottom of aquifer 20' below screen	0	0.85	0.20	0.41	45.0	2.80	0.55	--	2.488	24.076
R-4	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at screen bottom	0	1.05	0.20	0.37	13.8	--	--	1.40	1.918	27.217
				Bottom of aquifer 5' below screen	0	1.05	0.20	0.37	13.8	2.00	0.30	--	1.602	19.852
				Bottom of aquifer 10' below screen	0	1.05	0.20	0.37	13.8	2.00	0.30	--	1.564	19.114
				Bottom of aquifer 15' below screen	0	1.05	0.20	0.37	13.8	2.00	0.30	--	1.543	18.710
				Bottom of aquifer 20' below screen	0	1.05	0.20	0.37	13.8	2.00	0.30	--	1.528	18.435
R-5	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at refusal	0	0.132	5.50	0.06	7.5	1.75	0.25	--	1.261	14.121
				Bottom of aquifer 5' below refusal	0	0.132	5.50	0.06	7.5	1.75	0.25	--	1.146	12.581
				Bottom of aquifer 10' below refusal	0	0.132	5.50	0.06	7.5	1.75	0.25	--	1.118	12.238
				Bottom of aquifer 15' below refusal	0	0.132	5.50	0.06	7.5	1.75	0.25	--	1.102	12.044
				Bottom of aquifer 20' below refusal	0	0.132	5.50	0.06	7.5	1.75	0.25	--	1.091	11.909

SLUG TEST CALCULATION TABLE
CAMP FOGARTY FIRING RANGE

WELL NO.	SCREEN IN	TYPE OF TEST	NOTES		HYDRAULIC CONDUC-TIVITY K (in/min)	HYDRAULIC CONDUC-TIVITY K (ft/day)	HYDRAULIC CONDUC-TIVITY K (cm/sec)
R-1	Over-burden	Ri-sing head test	Bottom of aquifer uncertain, measured recovery.	Aquifer bottom at screen bottom	2.62E-01	31.46	1.11E-02
				Bottom of aquifer 5' below screen	2.20E-01	26.35	9.30E-03
				Bottom of aquifer 10' below screen	2.15E-01	25.78	9.10E-03
				Bottom of aquifer 15' below screen	2.12E-01	25.46	8.98E-03
				Bottom of aquifer 20' below screen	2.10E-01	25.23	8.90E-03
			Bottom of aquifer uncertain, adjusted recovery.	Aquifer bottom at screen bottom	2.69E-01	32.32	1.14E-02
				Bottom of aquifer 5' below screen	2.26E-01	27.08	9.55E-03
				Bottom of aquifer 10' below screen	2.21E-01	26.49	9.34E-03
				Bottom of aquifer 15' below screen	2.18E-01	26.16	9.23E-03
				Bottom of aquifer 20' below screen	2.16E-01	25.93	9.15E-03
R-2	Over-burden	Ri-sing head test	Bottom of aquifer uncertain, measured recovery.	Aquifer bottom at screen bottom	7.27E-03	0.87	3.08E-04
				Bottom of aquifer 5' below screen	6.33E-03	0.76	2.68E-04
				Bottom of aquifer 10' below screen	6.19E-03	0.74	2.62E-04
				Bottom of aquifer 15' below screen	6.12E-03	0.73	2.59E-04
				Bottom of aquifer 20' below screen	6.07E-03	0.73	2.57E-04
			Bottom of aquifer uncertain, adjusted recovery.	Aquifer bottom at screen bottom	1.03E-02	1.23	4.35E-04
				Bottom of aquifer 5' below screen	8.95E-03	1.07	3.79E-04
				Bottom of aquifer 10' below screen	8.76E-03	1.05	3.71E-04
				Bottom of aquifer 15' below screen	8.65E-03	1.04	3.66E-04
				Bottom of aquifer 20' below screen	8.58E-03	1.03	3.63E-04
R-3	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at screen bottom	6.05E-02	7.27	2.56E-03
				Bottom of aquifer 5' below screen	5.30E-02	6.36	2.24E-03
				Bottom of aquifer 10' below screen	5.18E-02	6.22	2.19E-03
				Bottom of aquifer 15' below screen	5.12E-02	6.14	2.17E-03
				Bottom of aquifer 20' below screen	5.07E-02	6.09	2.15E-03
R-4	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at screen bottom	4.36E-01	52.36	1.85E-02
				Bottom of aquifer 5' below screen	3.65E-01	43.74	1.54E-02
				Bottom of aquifer 10' below screen	3.56E-01	42.71	1.51E-02
				Bottom of aquifer 15' below screen	3.51E-01	42.13	1.49E-02
				Bottom of aquifer 20' below screen	3.48E-01	41.72	1.47E-02
R-5	Over-burden	Ri-sing head test	Bottom of aquifer uncertain	Aquifer bottom at refusal	1.52E-02	1.83	6.45E-04
				Bottom of aquifer 5' below refusal	1.39E-02	1.66	5.86E-04
				Bottom of aquifer 10' below refusal	1.35E-02	1.62	5.72E-04
				Bottom of aquifer 15' below refusal	1.33E-02	1.60	5.64E-04
				Bottom of aquifer 20' below refusal	1.32E-02	1.58	5.58E-04