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SAMPLING AND ANALYSIS PLAN FOR ZONE C SITE 34-BUILDING NH-1137 SITE IDENTIFICATION NUMBER 17754 CNC CHARLESTON SC

8/1/2000

CH2M HILL

SAMPLING AND ANALYSIS PLAN
FOR
ZONE C/ SITE 34-BUILDING NH-1137

SITE IDENTIFICATION # 17754

Charleston Naval Complex
Charleston, South Carolina

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

Contract Number N62467-99-C-0960

August 2000

SAMPLING AND ANALYSIS PLAN
FOR
ZONE C/ SITE 34-BUILDING NH-1137

SITE IDENTIFICATION # 17754

Charleston Naval Complex
Charleston, South Carolina

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29406

Submitted by:
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115 Perimeter Center Place NE
Suite 700
Atlanta, Georgia 30346-1278

Contract Number: N62467-99-C-0960

August 2000

REPARED BY:

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ACRONYMS AND ABBREVIATIONS

AST	Aboveground Storage Tank
bls	below land surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene Isomers
CAP	Corrective Action Plan
CNC	Charleston Naval Complex
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
EPA	Environmental Protection Agency
ft	foot
mg/kg	microgram per kilogram
mg/L	microgram per liter
OVA	Organic Vapor Analyzer
QA	Quality Assurance
QC	Quality Control
RBSL	Risk-Based Screening Level
RDA	Redevelopment Authority
SAP	Sampling and Analysis Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SSTL	Site-Specific Target Level
TTNUS	Tetra Tech NUS
UST	Underground Storage Tank

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared by CH2M-JONES, LLC. The plan is designed for Zone C/ Site 34-Building NH-1137; Underground Storage Tank (UST) 1137-2 located at the Charleston Naval Complex (CNC), Charleston, South Carolina.

The South Carolina Department of Health and Environmental Control (SCDHEC) has designated this site as Identification Number: 17754. This SAP provides methods to further evaluate the applicability of intrinsic remediation and monitoring well abandonment as a corrective action for UST 1137-2 in accordance with SCDHEC Corrective Action Guidance, June 1997.

1.1 General Site Description

The CNC is in the city of North Charleston, on the west bank of the Cooper River in Charleston County, South Carolina as shown in Figure 1. This installation consists of two major areas: an undeveloped dredge materials area on the east bank of the Cooper River on Daniel Island in Berkley County, and a developed area on the west bank of the Cooper River. The developed portion of the base is on the peninsula bounded on the west by the Ashley River and on the east by the Cooper River. The site is located within the developed portion of the base as shown in Figure 2. (Tetra Tech, NUS [TTNUS], Tier Standard Limited Assessment [SLA] for UST 1137, 1999).

The area surrounding CNC is "mature urban", having long been developed with commercial, industrial, and residential land use. Commercial areas are primarily west of CNC; industrial areas are primarily to the north of the base along Shipyard Creek. A site vicinity map, which exhibits adjacent properties and structures, vicinity roads, current utilities, and vicinity surface drainage, is included as Figure 2.

1.2 Objective

This SAP presents the groundwater monitoring plan to assess the down gradient plume migration and intrinsic bioremediation/natural attenuation of petroleum hydrocarbons contamination in order to validate the assumptions and calculations used in the in the SLA completed by TTNUS 1999. Details for the abandonment of monitoring wells at this site are also included in this plan.

2.0 RECEPTOR SURVEY

A receptor survey of the site vicinity was conducted by TTNUS to identify potential receptors for petroleum hydrocarbon contamination. Figure 2 depict the public utilities located within 250 feet of the former UST 1137-2 study area. Specific information concerning the depth of utilities below land surface (bls) is currently unavailable, however, utilities at this site generally are between 2 to 6 feet (ft) bls. The following utility receptors were located:

TABLE 1

UTILITY	ON-SITE OR DISTANCE/ DIRECTION FROM SITE	DEPTH TO UTILITY
Gas	80-ft east, 120-ft north	2-6-ft bls
Electrical	30-ft east	2-6-ft bls
Sewer	150-ft south, 110-ft north	2-6-ft bls
Storm Drain	20-ft east, 20-ft north, 180-ft south, 70-ft west	2-6-ft bls
Water	150-ft south, 150-ft feet west	2-6-ft bls

According to the SLA report completed by TTNUS, a survey of groundwater users within a 7-mile radius of CNC was conducted by the South Carolina Water Resources Commission to ascertain the extent of any shallow groundwater usage. Results of the water use investigation revealed that no drinking water wells, which utilize the shallow aquifer, are located within a 4- mile radius of CNC. Irrigation wells are not identified within 1,000 feet of the site. Numerous monitoring wells are located within 1,000 feet of the site.

There are no city, county or state-zoning ordinances, the property (CNC) is currently owned by the federal government. Information concerning zoning ordinances was obtained from the SOUTHDIV Remedial Project Manager located at 2155 Eagle Drive, North Charleston, South Carolina 29406 (TTNUS, 1999).

2.1 Fate and Transport Modeling

No groundwater concentrations exceeded the SCDHEC Risk Based Screening Levels (RBSLs); therefore, fate and transport modeling is not required.

2.2 Site-Specific Target Levels

According to the SLA, the only potential receptor as a construction worker ingesting or dermally contacting soil while working in a utility trench. Site soil concentrations were compared with RBSLs for ingestion or dermal contact with surficial soil. Surficial soil was not impacted at the site; however, for the construction worker pathway, exposure to subsurface soil is evaluated as surface soil because the worker is expected to have direct contact with the subsurface soil. The calculations for dermal contact and incidental ingestion can be found in the SLA completed by TTNUS.

2.3 Soil Leaching SSTL

Site Specific Target Levels (SSTLs) were calculated for COC concentrations leaching from subsurface soil to groundwater using the SCDHEC Soil Leachability Model and Selected Minimum RBSLs. The input parameters for the leachability model were determined using the figures in the SCDHEC Risk-based Corrective Action Guidelines (January 1998), soil quality and grain size data, and the Selected Minimum RBSLs calculated for the site.

The soil leaching SSTLs calculated COCs is provided in the following table (TTNUS 2000).

TABLE 2

Chemical of Concern	Concentration in SB-01 (mg/kg)	Soil Leaching SSTL (mg/kg)
Benzene	< 0.85	5.72
Toluene	< 0.85	366.0
Ethylbenzene	< 0.85	6,796
Naphthalene	< 0.85	218,156

The soil leaching SSTL for Benzene, Toluene, Ethylbenzene, and Naphthalene is above the maximum concentrations detected (<0.85 mg/kg), indicating the soil benzene, Toluene, Etylbenzene and naphthalene levels will not leach into the groundwater at concentrations above RBSL for a construction worker.

3.0 PROPOSED REMEDIATION TECHNOLOGY

Based on the results of the Tier I and Tier II modeling, an Intrinsic Remediation with a monitoring period of 9 months will be performed for the site. The monitoring program will consist of sampling initially a total of three surrounding wells adjacent to the source point, and only sampling selected wells thereafter. The proposed monitoring program is described in detail in Sections 4.0 and 5.0 of this plan.

4.0 MONITORING WELL INSTALLATION AND ABANDONMENT

4.1 Monitoring Well Installation

Because of the amount of monitoring wells located in and around this site, no monitoring wells will be installed as part of this plan.

4.2 Monitoring Well Abandonment

Three monitoring wells will be abandoned at Building 1137 following the South Carolina Well Standards and Regulations R.61-71. The well abandonment will include grouting wells, removing stick-ups and removing all guard posts.

4.3 Surveying

Because no monitoring wells will be installed at this site, a new survey will not be conducted.

4.4 Equipment Decontamination

All drilling equipment, augers, well casing and screens, and soil and groundwater sampling equipment involved in field sampling activities will be decontaminated according to the Environmental Protection Agencies (EPA) " Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM).

5.0 PROPOSED GROUNDWATER MONITORING PROGRAM

5.1 Monitoring Frequency and Reporting

The groundwater monitoring program proposed at building 1137 will be performed in accordance with SCDHEC Corrective Action Guidance, June 1997, and consist of the following:

TABLE 3

Sampling date or (Quarter)	Monitoring Wells Sampled	Field Measures	Laboratory Analytical
Forth quarter [1] 2000	MW-01, MW-001, MW-02, MW-03	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	Naphthalene 8260 BTEX 8260 Nitrate, sulfate, total dissolved iron, methane, alkalinity
First quarter [2] 2001	MW-01, MW-001, MW-02, MW-03	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	Naphthalene 8260 BTEX 8260 Nitrate, sulfate, total dissolved iron, methane, alkalinity
second quarter [1] 2001	MW-01, MW-001, MW-02, MW-03	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	Naphthalene 8260 BTEX 8260 Nitrate, sulfate, total dissolved iron, methane, alkalinity

1. Forth quarter is as October November and December.
2. First quarter is defined as January February and March.
3. second quarter is defined as April May and June

- **Frequency:** Initially all monitoring wells at this site will be sampled. Thereafter, groundwater samples will be collected from wells MW-01, MW-02 and MW-03.

- **Reporting:** Semi-annual groundwater monitoring reports will be submitted to SCDHEC.

Included in the semi-annual reports will be field and analytical information from the certified laboratory indicating well numbers, analytical methods used, date sampled, date analyzed, and method detection limits.

At the end of the second quarter 2001 period, (or as necessary) a performance evaluation will be submitted to SCDHEC providing the effectiveness of the intrinsic biodegradation/natural attenuation occurring and any recommendations for the site if needed. It is possible that the levels are not above the RBSLs in the groundwater, which will result in a different approach to the closure of these tanks.

- **Groundwater Sampling**

Prior to any groundwater sampling, each well will be measured for water levels and total depth and each well will be purged in accordance the EPA EISOPQAM.

5.2 Analytical Parameters

The following constituents will be analyzed for each groundwater sample:

- Naphthalene using method 8260.
- BTEX using method 8260.

The following parameters will be analyzed in order to evaluate the effectiveness of intrinsic remediation:

- Nitrate (NO^{-3})
- Sulfate (SO^{-4})
- Total dissolved iron
- Methane (CH_4)
- Alkalinity

5.3 Field Measurements

The following parameters will be sampled in the field:

- Temperature
- pH
- Dissolved Oxygen
- Depth to water table
- Depth of well
- Turbidity
- Specific Conductance

Field measurements will be recorded in the field book and in field forms provided in Appendix B.

5.4 Groundwater Level Measurements

Groundwater measurements will be taken from all monitoring wells at the site during each sampling event. All water level measurements will be taken on the same day as anticipated sampling.

Measurements will be taken with an electrical water level meter or interface probe if floating product is present using the highest part of the top of the casing as a reference point for determining depths to water and total depths. Water level measurements will be recorded to the nearest 0.01-foot in the field book.

5.5 Sample Handling

Sample Handling will be conducted in accordance with the following references:

EPA EISOPQAM (EPA May, 1996)

5.6 Sample Packing and Shipping

The following forms will be completed to complete the packing/shipping process:

- Sample labels
- Chain-of-custody labels
- Appropriate labels applied to shipping coolers
- Chain-of-custody forms
- Federal express air bills

5.7 Quality Check

Quality Control (QC) samples will be collected during sampling events. QC samples may include field blanks, field duplicates, and trip blanks. Definitions of each can be found below as described by the EISOPQAM:

- **Field Blank:** a sample collected using organic-free water, which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been field cleaned.

- **Field Duplicates:** Two or more samples collected from a common source. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contamination associated with a population.

- **Trip Blank:** A sample, which is prepared prior to the sampling event in the actual container and is stored with the investigative samples throughout the sampling event. They are often packaged for shipment

- with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If samples are to be shipped, trip blanks are to be provided with each shipment but not for each cooler.

5.8 Control Limits

TABLE 4

Analysis	Control Parameter	Control Limit	Corrective Action
Air Monitoring	Check Calibration of OVA daily	Calibrate to manufactures specifications	Recalibrate. If unable to calibrate, replace.
pH of water	Continuing calibration check of pH 7.0 buffer	pH= 7.0	Recalibrate. If unable to calibrate, replace electrode.
Specific Conductance of water	Continuing calibration check of standard solution	> 1% of standard	Recalibrate.

5.9 Record keeping

In addition to records kept in logbooks, forms will be kept on log sheets for soil and groundwater. See Appendix B.

5.10 Site Management and Base Support

Throughout the investigation activities, work on the CNC will be coordinated through SOUTHDIV and SCDHEC.

The primary contacts for each are as follows:

1. SOUTHDIV point of contact
   Gabe Magwood
   Southern Division Engineering Command
   2155 Eagle Drive
   North Charleston, SC 29406
   (843) 820-7307

2. SOUTHDIV point of contact
   Tony Hunt
   Southern Division Engineering Command
   2155 Eagle Drive
   North Charleston, SC 29406
   (843) 820-7307

3. SCDHEC point of contact
   Paul Bristol
   South Carolina Department of Health and Environmental Control
   2600 Bull Street
   Columbia, SC 29201
   (843) 898-3559

REFERENCES

South Carolina Department of Health and Environmental Control. 1997. Corrective Action Guidance.

Tetra Tech NUS, Inc.; 1999 Rapid Assessment for Site 34 (Building 1137), Charleston, South Carolina.

United States Environmental Protection Agency. 1990. Code of Federal Regulations 136.

United States Environmental Protection Agency. 1988. EPA Users Guide to Contract Laboratory Program.

United States Environmental Protection Agency. 1996. EPA Environmental Investigations Standard Operating Procedures for Quality Assurance Manual.

APPENDIX A

Minimum Construction Worker RBSLs

	Dermal	Incidental Ingestion	Inhalation	Minimum
	RBSL	RBSL	RBSL	RBSL
	mg/L	mg/L	mg/L	mg/L
Benzene	0.85	68.52	0.15	0.15
Toluene	23.98	5677.78	5.38	5.38
Ethylbenzene	6.05	2838.89	14.50	6.05
Xylene	102.33	56777.78	NA*	102.33
Naphthalene	1.63	1135.56	2.63	1.63

*No inhalation reference dose is available for xylenes; therefore, no inhalation RBSL can be calculated.

Prepared By: _____ Reviewed By: _____ 11/1/99

Construction Worker Dermal RBSLs

	Kow	MW	Kp	B	τ_{event}	c	b	t*	t_{event}	DAevent
			cm/hr	unitless	hr/event			hr	hr/event	
Benzene	199.5262315	78.1	0.11551543	0.392637855	2.87E-01	6.32E-01	6.03E-01	6.90E-01	1	eq 3.3
Toluene	537.0317964	92.1	0.259561335	0.958068292	3.44E-01	1.13E+00	1.31E+00	1.33E+00	1	eq 3.2
Ethylbenzene	1412.537545	106.2	0.569219802	2.256154884	4.13E-01	2.36E+00	4.39E+00	1.70E+00	1	eq 3.2
Xylene*	1584.893192	106.2	0.638675123	2.531447415	4.13E-01	2.63E+00	5.31E+00	1.72E+00	1	eq 3.2
Naphthalene	1995.262315	128.2	0.605452393	2.636638957	5.48E-01	2.73E+00	5.69E+00	2.29E+00	1	eq 3.2

	BW	AT	EV	ED	EF	SA	CSF derm	Rfd derm	Target	RBSL	RBSL
	kg	day	events/day	yrs	days/yr	cm^2	$(mg/kg\text{-}day)^{-1}$	mg/kg-day	Risk or HQ	mg/L	mg/L
Benz ne	70	25550	1	1	90	4500	2.99E-02	NA	1.00E-06		8.52E-01
Toluene	70	365	1	1	90	4500	NA	1.60E-01	1.0	2.40E+01	
Ethylbenzene	70	365	1	1	90	4500	NA	9.70E-02	1.0	6.05E+00	
Xyl ne*	70	365	1	1	90	4500	NA	1.84E+00	1.0	1.02E+02	
Naphthalene	70	365	1	1	90	4500	NA	3.20E-02	1.0	1.63E+00	

* Kow and MW values for xylene, m-

Prepared By: _____

Reviewed By: gdz 11/1/99

Construction Worker Incidental Ingestion RBSLs

	BW	AT	IR	ED	EF	Target	CSF oral	Rfd oral	RBSL
	kg	day	L/day	yrs	days/yr	Risk or HQ			mg/L
Benzene	70	25550	0.01	1	90	1.00E-06	2.90E-02		6.85E+01
Toluene	70	365	0.01	1	90	1.0	NA	2.00E-01	5677.778
Ethylbenzene	70	365	0.01	1	90	1.0	NA	1.00E-01	2838.889
Xylene	70	365	0.01	1	90	1.0	NA	2.00E+00	56777.78
Naphthalene	70	365	0.01	1	90	1.0	NA	4.00E-02	1135.556

Prepared By: _____

Reviewed By: _____ 11/1/99

Construction Worker Inhalation RBSLs

Chemical	TR (carc)	HI (nonc)	BWadult	AT	Sfi (carc)	RfD (nonc)	IR air	EF	ED	RBSLair	H	RBSLwater
			kg	yr	$[mg/kg\text{-}day]^{-1}$	[mg/kg-day]	m^3/day	day/yr	yr	mg/m^3	cm^3/cm^3	mg/L
Benzene	1.00E-06	NA	70	70	2.90E-02	NA	20	90	1	3.43E-02	2.26E-01	0.15
T luene	NA	1	70	1	NA	1.14E-01	20	90	1	1.62E+00	3.01E-01	5.38
Ethylbenzene	NA	1	70	1	NA	2.86E-01	20	90	1	4.06E+00	2.80E-01	14.50
Xylenes	NA	1	70	1	NA	NA*	20	90	1	NA*	2.78E-01	NA*
Naphthalene	NA	1	70	1	NA	3.71E-04	20	90	1	5.27E-03	2.00E-03	2.63

*No inhalation reference dose is available for xylenes; therefore, no RBSL can be calculated for xylene.

Prepared By: _____

Reviewed By: gab 11/1/99

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID #	17754	COUNTY	Charleston
FACILITY NAME	Site 34, Building NH1137		
STREET ADDRESS	Turnbull Ave, Charleston Naval Complex, North Charleston, SC		

Soil Risk Evaluation Data

					Figure
TPH		**464**	mg/kg		
Soil % SAND (Estimated)		**48**	%		
Soil % CLAY (Estimated)		**40**	%		
Worst Case	Benzene	**0.85**	mg/kg	Cs	
Soil Analyses	Toluene	**0.85**	mg/kg	Cs	
	Ethylbenzene	**0.85**	mg/kg	Cs	
	Xylenes	**0.85**	mg/kg	Cs	
	Naphthalene	**0.85**	mg/kg	Cs	
			mg/kg	Cs	
Natural Organic Carbon Content		**16,600**	mg/kg	foc	
Average Annual Recharge		25	cm	Hw	
Distance from highest Soil Impact to water table		**107**	cm	L	
Bulk Density of Soil		*1.59*	g/cc	Bd	1
Wetting Front Suction		*28*	cm	Hf	2
Soil Hydraulic Conductivity		*4.20E-05*	cm/sec	Kf	3
Porosity		*0.45*	decimal %	Φ	4
Residual Water Content		*0.08*	decimal %	Wr	5

List possible human exposure pathways from surface soil.
Soil leaching to groundwater - off-site ingestion or irrigational use of shallow groundwater.

Bold indicates site specific input

IN-SITU SOIL RISK EVALUATION

SOIL LEACHABILITY MODEL FOR BENZENE

RISK-BASED CORRECTIVE ACTION FOR PETROLEUM RELEASES

SITE INFORMATION:

Site: Site 34, Building NH1137

Location: Turnbull Ave, Charleston Naval Complex, North Charleston, SC

REFERENCES:

(1) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 1.
(2) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 2.
(3) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Input Parameters.
(4) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 1.
(5) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 2.
(6) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 3.
(7) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 4.
(8) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 5.

INPUT:

		0.82		
COC	Chemical of Concern	0.85		BENZENE
Bd	Soil Bulk Density (1)		g/cm3	1.59
Crsbl	Risk Based Screening Level		mg/L	0.15
Cs	Concentration of COC in soil		mg/kg	0.85
DAF	Dilution/Attenuation Factor (2)		unitless	8
foc	Organic Carbon Content in Soil (3)		mg/kg	16600
H'	Henry's Law Constant (4)		unitless	0.23
Hf	Wetting front suction head (always negative) (5)		cm	-28
Hw	Average Annual Recharge (3)		cm	25.00
Kf	Soil Hydraulic Conductivity (6)		cm/s	4.20E-05
Koc	Soil/Water Partioning Coefficient (2)		ml/g	81
L	Depth between soil sample with greatest COC concentration to groundwater.		cm	107
Φ	Porosity (7)		unitless	0.45
t1/2	Biodegradation "half life" (2)		days	16
TPH	Total Petroleum Hydrocarbons, EPA Method 3550		mg/kg	464
Wr	Residual Water Content (8)		volume fraction	0.08

CALCULATIONS:

Equation Set I - Determine soil pore water concentration resulting from physical partioning (Cw).

Step 1 - Calculate the total organic carbon content (fcs) of the soil.

fcs = (foc +TPH/1.724)*1E-6 = 0.0169 decimal %

Step 2 - Calculate the concentration of COC in soil pore water (Cw) directly in contact with the contaminate soil.

Cw = Cs*((Wr *1g/cc+Bd)/((Bd*Koc*fcs)+Wr+((ø-Wr)*H'))) = 0.6076 mg/l

Equation Set II - Determine the velocity of the soil pore water (Vw)

Step 1 - Calculate the air filled porosity (f) in decimal percent.

f = Ø - Wr = 0.37 decimal %

Step 2 - Determine the time for water to percolate through the vadose zone soil (from depth of worst case soil sample to the water table at site).

t = (f/Kf)*(L-((Hw-Hf)*(ln((Hw+L-Hf)/(Hw-Hf))))) = 424,860 seconds

Step 3 - Determine the velocity of the water (Vw) in feet per year.

Vw = (L/30.48cm/ft)/(t/31,500,000sec/year) = 259 ft/year

Equation Set III - Determine the organic retardation effect (Vc) of the contaminant.

Step 1 - Calculate the soil/water distribution coefficient (Kd) (ml/g) for uncontaminated soil.

Kd = Koc*foc*1E-6 = 1.3446 ml/g

Step 2 - Calculate the retardation effect of natural soil organic matter on COC migration.

Vc = Vw/(1+((Bd*Kd)/ø)) = 45 ft/year

Equation Set IV - Determine biodegradation rates and provide final COC concentration (Cf) at depth of concern.

Step 1 - Calculate the time (Tc) in days required for the COC to reach groundwater.

Tc = 365 day/yr*((L/30.48cm/ft)/Vc) = 28.31 days

Step 2 - Calculate estimated concentration of COC in the soil pore water (Cp) necessary to protect groundwater.

Cp = 10^(log (Crsbl)+(Tc/2.3)*(0.693/t1/2))) = 0.5112 mg/l

COC concentration in soil pore water (Cw) is less than concentration necessary to protect groundwater (Cp). Not necessary to calculate SSTL

Equation Set V - Calculate the Site Specific Target Level (SSTL) for the COC in soil.

Csstl for BENZENE in soil = Cp*DAF*(((Bd*Koc*fcs)+Wr+(F*'H'"))/(Wr*1g/cc+Bd)) = 5.720 mg/kg

PREPARED BY:_____

Date

CHECKED BY:_____

Date

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID # 17754
FACILITY NAME Site 34, Building NH1137

Instructions

Provide results, separately, for each constituent in the worst case soil analysis.

Data

List Constituent: BENZENE
(BTEX, Napth.)

				Table
Bioremediation "half-life"	16	days	t 1/2	1
Soil/water partitioning coefficient	81	ml/g	K oc	1

Results

	0.82 / **0.85**			Equation Set	Step
Total Organic Carbon Content	0.0169	decimal %	f cs	I	1
Leachate Concentration	0.608	mg/l	C w	I	2
Air Filled Porosity	0.37	decimal %	f	II	1
Infiltration Rate Time	424,860	seconds	t	II	2
Velocity of Water	259	ft/year	V w	II	3
Soil/Water Distribution Coefficient	1.3446	ml/g	K d	III	1
Contaminant Percolation Rate	45	ft/year	V c	III	2
Time to Reach Groundwater	28.31	days	T c	IV	1
Concentration reaching Groundwater	5.112E-01	mg/l	C p	IV	2
Site Specific Target Level	**5.720**	mg/kg	C sstl	V	

Conclusions

Does concentration of chemical of concern in soil exceed SSTL? NO

Risk of Human Exposure due to contaminated soil.

YES	X	NO

IN-SITU SOIL RISK EVALUATION

SOIL LEACHABILITY MODEL FOR TOLUENE

RISK-BASED CORRECTIVE ACTION FOR PETROLEUM RELEASES

SITE INFORMATION:

Site:	Site 34, Building NH1137
Location:	Turnbull Ave, Charleston Naval Complex, North Charleston, SC

REFERENCES:

(1) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 1.
(2) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 2.
(3) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Input Parameters.
(4) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 1.
(5) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 2.
(6) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 3.
(7) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 4.
(8) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 5.

INPUT:

		0.82		
COC	Chemical of Concern	0.85		TOLUENE
Bd	Soil Bulk Density (1)		g/cm3	1.59
Crsbl	Risk Based Screening Level		mg/L	5.19
Cs	Concentration of COC in soil		mg/kg	0.85
DAF	Dilution/Attenuation Factor (2)		unitless	8
foc	Organic Carbon Content in Soil (3)		mg/kg	16600
H'	Henry's Law Constant (4)		unitless	0.30
Hf	Wetting front suction head (always negative) (5)		cm	-28
Hw	Average Annual Recharge (3)		cm	25
Kf	Soil Hydraulic Conductivity (6)		cm/s	0.0000
Koc	Soil/Water Partioning Coefficient (2)		ml/g	133
L	Depth between soil sample with greatest COC concentration to groundwater.		cm	107
ø	Porosity (7)		unitless	0.45
t1/2	Biodegradation "half life" (2)		days	22
TPH	Total Petroleum Hydrocarbons, EPA Method 3550		mg/kg	464
Wr	Residual Water Content (8)		volume fraction	0.08

CALCULATIONS:

Equation Set I - Determine soil pore water concentration resulting from physical partioning (Cw).

Step 1 - Calculate the total organic carbon content (fcs) of the soil.

fcs = (foc +TPH/1.724)*1E-6 = 0.0169 decimal %

Step 2 - Calculate the concentration of COC in soil pore water (Cw) directly in contact with the contaminate soil.

Cw = Cs*((Wr *1g/cc+Bd)/((Bd*Koc*fcs)+Wr+((ø-Wr)*H'))) = 0 mg/l

Equation Set II - Determine the velocity of the soil pore water (Vw)

Step 1 - Calculate the air filled porosity (f) in decimal percent.

f = Ø - Wr = 0.37 decimal %

Step 2 - Determine the time for water to percolate through the vadose zone soil (from depth of worst case soil sample to the water table at site).

t = (f/Kf)*(L-(Hw-Hf))*(ln(Hw+((L-Hf)/(Hw-Hf)))) = 424,860 seconds

Step 3 - Determine the velocity of the water (Vw) in feet per year.

Vw = (L/30.48cm/ft)/(t/31,500,000sec/year) = 259 ft/year

Equation Set III - Determine the organic retardation effect (Vc) of the contaminant.

Step 1 - Calculate the soil/water distribution coefficient (Kd) (ml/g) for uncontaminated soil.

Kd = Koc*foc*1E-6 = 2.2078 ml/g

Step 2 - Calculate the retardation effect of natural soil organic matter on COC migration.

Vc = Vw*(1+((Bd*Kd)/ø)) = 29 ft/year

Equation Set IV - Determine biodegradation rates and provide final COC concentration (Cf) at depth of concern.

Step 1 - Calculate the time (Tc) in days required for the COC to reach groundwater.

Tc = 365 day/yr*((L/30.48cm/ft)/Vc) = 43.33 days

Step 2 - Calculate estimated concentration of COC in the soil pore water (Cp) necessary to protect groundwater.

Cp = 10^(log (Crsbl)+((Tc/2.3)*(0.693/t1/2))) = 20.3133 mg/l

COC concentration in soil pore water (Cp) is greater than Crsbl, therefore the SSTL must be calculated.

Equation Set V - Calculate the Site Specific Target Level (SSTL) for the COC in soil.

Csstl for TOLUENE in soil = Cp*DAF*(((Bd*Koc*fcs)+Wr+(F*'H'''))/(Wr*1g/cc+Bd)) = 365.755388 mg/kg

PREPARED BY:_____

Date

CHECKED BY:_____

Date

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID # 17754
FACILITY NAME Site 34, Building NH1137

Instructions

Provide results, separately, for each constituent in the worst case soil analysis.

Data

List Constituent: TOLUENE
(BTEX, Napth.)

				Table
Bioremediation "half-life"	22	days	t 1/2	1
Soil/water partitioning coefficient	133	ml/g	K oc	1

Results

	0.82 / **0.85**			Equation Set	Step
Total Organic Carbon Content	0.0169	decimal %	f cs	I	1
Leachate Concentration	0.029	mg/l	C w	I	2
Air Filled Porosity	0.37	decimal %	f	II	1
Infiltration Rate Time	424,860	seconds	t	II	2
Velocity of Water	259	ft/year	V w	II	3
Soil/Water Distribution Coefficient	2.2078	ml/g	K d	III	1
Contaminant Percolation Rate	29	ft/year	V c	III	2
Time to Reach Groundwater	43	days	T c	IV	1
Concentration reaching Groundwater	2.031E+01	mg/l	Cp	IV	2
Site Specific Target Level	**366**	mg/kg	C sstl	V	

Conclusions

Does concentration of chemical of concern in soil exceed SSTL? NO

Risk of Human Exposure due to contaminated soil.

YES X NO

Page 3 of 6 Pages

IN-SITU SOIL RISK EVALUATION

SOIL LEACHABILITY MODEL FOR ETHYLBENZENE

RISK-BASED CORRECTIVE ACTION FOR PETROLEUM RELEASES

SITE INFORMATION:

Site:	Site 34, Building NH1137
Location:	Turnbull Ave, Charleston Naval Complex, North Charleston, SC

REFERENCES:

(1) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 1.
(2) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 2.
(3) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Input Parameters.
(4) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 1.
(5) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 2.
(6) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 3.
(7) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 4.
(8) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 5.

INPUT:

		0.82		
COC	Chemical of Concern	0.85		ETHYLBENZENE
Bd	Soil Bulk Density (1)		g/cm3	1.59
Crsbl	Risk Based Screening Level		mg/L	6.05
Cs	Concentration of COC in soil		mg/kg	0.85
DAF	Dilution/Attenuation Factor (2)		unitless	8
foc	Organic Carbon Content in Soil (3)		mg/kg	16600
H'	Henry's Law Constant (4)		unitless	0.28
Hf	Wetting front suction head (always negative) (5)		cm	-28
Hw	Average Annual Recharge (3)		cm	25
Kf	Soil Hydraulic Conductivity (6)		cm/s	0.0000
Koc	Soil/Water Partioning Coefficient (2)		ml/g	176
L	Depth between soil sample with greatest COC concentration to groundwater.		cm	107
ø	Porosity (7)		unitless	0.45
t1/2	Biodegradation "half life" (2)		days	10
TPH	Total Petroleum Hydrocarbons, EPA Method 3550		mg/kg	464
Wr	Residual Water Content (8)		volume fraction	0.08

CALCULATIONS:

Equation Set I - Determine soil pore water concentration resulting from physical partioning (Cw).

Step 1 - Calculate the total organic carbon content (fcs) of the soil.

fcs = (foc +TPH/1.724)*1E-6 = 0.0169 decimal %

Step 2 - Calculate the concentration of COC in soil pore water (Cw) directly in contact with the contaminate soil.

Cw = Cs*((Wr *1g/cc+Bd)/((Bd*Koc*fcs)+Wr+((ø-Wr)*H'))) = 0.0220461 mg/l

Equation Set II - Determine the velocity of the soil pore water (Vw)

Step 1 - Calculate the air filled porosity (f) in decimal percent.

f = Ø - Wr = 0.37 decimal %

Step 2 - Determine the time for water to percolate through the vadose zone soil (from depth of worst case soil sample to the water table at site).

t = (f/Kf)*(L-(Hw-Hf))*(ln(Hw+((L-Hf)/(Hw-Hf)))) = 424,860 seconds

Step 3 - Determine the velocity of the water (Vw) in feet per year.

Vw = (L/30.48cm/ft)/(t/31,500,000sec/year) = 259 ft/year

Equation Set III - Determine the organic retardation effect (Vc) of the contaminant.

Step 1 - Calculate the soil/water distribution coefficient (Kd) (ml/g) for uncontaminated soil.

Kd = Koc*foc*1E-6 = 2.9216 ml/g

Step 2 - Calculate the retardation effect of natural soil organic matter on COC migration.

Vc = Vw*(1+((Bd*Kd)/ø)) = 23 ft/year

Equation Set IV - Determine biodegradation rates and provide final COC concentration (Cf) at depth of concern.

Step 1 - Calculate the time (Tc) in days required for the COC to reach groundwater.

Tc = 365 day/yr*((L/30.48cm/ft)/Vc) = 55.74 days

Step 2 - Calculate estimated concentration of COC in the soil pore water (Cp) necessary to protect groundwater.

Cp = 10^(log (Crsbl)+((Tc/2.3)*(0.693/t1/2))) = 289.28 mg/l

COC concentration in soil pore water (Cp) is greater than Crsbl, therefore the SSTL must be calculated.

Equation Set V - Calculate the Site Specific Target Level (SSTL) for the COC in soil.

Csstl for ETHYLBENZENE in soil = Cp*DAF*(((Bd*Koc*fcs)+Wr+(F*H'''))/(Wr*1g/cc+Bd)) = 6796.090465 mg/kg

PREPARED BY:_____

Date

CHECKED BY:_____

Date

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID # 17754
FACILITY NAME Site 34, Building NH1137

Instructions

Provide results, separately, for each constituent in the worst case soil analysis.

Data

List Constituent: ETHYLBENZENE
(BTEX, Napth.)

				Table
Bioremediation "half-life"	10	days	t 1/2	1
Soil/water partitioning coefficient	176	ml/g	K oc	1

Results

				Equation Set	Step
	0.82				
	0.85				
Total Organic Carbon Content	0.0169	decimal %	f cs	I	1
Leachate Concentration	2.20E-02	mg/l	C w	I	2
Air Filled Porosity	0.37	decimal %	f	II	1
Infiltration Rate Time	424,860	seconds	t	II	2
Velocity of Water	259	ft/year	V w	II	3
Soil/Water Distribution Coefficient	2.9216	ml/g	K d	III	1
Contaminant Percolation Rate	23	ft/year	V c	III	2
Time to Reach Groundwater	56	days	T c	IV	1
Concentration reaching Groundwater	2.893E+02	mg/l	C p	IV	2
Site Specific Target Level	**6796**	mg/kg	C sstl	V	

Conclusions

Does concentration of chemical of concern in soil exceed SSTL? NO

Risk of Human Exposure due to contaminated soil.

_____ YES X _____ NO

Page 4 of 6 Pages

IN-SITU SOIL RISK EVALUATION

SOIL LEACHABILITY MODEL FOR NAPHTHALENE

RISK-BASED CORRECTIVE ACTION FOR PETROLEUM RELEASES

SITE INFORMATION:

Site: Site 34, Building NH1137
Location: Turnbull Ave, Charleston Naval Complex, North Charleston, SC

REFERENCES:

(1) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 1.
(2) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 2.
(3) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Input Parameters.
(4) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 1.
(5) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 2.
(6) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 3.
(7) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 4.
(8) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 5.

INPUT:

	COC Chemical of Concern		NAPHTHALENE
Bd	Soil Bulk Density (1)	g/cm3	1.59
Crsbl	Risk Based Screening Level	mg/L	1.63
Cs	Concentration of COC in soil	mg/kg	0.85
DAF	Dilution/Attenuation Factor (2)	unitless	8
foc	Organic Carbon Content in Soil (3)	mg/kg	16600
H'	Henry's Law Constant (4)	unitless	0.23
Hf	Wetting front suction head (always negative) (5)	cm	-28
Hw	Average Annual Recharge (3)	cm	25
Kf	Soil Hydraulic Conductivity (6)	cm/s	0.0000
Koc	Soil/Water Partioning Coefficient (2)	ml/g	1543
L	Depth between soil sample with greatest COC concentration to groundwater.	cm	107
Ø	Porosity (7)	unitless	0.45
t1/2	Biodegradation "half life" (2)	days	48
TPH	Total Petroleum Hydrocarbons, EPA Method 3550	mg/kg	464
Wr	Residual Water Content (8)	volume fraction	0.08

CALCULATIONS:

Equation Set I - Determine soil pore water concentration resulting from physical partioning (Cw).

Step 1 - Calculate the total organic carbon content (fcs) of the soil.

fcs = (foc +TPH/1.724)*1E-6 = 0.0169 decimal %

Step 2 - Calculate the concentration of COC in soil pore water (Cw) directly in contact with the contaminate soil.

Cw = Cs*((Wr *1g/cc+Bd)/((Bd*Koc*fcs)+Wr+((ø-Wr)*H'))) = 0.00 mg/l

Equation Set II - Determine the velocity of the soil pore water (Vw)

Step 1 - Calculate the air filled porosity (f) in decimal percent.

f = Ø - Wr = 0.37 decimal %

Step 2 - Determine the time for water to percolate through the vadose zone soil (from depth of worst case soil sample to the water table at site).

t = (t/Kf)*(L-(Hw-Hf))*(ln(Hw+(L-Hf)/(Hw-Hf)))) = 424,860 seconds

Step 3 - Determine the velocity of the water (Vw) in feet per year.

Vw = (L/30.48cm/ft)/(t/31,500,000sec/year) = 259 ft/year

Equation Set III - Determine the organic retardation effect (Vc) of the contaminant.

Step 1 - Calculate the soil/water distribution coefficient (Kd) (ml/g) for uncontaminated soil.

Kd = Koc*foc*1E-6 = 25.6138 ml/g

Step 2 - Calculate the retardation effect of natural soil organic matter on COC migration.

Vc = Vw*(1+((Bd*Kd)/ø)) = 3 ft/year

Equation Set IV - Determine biodegradation rates and provide final COC concentration (Cf) at depth of concern.

Step 1 - Calculate the time (Tc) in days required for the COC to reach groundwater.

Tc = 365 day/yr*((L/30.48cm/ft)/Vc) = 450.46 days

Step 2 - Calculate estimated concentration of COC in the soil pore water (Cp) necessary to protect groundwater.

Cp = 10^(log (Crsbl)+((Tc/2.3)*(0.693/t1/2))) = 1096.03 mg/l

COC concentration in soil pore water (Cp) is greater than Crsbl, therefore the SSTL must be calculated.

Equation Set V - Calculate the Site Specific Target Level (SSTL) for the COC in soil.

Csstl for NAPHTHALENE in soil = Cp*DAF*(((Bd*Koc*fcs)+Wr+(F*'H'"))/(Wr*1g/cc+Bd)) = 2.18E+05 mg/kg

PREPARED BY:_____

Date

CHECKED BY:_____

Date

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID # 17754
FACILITY NAME Site 34, Building NH1137

Instructions

Provide results, separately, for each constituent in the worst case soil analysis.

Data

List Constituent: NAPHTHALENE
(BTEX, Napth.)

				Table
Bioremediation "half-life"	48	days	t 1/2	1
Soil/water partitioning coefficient	1543	ml/g	K oc	1

Results

				Equation Set	Step
Total Organic Carbon Content	0.0169	decimal %	f cs	I	1
Leachate Concentration	0.003	mg/l	C w	I	2
Air Filled Porosity	0.37	decimal %	f	II	1
Infiltration Rate Time	424,860	seconds	t	II	2
Velocity of Water	259	ft/year	V w	II	3
Soil/Water Distribution Coefficient	25.61	ml/g	K d	III	1
Contaminant Percolation Rate	3	ft/year	V c	III	2
Time to Reach Groundwater	450	days	T c	IV	1
Concentration reaching Groundwater	1096.03	mg/l	C p	IV	2
Site Specific Target Level	**218,156**	mg/kg	C sstl	V	

Conclusions

Does concentration of chemical of concern in soil exceed SSTL? NO

Risk of Human Exposure due to contaminated soil.

YES X NO

IN-SITU SOIL RISK EVALUATION

APPENDIX B

Monitoring Well Data
Contract Task Order No.

Well Identification	Date/Time	Total Depth of Well	Depth to Product	Depth to Water	pH	Temperature (°C)	Conductivity (ms/cm)	Dissolved O_2 (mg/l)	Turbidity (NTU)	Sample ID

APPENDIX C

BORING LOG

Page 1 of 1

PROJECT NAME: CNE Site 34 Bldg. NH1137 BORING NUMBER: 34BH4
PROJECT NUMBER: ND164 Zone C CTO 0093 DATE: 6/6/94
DRILLING COMPANY: Colemans GEOLOGIST:
DRILLING RIG: Stratoprobe DRILLER: R. Brand

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1	/				Brn.	Fine Sand		Dry				
	2	/				Blk	Asphalt		↓				
	3	/					↓						
	4	/	1.5/4				↓						
1232	5	/				DK Gray	Silt Sand		Dry	130	0	—	—
	6	/				↓	↓		↓				
	7	/					Soft Silty Clay		Moist	330	0	—	—
1234	8	/	3.5/4			↓	↓ w/wood chips		↓				
	9	/				Blk	Silty Sand Clay		Saturated				
	10	/				↓	↓		↓				
	11	/				Gray	Silty Sand		↓				
	12	/	2.7/4										
1241		/											
		/											
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* When rock coring, enter rock brokeness.

* Include monitor reading in 6 foot intervals @ borehole Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks:

Converted to Well: Yes Temp. No Well I.D. #:

BORING LOG

PROJECT NAME: CWE Site 34 Bldg. NH1137 BORING NUMBER: 34B07
PROJECT NUMBER: N0164 Zone C CTO 0093 DATE: 6/6/94
DRILLING COMPANY: Columbia GEOLOGIST:
DRILLING RIG: Stratoprobe DRILLER: R. Brant

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					Brn	Stiff Silty Clay		Dry				
	2					Olive	↓		↓				
	3					↓	↓		Moist	4			
1134	4		3.5/4			↓	↓		↓				
	5					↓	↓		↓				
	6					Red	Crushed brick - 6"		Saturated				
	7					Black	Silty Clay		↓	500			
1137	8		3/4			Light Gray	Fine Silty Sand		↓				
	9					↓	↓		↓				
	10					↓	↓		↓				
	11					↓	↓		↓				
1149	12		4/4			↓	↓		↓				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks:

Converted to Well: Yes ____ No ____ Well I.D. #:

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH1137
PROJECT NUMBER: N0164 Zone C CTO 0093
DRILLING COMPANY:
DRILLING RIG: 250/5400
BORING NUMBER: CNC34-BG5
DATE: 5-11
GEOLOGIST: Sisco
DRILLER: COLEMAN

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	25				Lt. Gray		Sand		Moist				
	26		2		Lt. Gray		Sand		Moist				
	27				Lt. Gray		Sand		Moist				
	28		2		"	"	Sand		Moist				
				EOB									

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read

Remarks:

Drilling Area Background (ppm): 3

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH 1137
PROJECT NUMBER: N0164 Zone C, CTO 0093
DRILLING COMPANY:
DRILLING RIG: 250 / 5400
BORING NUMBER: CNC34-B04
DATE: 5-11
GEOLOGIST: Silco
DRILLER: COLEMAN

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0												
	1				Lt. Brown		Sandy Silt		Dry	2			
	2				Olive (Dk.)		Silty org. clay		Moist	15	10		
	3				Olive gray		" " "		"	15	10		
	4		3										
	5				Olive gray		Silty Org. clay		Moist	15			
	6				Black		Silty sand		Wet	20			
	7				Black		" "		Wet	20			
	8		25										
	9			▼	Black		~~Silty~~ Sandy silt/stone clay		Wet				
	10				Black		Silty Sand		Saturated				
	11				Gray		" "		"				
	12		35		Gray		" "		"				
				EOB									

2nd No. for filter.

Last filter.

* When rock coring, enter rock brokeness

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 2

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH 1137
PROJECT NUMBER: N0116.4 Zone C CTO 0093
DRILLING COMPANY:
DRILLING RIG: 250 w/ 5400
BORING NUMBER: CNC34-B02
DATE: 5-11
GEOLOGIST: SIGED
DRILLER: M. COLEMAN

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0												
	1				Brown		Sandy Silt		Moist	6			
	2				Olive		" w/ Brick fragments		Moist	20+			
X	3				Olive		Silty org. Clay some Concrete		Moist	100+			
X	4		3										
	5				Olive		Silty org. Clay/concrete		Moist				
	6				Grey		Concrete gravel mix		Wet				
	7			▼	Olive		Silty sand		Saturated				→ Strong odor
	8		2										
	9				Olive		Clay/gravel/sand		Saturated				
	10				Gray		Silty sand		Saturated				
	11				Grey		Silty sand		"				
	12		3										
				EOB									

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 6

Remarks:

Converted to Well: Yes ____ No X Well I.D. #: ____

APPENDIX A
SOIL BORING LOGS

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH1137 BORING NUMBER: CNC34-B01
PROJECT NUMBER: N0164 Zone C CTO 0093 DATE: 5-11-99
DRILLING COMPANY: GEOLOGIST: 81SCO
DRILLING RIG: F-250 w/5400 DRILLER: M. COLEMAN

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	0												
	1				Brown		Sandy silt		Moist	15			
X	2					"	" "		"	100			
	3					"	Silty org. clay		"	20			
	4		4		Olive		" "		"	20			
	5												
	6												
	7												
	8		0				NO RECOVERY						
	9												
	10			▼	Dk. gray		Silty Sand		Wet				
	11				Lt. Gray		Silty Sand		Saturated				
	12		3		"	"	Silty Sand		Saturated				
				EOB									

Strong Odor

* When rock coring, enter rock brokeness.
Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read

Remarks: ______ Drilling Area Background (ppm): 5

Converted to Well: Yes ____ No X Well I.D. #: ______

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH1137
PROJECT NUMBER: N0164 Zone C, CTO 0093
DRILLING COMPANY:
DRILLING RIG: 250 w/ 5400

BORING NUMBER: CNC34-B03
DATE: 5-11
GEOLOGIST: SISCO
DRILLER: COLEMAN

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/FL or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Drifter BZ**
	0												
	1				Brown		Sandy silt		Moist	2			
	2				Mix		Silt brick, wood		"	2			
	3				Dk. olive		Silty org. clay		"	2			
	4		3										
	5				Olive (Dk.)		Sandy silt		Moist	2			
	6				Olive gray		Silty sand		Wet				
	7												
	8		2										
	9			▼	Dk. olive gray		Sandy silt		Wet				
	10				Gray		Silty sand		Saturated				
	11				Gray		Silty sand		Sat.				
	12		3										
				EOB									

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area
Background (ppm): 2

Remarks:

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH1157 BORING NUMBER: CNC34-B05
PROJECT NUMBER: N0164 Zone C CTO 0093 DATE: 5-11
DRILLING COMPANY: GEOLOGIST: SISCO
DRILLING RIG: 250 / 5200 DRILLER: COLEMAN

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0												
	1	/			Lt. Brown		Sandy Silt		Dry	4			
X	2	/			Dk. Brown		" " some clay		Moist	100/20			— filter
X	3	/			Dk. olive		Silty org. clay		"	50/20			— filter
	4	/	3.5		" "		" " "		"	10			
	5	/			" "		Silty org. clay		Moist	10			
	6	/		▼	Black		Silty Sand		Saturated	✓			
	7	/											
	8	/	2										
	9	/			Dk. Olive		Silty org. clay		Wet	✓			
	10	/			Black		Silty Sand		Wet	✓			
	11	/			Gray		" "		Saturated	✓			
	12	/	4		Gray		" "		Saturated	✓			
	13	/								✓			
	14	/								✓			
	15	/								✓			
	16	/	0				With Core Catcher			✓			
	17	/			Black		Sandy Silt with some clay		Saturated	✓			
	18	/			Gray		Silty Sand		Saturated	✓			
	19	/			Gray		Silty Sand		Saturated	✓			
	20	/	4		Gray		Silty Sand		"	✓			
	21	/			Gray		Silty Sand		Moist	✓			
	22	/	2		Gray		Silty Sand		Moist	✓			
	23	/			"		Silty Sand		Moist	✓			
	24	/	2		"		Silty Sand		Moist	✓			
		/											

* When rock coring, enter rock brokeness.

Include monitor reading in 5 foot intervals @ borehole. Increase reading frequency if elevated reponse read

Remarks:

Drilling Area Background (ppm): 4

Converted to Well: Yes ____ No X Well I.D. #: ____

BORING LOG

PROJECT NAME: CNC Site 34 Bldg. NH 1137 BORING NUMBER: 34B06
PROJECT NUMBER: ND1164 Zone C CTO 0093 DATE: 6/6/99
DRILLING COMPANY: Columbia GEOLOGIST:
DRILLING RIG: Strata probe DRILLER: R. Brand

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1	/				Br.	Clayey Sand		Dry				
	2	/					↓		↓				
	3	/				Dk Brn	Silty Clay - Mud		↓	50	0	0	0
1103	4	/	4/4			↓	↓		↓				
	5	/				↓	↓		↓				
	6	/				Bl.	↓		Moist				
	7	/					↓		↓	200			
1109	8	/	2.3/4			Gray	Silty Fine Sand		Saturated				
	9	/				Blk	Silty Sandy Clay			-			
	10	/					↓		↓	400		440	
	11	/				Gray	Silty Sand		↓				
	12	/	2.9/4										
1111		/											
		/											
		/											
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* When rock conng, enter rock brokeness

Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks:

Converted to Well: Yes Temp/ piezometer No Well I.D. #:

BORING LOG

Page 1 of 1

PROJECT NAME: CWE Site 34 Bldg. NH1137 BORING NUMBER: 34BS8
PROJECT NUMBER: N0164 Zone C CTO 0093 DATE: 6/6/99
DRILLING COMPANY: Columbia GEOLOGIST:
DRILLING RIG: DRILLER:

Sample No and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					Brn	Silty Sand		Dry				
	2					DK Brn	Sandy Clay		↓				
	3					Olive	Silty Clay - Soft	-	Moist			.	
1200	4		3.7/4			↓	↓		↓				
	5												
	6												
	7					↓	↓		↓				
1210	8		2.7/4			Blk	Silty Clay - Soft		Saturated				
	9					↓	↓		↓				
	10					DK Brn	Clayey fine Sand - wood chips						
	11					Gray	Silty Fine Sand						
1215	12		4/4			↓	↓		↓				

When rock coring enter rock brokeness

Include monitor reading in 6 foot intervals @ borehole Increase reading frequency if elevated reponse read

Drilling Area Background (ppm):

Remarks:

Converted to Well: Yes ____ No ____ Well I.D. #:

APPENDIX D

SUMMARY OF SLUG TEST

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID #: 17754 **COUNTY:** Charleston

FACILITY NAME: Charleston Naval Complex Site 34, UST 1137-2 at Bldg 1137

Slug Data

See Appendix: **Table:** **Figure:** **X** **for a list of all data measurements.**
(water level logs, etc.) (Complete as appropriate.)

Water Level Recovery Data was measured by ND
(Hermit Data Logger, Manually with Water Level Indicator, etc.) (List Method).

Complete the following table for each well tested.

COMPLETE A SECOND SHEET IF MORE THAN FOUR WELLS ARE TESTED

Slug Test Conducted in well(s) number	047006	510-01	523-01	GDC-01
Initial Rise/Drawdown in well (feet)	1.6	1.19	2.77	1.94
Radius of Well Casing (feet)	0.0833	0.083	0.083	0.083
Effective Radius of Well (feet)	0.35	0.35	0.35	0.35
Static Saturated Aquifer Thickness (feet)	7.4	5.9	7.8	3.4
Length of Well Screen (feet)	7.4	5.9	7.8	3.4
Static Height of Water Column in Well (ft)	7.4	5.9	7.8	3.4

Calculations

See Appendix: **Table:** **Figure:** **X** **for calculations. (Complete as appropriate.)**

The method for aquifer calculations was: Bouwer-Rice **(i.e. Bouwer-Rice, Cooper, etc.)**

Calculated values by well were as follows:

Slug Test Conducted in well(s) number	047006	510-01	523-01	GDC-01
Hydraulic Conductivity (ft/min)	0.002016	0.00612	0.002004	0.0003653

Thickness of the aquifer used to calculate hydraulic conductivity was **feet.**
The aquifer is **confined** **semi-confined** **Water table (Check as appropriate)**
The estimated seepage velocity is **feet per year based on**
a hydraulic conductivity of **, a hydraulic gradient of** **, and**
a porosity of **per cent for** **soil (list type i.e., silty sand, clay, etc).**

SUMMARY OF SLUG TEST

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID #: 17754 **COUNTY:** Charleston

FACILITY NAME: Charleston Naval Complex Site 34, UST 1137-2 at Bldg 1137

Slug Data

See Appendix: X **Table:** **Figure:** **for a list of all data measurements. (water level logs, etc.) (Complete as appropriate.)**

Water Level Recovery Data was measured by NA
(Hermit Data Logger, Manually with Water Level Indicator, etc.) (List Method).

Complete the following table for each well tested.

COMPLETE A SECOND SHEET IF MORE THAN FOUR WELLS ARE TESTED

Slug Test Conducted in well(s) number	044001	044006	047001	047003
Initial Rise/Drawdown in well (feet)	1.414	1.684	3.263	4.369
Radius of Well Casing (feet)	0.0833	0.0833	0.0833	0.0833
Effective Radius of Well (feet)	0.333	0.333	0.333	0.35
Static Saturated Aquifer Thickness (feet)	10.5	12.07	8.7	10.3
Length of Well Screen (feet)	10	10	8.7	10
Static Height of Water Column in Well (ft)	10.5	12.07	8.7	10.3

Calculations

See Appendix: **Table:** **Figure:** **for calculations. (Complete as appropriate.)**

The method for aquifer calculations was: Bouwer-Rice **(i.e. Bouwer-Rice, Cooper, etc.)**

Calculated values by well were as follows:

Slug Test Conducted in well(s) number	044001	044006	047001	047003
Hydraulic Conductivity (ft/min)	0.001908	0.0008453	0.009843	0.003599

Thickness of the aquifer used to calculate hydraulic conductivity was 10.05 **feet.**
The aquifer is **confined** **semi-confined** X **Water table (Check as appropriate.)**

The estimated seepage velocity is 23 **feet per year based on**
a hydraulic conductivity of 4.38 ft/d **, a hydraulic gradient of** 0.005 **, and**
a porosity of 34.5 **per cent for** sand **Soil (list type i.e., silty sand, clay, etc).**

SUMMARY OF SLUG TEST

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID #: 17754 **COUNTY:** Charleston

FACILITY NAME: Charleston Naval Complex Site 34, UST 1137-2 at Bldg 1137

Slug Data

See Appendix: **Table:** **Figure:** X **for a list of all data measurements.**
(water level logs, etc.) (Complete as appropriate.)

Water Level Recovery Data was measured by ND
(Hermit Data Logger, Manually with Water Level Indicator, etc.) (List Method).

Complete the following table for each well tested.

COMPLETE A SECOND SHEET IF MORE THAN FOUR WELLS ARE TESTED

Slug Test Conducted in well(s) number	GDC-02	GDC-1D		
Initial Rise/Drawdown in well (feet)	2.4	3.99		
Radius of Well Casing (feet)	0.083	0.083		
Effective Radius of Well (feet)	0.35	0.35		
Static Saturated Aquifer Thickness (feet)	7.6	26.8		
Length of Well Screen (feet)	7.6	10		
Static Height of Water Column in Well (ft)	7.6	26.8		

Calculations

See Appendix: **Table:** **Figure:** X **for calculations. (Complete as appropriate.)**

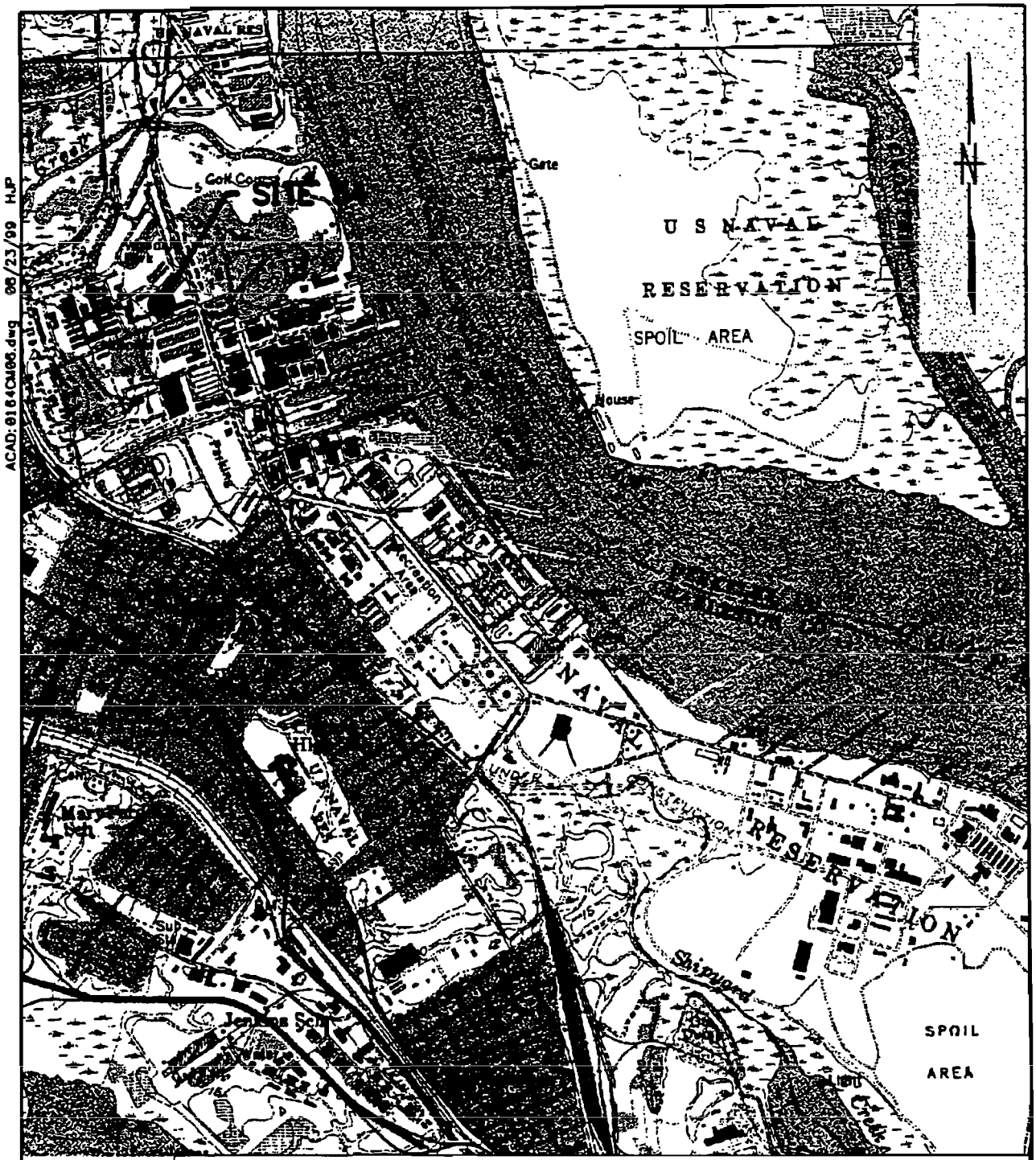
The method for aquifer calculations was: Bouwer-Rice **(i.e. Bouwer-Rice, Cooper, etc.)**

Calculated values by well were as follows:

Slug Test Conducted in well(s) number	GDC-02	GDC-1D	**Geo-Mean**
Hydraulic Conductivity (ft/min)	0.002395	0.002677	**0.003**

Thickness of the aquifer used to calculate hydraulic conductivity was feet.
The aquifer is confined semi-confined X **Water table (Check as appropriate.)**
The estimated seepage velocity is feet per year based on
a hydraulic conductivity of , a hydraulic gradient of , and
a porosity of per cent for soil (list type i.e., silty sand, clay, etc).

FIGURE 1



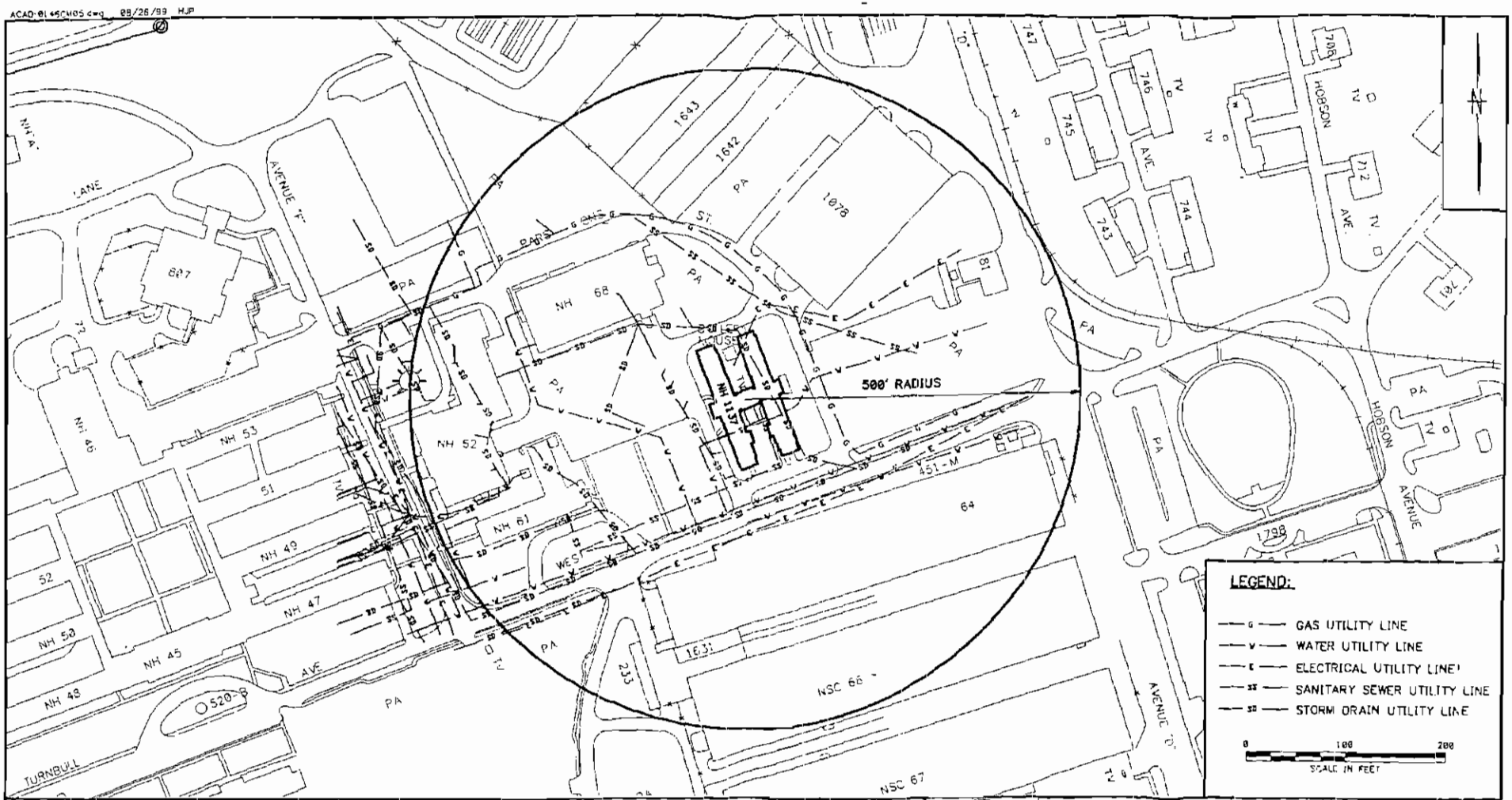
ACAD: 8164CM86.dwg 08/23/99 HJP

SOURCE: QUADRANGLE MAP SOUTH CAROLINA, REVISED 1979
QUADRANGLE MAP NORTH CHARLESTON REVISED, 1979

DRAWN BY HJP DATE 8/20/99		SITE LOCATION MAP SITE 34, BUILDING NH1137-1 & 2, ZONE C CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SC	CONTRACT NO. N0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1 REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

FIGURE 2



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

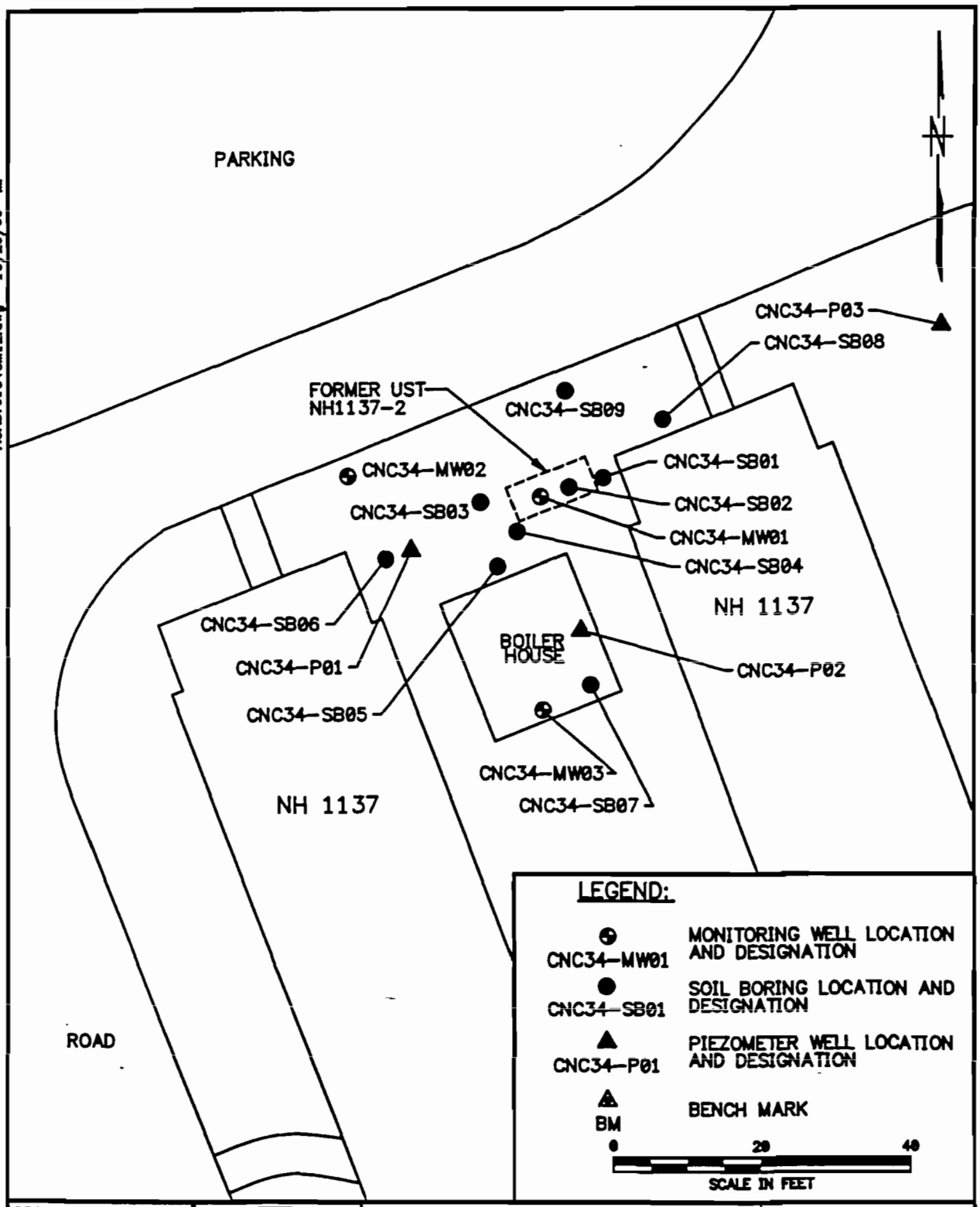
DRAWN BY DLT DATE 8/18/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE VICINITY MAP
SITE 34, BUILDING NH 1137
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0146
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2
REV. 0

FORM CADD NO. SDTV_BH.DWG - REV 0 - 1/20/98

FIGURE 3

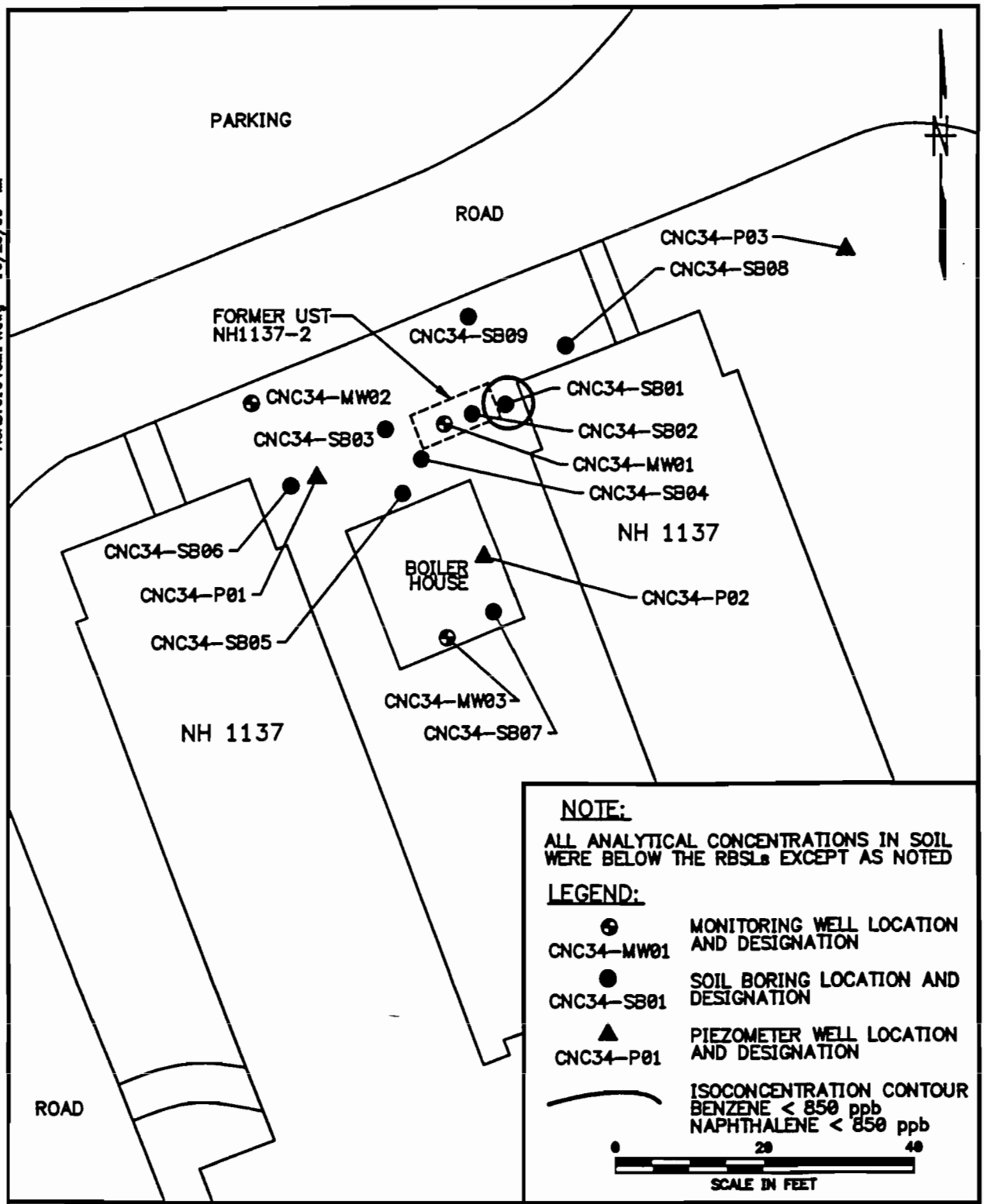


ACAD:0184CM12.dwg 10/29/99 MF

DRAWN BY MF DATE 9/28/99		SITE MAP SITE 34, BUILDING NH 1137-1 & 2 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0124
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

FIGURE 4

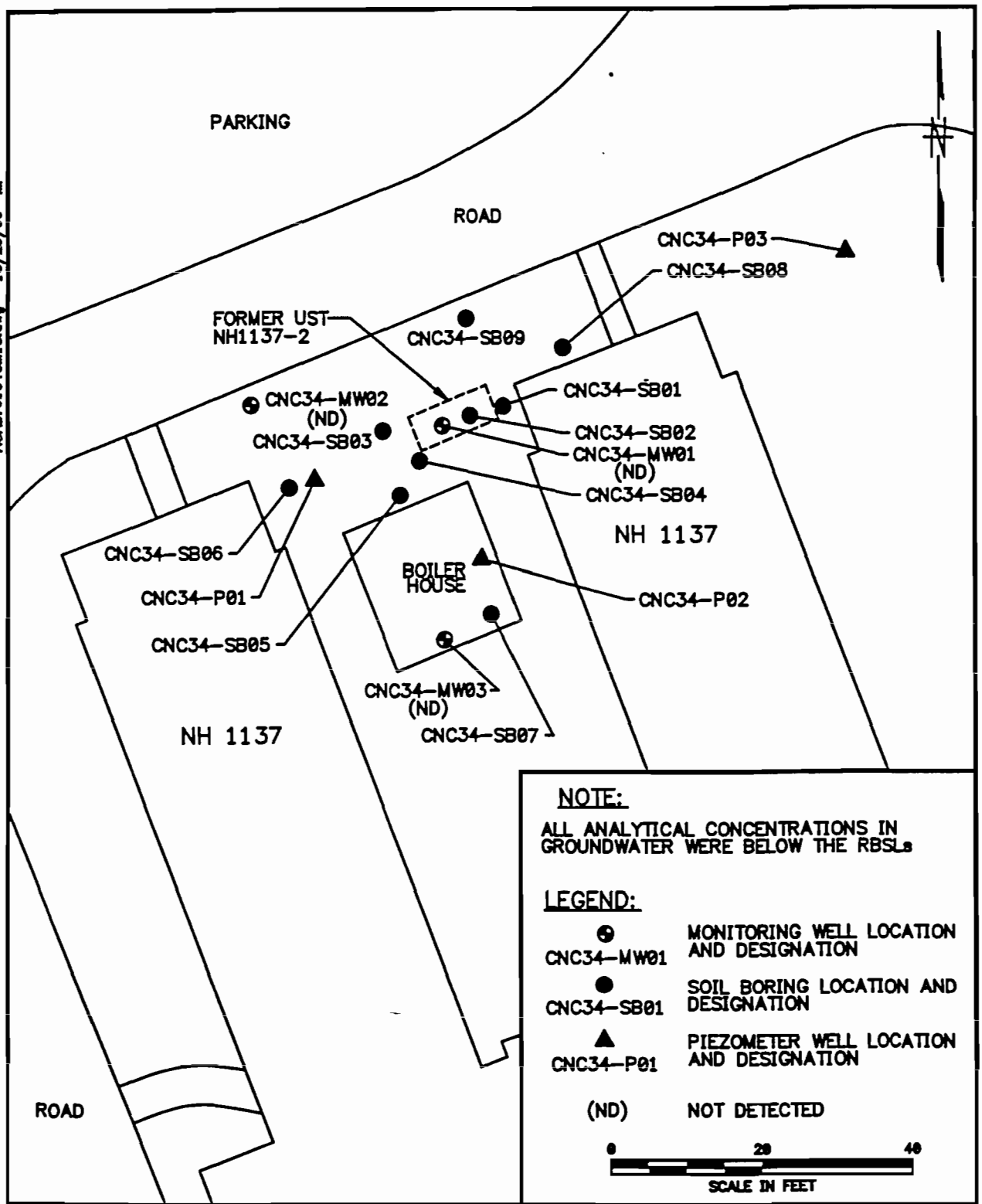


ACAD: 01640M14.dwg 10/29/99 MF

DRAWN BY MF DATE 9/28/99		SOIL COC MAP SITE 34, BUILDING NH 1137-1 & 2 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0124
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4 / REV. 0

FORM CADD NO. SDN_AV.DWG - REV 0 - 1/20/98

FIGURE 5



ACAD:0104GM15.dwg 10/29/99 MF

DRAWN BY MF DATE 9/28/99		GROUNDWATER COC MAP SITE 34, BUILDING NH 1137-1 & 2 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0124
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 5 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98