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CNC CHARLESTON
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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT ADDENDUM ZONE G VOLUME IV OF VI SECTIONS 10.13 TO 13.0 APPENDIX A TO C CNC CHARLESTON SC
3/31/1999
ENSAFE

ZONE G
RCRA FACILITY
INVESTIGATION REPORT - ADDENDUM
CHARLESTON NAVAL COMPLEX

VOLUME IV of VI
SECTIONS 10.13 to 13.0
APPENDIX A TO C

CONTRACT N62467-89-D-0318
CTO-029

Prepared for:

Comprehensive Long-Term Environmental Action Navy (CLEAN)
Charleston Naval Complex
Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901)372-7962

March 31, 1999
Revision: 0

10.13 AOC 646, Operational Storage, Building 3906Q

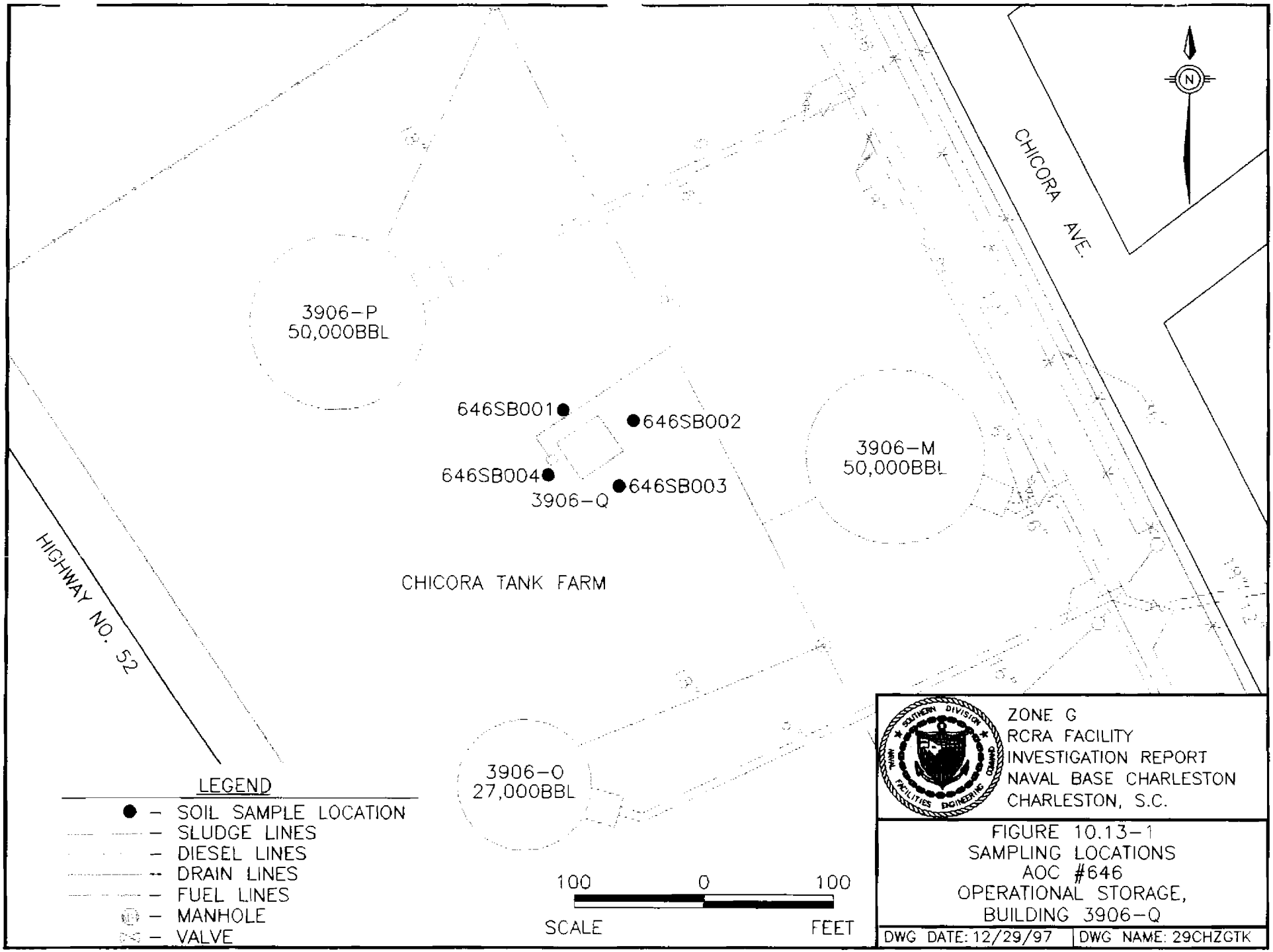
A CSI site, AOC 646 is located at Building 3906Q, the operational storage for the Chicora Tank Farm. Building 3906Q is a single story block structure with a flat concrete roof and a concrete floor. It was built in 1943 to house a boiler that heated residual fuel oil stored at the tank farm. The boiler was removed in 1971, and the building converted to a storage facility. Until recently, the building was used to store absorbent materials, and pumps and compressors used to operate the fuel terminal. A flammable storage locker in the southeast corner of the structure stored small quantities of paints, lubricants, kerosene, and gasoline.

10.13.1 Site Geology

Figure 10.13-1 depicts the soil sampling locations within this area. The detailed stratigraphy at AOC 633 could not be determined as no monitoring well borings were installed within this area. The anticipated stratigraphy would be silty clay and clayey sand to the top of Ashley Formation.

10.13.2 Field Investigation Approach

The objective of the field investigation at AOC 646 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included site soil. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used for soil sampling, and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols used for sample analyses. Figure 10.13-1 depicts the soil sampling locations within the AOC 646 area. Appendix D contains the analytical data report for samples collected in Zone G.


CHICORA AVE.
N
3906-P
50,000BBL
646SB001
646SB002
646SB004
646SB003
3906-Q
3906-M
50,000BBL
CHICORA TANK FARM
HIGHWAY NO. 52
3906-O
27,000BBL
LEGEND
SOIL SAMPLE LOCATION
SLUDGE LINES
DIESEL LINES
DRAIN LINES
FUEL LINES
MANHOLE
VALVE
100 0 100
SCALE FEET
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.13-1
SAMPLING LOCATIONS
AOC #646
OPERATIONAL STORAGE,
BUILDING 3906-Q
DWG DATE: 12/29/97
DWG NAME: 29CHZGTK

10.13.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing four soil borings within the AOC 646 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. During the field investigation, four soil borings were advanced in the site area, as depicted in Figure 10.13-1. All borings included both soil sampling intervals. In accordance with the approved RFI work plan, soil samples from AOC 646 were analyzed for metals, PCBs, SVOCs, PAHs and VOC at DQO Level III. Additionally, four upper interval and three lower interval duplicate samples were collected for Appendix IX analyses at DQO Level IV. Table 10.13.1 summarizes the AOC 646 soil samples and analyses.

10.13.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.13.2. Inorganic analytical results for soil are summarized in Table 10.13.3. Table 10.13.4 presents a summary of all analytes detected in soil at AOC 646. Appendix D contains a complete analytical data report for all Zone G samples collected.

Volatile Organic Compounds in Soil

One VOC was detected in AOC 646 surface soil samples. Concentrations of this parameter were far below its RBC.

No VOCs were detected in subsurface soil samples at AOC 646.

Table 10.13.1
Zone G
AOC 646
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
646SB001	646SB00101	Upper	10/15/96	Note 1	
	646CB00101*			Note 2	*Duplicate sample
	646SB00202	Lower			
	646CB00101*			Note 2	*Duplicate sample
646SB002	646SB00201	Upper	10/15/96	Note 1	
	646CB00201*			Note 2	*Duplicate sample
	646SB00202	Lower			
646SB003	646SB00301	Upper	10/15/96	Note 1	
	646CB00301*			Note 2	*Duplicate sample
	646SB00302	Lower			
	646CB00302*			Note 2	*Duplicate sample
646SB004	646SB00401	Upper	10/15/96	Note 1	
	646CB00401*			Note 2	*Duplicate sample
	646SB00402	Lower			
	646CB00402*			Note 2	*Duplicate sample

Note:

1 = SW-846 (metals, PCBs, SVOCs, PAHs,VOCs) at DQO Level III

2 = Appendix IX suite: SW-846 (metals, pesticides/PCBs, herbicides, OP-pesticides, dioxins, SVOCs, VOCs); cyanide; hex-chrome at DQO Level IV

* = Duplicate sample

Table 10.13.2
Zone G
AOC 646
Organic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 4 Samples plus 4 Duplicate Samples/Lower Interval - 4 Samples plus 3 Duplicate Samples) (μg/kg)						
Trichloroethene	Upper	3/4	1.000 - 2.00	1.33	58000	0
	Lower	0/4	ND	ND	60	0
Semivolatile Organic Compounds (Upper Interval - 4 Samples plus 4 Duplicate Sample/Lower Interval - 4 Samples plus 3 Duplicate Samples) (μg/kg)						
BEQs[1]	Upper	2/4	44.24 - 117.16	80.7	88	1
	Lower	0/0	NA	NA	NA	0
Benzo(a)anthracene	Upper	1/4	50.0	50.0	880	0
	Lower	0/4	ND	ND	2000	0
Benzo(b)fluoranthene	Upper	2/4	42.0 - 71.0	56.5	880	0
	Lower	0/4	ND	ND	5000	0
Benzo(k)fluoranthene	Upper	1/4	69.5	69.5	8800	0
	Lower	0/4	ND	ND	49000	0
Benzo(a)pyrene	Upper	2/4	40.0 - 100	70.0	88	1
	Lower	0/4	ND	ND	8000	0
Chrysene	Upper	2/4	39.0 - 67.5	53.3	88000	0
	Lower	0/4	ND	ND	160000	0
Indeno(1,2,3-cd)pyrene	Upper	1/4	43.0	43.0	880	0
	Lower	0/4	ND	ND	14000	0
Benzo(g,h,i)perylene	Upper	1/4	54.0	54.0	230000	0
	Lower	0/4	ND	ND	4.66E08	0

Table 10.13.2
Zone G
AOC 646
Organic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Butylbenzylphthalate	Upper	1/4	45.0	45.0	1600000	0
	Lower	0/4	ND	ND	930000	0
Fluoranthene	Upper	3/4	50.0 - 74.5	65.2	310000	0
	Lower	0/4	ND	ND	4300000	0
Phenanthrene	Upper	1/4	40.0	40.0	230000	0
	Lower	0/4	ND	ND	1380000	0
Pyrene	Upper	3/4	39.0 - 76.5	59.2	230000	0
	Lower	0/4	ND	ND	4200000	0
Pesticides and PCBs (Upper Interval - 4 Samples plus 4 Duplicate Sample/Lower Interval - 4 Samples plus 3 Duplicate Samples) (µg/kg)						
Aldrin	Upper	1/4	2.20	2.20	38	0
	Lower	0/4	ND	ND	500	0
beta-BHC	Upper	1/4	2.00	2.00	350	0
	Lower	0/4	ND	ND	3	0
Dieldrin	Upper	2/4	3.30 - 3.40	3.35	40	0
	Lower	0/4	ND	ND	4	0
Endrin aldehyde	Upper	1/4	3.60	3.60	2300	0
	Lower	0/4	ND	ND	1000	0
Dioxins (Upper Interval - 4 Sample/Lower Interval - 3 Samples) (ng/kg)						
Dioxin(2,3,7,8-TCDD TEQ)[1]	Upper	4/4	0.0682 - 0.3167	0.199	1000	0
	Lower	2/3	0.0603 - 0.0695	0.0649	1900	0

Table 10.13.2
Zone G
AOC 646
Organic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Herbicides (Upper Interval - 4 Duplicate Sample/Lower Interval - 3 Duplicate Samples) (μg/kg)						
2,4-D	Upper	1/4	37.0	37.0	78000	0
	Lower	0/4	ND	ND	2800	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable
ng/kg	=	Nanograms per kilogram
μg/kg	=	Micrograms per kilogram

Table 10.13.3
Zone G
AOC 646
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 4 Samples plus 4 Duplicate Samples/Lower Interval - 4 Samples plus 3 Duplicate Samples) (mg/kg)						
Aluminum (Al)	Upper	4/4	5315 - 6860	6350	7800	0
	Lower	4/4	7345 - 12200	9920	1000000	0
Arsenic (As)	Upper	4/4	2.95 - 4.90	3.68	0.430	4
	Lower	4/4	1.70 - 4.40	2.75	29	0
Barium (Ba)	Upper	4/4	22.7 - 27.8	25.0	550	0
	Lower	4/4	13.7 - 26.2	20.8	1600	0
Beryllium (Be)	Upper	3/4	0.210 - 0.405	0.282	0.150	3
	Lower	0/4	ND	ND	63	0
Calcium (Ca)	Upper	4/4	909 - 9650	3600	NL	NA
	Lower	4/4	275 - 1285	822	NL	NA
Chromium (Cr)	Upper	4/4	6.90 - 9.75	8.74	39.0	0
	Lower	4/4	8.95 - 16.4	12.4	1000000	0
Cobalt (Co)	Upper	4/4	0.400 - 2.00	0.874	470	0
	Lower	4/4	0.450 - 0.620	0.565	2000	0
Copper (Cu)	Upper	4/4	0.880 - 5.30	3.33	27000	0
	Lower	4/4	0.665 - 1.10	0.831	920	0
Iron (Fe)	Upper	4/4	3830 - 7350	5370	2300	4
	Lower	4/4	3385 - 12400	6960	NL	NA
Lead (Pb)	Upper	4/4	7.05 - 30.1	17.0	400	0
	Lower	4/4	4.75 - 9.90	7.13	400	0

Table 10.13.3
Zone G
AOC 646
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Magnesium (Mg)	Upper	4/4	258 - 363	321	NL	NA
	Lower	4/4	255 - 576	415	NL	NA
Manganese (Mn)	Upper	4/4	10.9 - 38.0	26.7	180	0
	Lower	4/4	4.90 - 9.10	6.96	1100	0
Mercury (Hg)	Upper	4/4	0.085 - 0.23	0.128	2.30	0
	Lower	3/4	0.060 - 0.080	0.0700	2.1	0
Nickel (Ni)	Upper	4/4	1.65 - 3.75	2.76	160	0
	Lower	4/4	2.25 - 5.30	3.11	130	0
Potassium (K)	Upper	1/4	225	225	NL	NA
	Lower	2/4	296 - 377	337	NL	NA
Selenium (Se)	Upper	3/4	0.40 - 0.45	0.420	39.0	0
	Lower	2/4	0.42 - 0.56	0.490	5	0
Sodium (Na)	Upper	4/4	150 - 262	188	NL	NA
	Lower	4/4	147 - 171	159	NL	NA
Thallium (Tl)	Upper	3/4	0.44 - 0.76	0.573	0.63	1
	Lower	3/4	0.49 - 0.64	0.587	0.95	0
Vanadium (V)	Upper	4/4	8.25 - 15.9	12.1	55.0	0
	Lower	4/4	7.50 - 27.1	15.0	6000	0
Zinc (Zn)	Upper	4/4	4.90 - 21.2	15.1	2300	0
	Lower	4/4	4.20 - 7.05	5.61	12000	0

Notes:

*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable
mg/kg	=	Milligrams per kilogram

Table 10.13.4
Zone G
AOC 646
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Trichloroethene	646SB001	1	58000	NA	ND	60	NA
	646SB002	1			ND		
	646SB003	2			ND		
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	646SB002	**117.16**	88.0	NA	ND	NA	NA
	646SB004	44.24			ND		
Benzo(a)anthracene	646SB002	50	880	NA	ND	2000	NA
Benzo(b)fluoranthene	646SB002	71	880	NA	ND	5000	NA
	646SB004	42			ND		
Benzo(k)fluoranthene	646SB002	69.5	8800	NA	ND	49000	NA
Benzo(a)pyrene	646SB002	**100**	88	NA	ND	8000	NA
	646SB004	40			ND		
Chrysene	646SB002	67.5	88000	NA	ND	160000	NA
	646SB004	39			ND		
Indeno(1,2,3-cd)pyrene	646SB002	43	880	NA	ND	14000	NA
Benzo(g,h,i)perylene	646SB002	54	230000	NA	ND	4.66E08	NA
Butylbenzylphthalate	646SB004	45	1600000	NA	ND	930000	NA

Table 10.13.4
Zone G
AOC 646
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Fluoranthene	646SB002	74.5	310000	NA	ND	4300000	NA
	646SB003	50			ND		
	646SB004	71			ND		
Phenanthrene	646SB004	40	230000	NA	ND	1380000	NA
Pyrene	646SB002	76.5	230000	NA	ND	4200000	NA
	646SB003	39			ND		
	646SB004	62			ND		
Pesticides/PCBs (μg/kg)							
Aldrin	646SB003	2.2	38	NA	ND	500	NA
beta-BHC	646SB004	2	350	NA	ND	3	NA
Dieldrin	646SB001	3.4	40	NA	ND	4	NA
	646SB003	3.3			ND		
Endrin aldehyde	646SB002	3.6	2300	NA	ND	1000	NA
Herbicides (μg/kg)							
2,4-D	646SB001	37	78000	NA	ND	2800	NA
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	646SB001	0.3167	1000	NA	0.0603	1900	NA
	646SB002	0.1321			NT		
	646SB003	0.2788			ND		
	646SB004	0.0682			0.0695		

Table 10.13.4
Zone G
AOC 646
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	646SB001	6860	7800.0	18700	7345	1000000	23600
	646SB002	6485			12200		
	646SB003	5315			11600		
	646SB004	6720			8535		
Arsenic (As)	646SB001	3.10	0.43	17.2[a]	1.70	29	15.5[a]
	646SB002	3.75			4.40		
	646SB003	4.90			2.75		
	646SB004	2.95			2.15		
Barium (Ba)	646SB001	22.7	550.0	109	13.7	1600	64.5
	646SB002	27.8			26.2		
	646SB003	23.5			25.3		
	646SB004	26			18.2		
Beryllium (Be)	646SB001	0.210	0.15	1.20	ND	63	1.63
	646SB002	0.230			ND		
	646SB003	0.405			ND		
Calcium (Ca)	646SB001	2135	NL	NL	275	NL	NL
	646SB002	1720			1110		
	646SB003	9650			1285		
	646SB004	909			619		
Chromium (Cr)	646SB001	9.05	39 VI	42.8	8.95	1000000	43.4[a]
	646SB002	6.90	7800 III		16.40		
	646SB003	9.25			14.95		
	646SB004	9.75			9.30		

Table 10.13.4
Zone G
AOC 646
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co)	646SB001	0.6	470.0	6.60	0.45	2000	8.14
	646SB002	0.5			0.62		
	646SB003	2			0.6		
	646SB004	0.4			0.59		
Copper (Cu)	646SB001	3.6	27000	260	0.75	920	32.6
	646SB002	5.3			0.81		
	646SB003	3.6			1.1		
	646SB004	0.88			0.665		
Iron (Fe)	646SB001	**5120**	2300	NL	3385	NL	NL
	646SB002	**3830**			12400		
	646SB003	**5185**			7850		
	646SB004	**7350**			4205		
Lead(Pb)	646SB001	17.8	400.0	181	4.75	400	66.3
	646SB002	30.1			9.9		
	646SB003	13.0			8.5		
	646SB004	7.05			5.4		
Magnesium (Mg)	646SB001	307	NL	NL	255	NL	NL
	646SB002	363			576		
	646SB003	358			506		
	646SB004	258			323		
Manganese (Mn)	646SB001	22.5	180.0	325	5.4	1100	291
	646SB002	38			9.1		
	646SB003	35.4			8.5		
	646SB004	10.9			4.9		

Table 10.13.4
Zone G
AOC 646
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg)	646SB001	0.10	2.3	1.03	0.06	2.1	0.31
	646SB002	0.23			0.07		
	646SB003	0.10			ND		
	646SB004	0.085			0.08		
Nickel (Ni)	646SB001	2.7	160.0	20.6	2.25	130	18.3
	646SB002	3			5.3		
	646SB003	3.75			2.5		
	646SB004	1.65			2.5		
Potassium (K)	646SB002	ND	NL	NL	377	NL	NL
	646SB003	225			296		
Selenium (Se)	646SB001	0.4	39.0	1.22	ND	5	1.26
	646SB002	0.45			0.56		
	646SB003	ND			0.42		
	646SB004	0.41			ND		
Sodium (Na)	646SB001	177	NL	NL	147	NL	NL
	646SB002	164			159		
	646SB003	262			171		
	646SB004	150			158		
Thallium (Tl)	646SB001	0.44	0.63	0.85	0.49	0.95	0.95
	646SB002	0.52			0.64		
	646SB003	ND			0.63		
	646SB004	0.76			ND		

Table 10.13.4
Zone G
AOC 646
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V)	646SB001	11.9	55.0	60.9	7.5	6000	72.5
	646SB002	8.25			27.1		
	646SB003	12.3			16.6		
	646SB004	15.9			8.9		
Zinc (Zn)	646SB001	17.3	2300.0	519	4.2	12000	145
	646SB002	17.2			6.7		
	646SB003	21.2			7.05		
	646SB004	4.9			4.5		

Notes:
a = Background value for non-clay samples
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
ND = Not detected
NT = Not taken
NL = Not listed
NA = Not applicable
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations

Semivolatile Organic Compounds in Soil

Eleven SVOCs were detected in surface soil samples at AOC 646. Benzo(a)pyrene was the only SVOC which exceeded its RBC in one surface soil sample at this AOC. Figure 10.13-2 presents the total BEQ concentrations detected in surface soil.

No SVOCs were detected in subsurface soil at AOC 646.

Pesticides and PCBs in Soil

Four pesticides were detected in surface soil samples at AOC 646. No PCBs were detected in surface soil samples. No pesticides exceeded their respective RBCs in surface soil samples at this AOC.

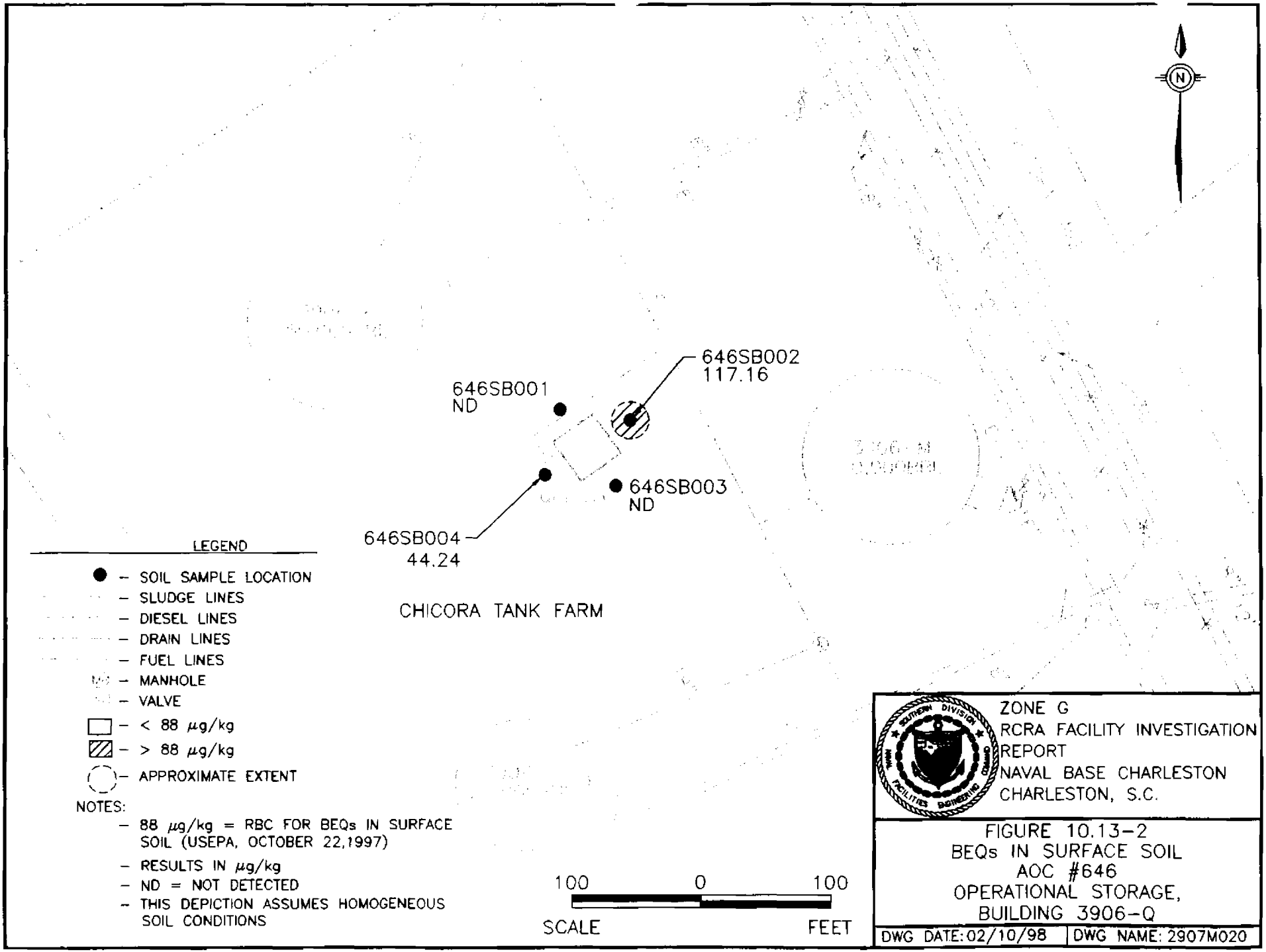
No pesticides or PCBs were detected in subsurface soil samples at AOC 646.

Other Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in four surface soil duplicate samples below the RBC for this parameter. Dioxin was detected in two subsurface soil duplicate samples below the SSL for this parameter. The herbicide 2,4-D was detected in one surface soil sample far below its RBC.

Inorganic Elements in Soil

Twenty metals were detected in soil samples collected at AOC 646. Nineteen metals were detected in subsurface soil samples collected at AOC 646. No metals were detected in surface or subsurface soils at concentrations exceeding the greater of their respective RBCs/SSLs and background concentrations for Zone G surface or subsurface soils. Iron was detected at concentrations exceeding its RBC in surface soil samples. Because iron is considered an essential nutrient, no background concentration was established for this element.


646SB002
117.16
646SB001
ND
646SB003
ND
646SB004
44.24
CHICORA TANK FARM
LEGEND
– SOIL SAMPLE LOCATION
– SLUDGE LINES
– DIESEL LINES
– DRAIN LINES
– FUEL LINES
– MANHOLE
– VALVE
– < 88 μg/kg
– > 88 μg/kg
– APPROXIMATE EXTENT
NOTES:
– 88 μg/kg = RBC FOR BEQs IN SURFACE SOIL (USEPA, OCTOBER 22,1997)
– RESULTS IN μg/kg
– ND = NOT DETECTED
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
100 0 100
SCALE FEET
ZONE G
RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.13-2
BEQs IN SURFACE SOIL
AOC #646
OPERATIONAL STORAGE,
BUILDING 3906-Q
DWG DATE: 02/10/98
DWG NAME: 2907M020

10.13.4 Fate and Transport Assessment

A CSI site, AOC 646 is located at Building 3906Q, the operational storage for the Chicora Tank Farm.

10.13.4.1 Soil-to-Groundwater Cross-Media Transport

Table 10.13.5 compares maximum detected organic compound concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

Several organic compounds were detected in AOC 646 surface soil, but none were detected at concentrations exceeding groundwater protection SSLs. None of the organics detected in surface soil were detected in subsurface soil. Based on the absence of organics in the subsurface soil at levels exceeding SSLs at AOC 646, the soil-to-groundwater migration pathway for organic compounds is considered invalid.

Several inorganic compounds were detected in the surface and subsurface soil at AOC 646, but none were detected at concentrations exceeding groundwater protection SSLs. Based on the absence of concentrations of inorganic constituents in the surface and subsurface soil exceeding the groundwater protection SSLs at AOC 646, the soil-to-groundwater pathway for inorganic constituents is considered invalid.

10.13.4.2 Soil-to-Air Cross-Media Transport

Table 10.13.6 lists the VOCs detected in surface soil samples collected at AOC 646, along with the corresponding soil-to-air volatilization screening criteria. One VOC, trichloroethene, was

Table 10.13.5
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G AOC 646
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max Concentration Shallow GW	Max Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Trichloroethene	2	ND	NA	NA	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Benzo(g,h,i)perylene	54	ND	NA	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	50	ND	NA	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	100	ND	NA	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	71	ND	NA	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	69.5	ND	NA	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	67.5	ND	NA	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	43	ND	NA	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	45	ND	NA	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Fluoranthene	74.5	ND	NA	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Phenanthrene	40	ND	NA	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	76.5	ND	NA	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aldrin	2.2	ND	NA	NA	500	0.004	0.13	UG/KG	UG/L	NO	NO	NO
beta-BHC	2	ND	NA	NA	3	0.037	NA	UG/KG	UG/L	NO	NO	NO
Dieldrin	3.4	ND	NA	NA	4	0.0042	0.0019	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	3.6	ND	NA	NA	1000	11	NA	UG/KG	UG/L	NO	NO	NO
Herbicides												
2,4-D	37	ND	NA	NA	2800	61	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.3167	0.0695	NA	NA	1900	0.45	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	6860	12200	NA	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	4.9	4.4	NA	NA	29	17.8	36	MG/KG	UG/L	NO	NO	NO
Barium	27.8	26.2	NA	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.41	ND	NA	NA	63	0.016	NA	MG/KG	UG/L	NO	NO	NO
Chromium (total)	9.8	16.4	NA	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	2	0.62	NA	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	5.3	1.1	NA	NA	920	130000	8.33	MG/KG	UG/L	NO	NO	NO
Lead	30.1	9.9	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	38	9.1	NA	NA	1100	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.23	0.08	NA	NA	2.1	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	3.8	5.3	NA	NA	130	730	21.7	MG/KG	UG/L	NO	NO	NO
Selenium	0.45	0.56	NA	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Thallium	0.76	0.64	NA	NA	0.95	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Vanadium	15.9	27.1	NA	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	21.2	7.1	NA	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS. Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

Table 10.13.6
Soil-to-Air Volatilization Screening Analysis
NAVBASE Charleston, Zone G: AOC 646
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Trichloroethene	2	5000	UG/KG	NO

Notes:
* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996.
NA - Not available

detected in surface soil at AOC 646, but did not exceed the applicable soil-to-air volatilization screening levels. Consequently, the soil-to-air volatilization migration pathway for volatiles at AOC 646 is considered invalid.

10.13.3 Fate and Transport Summary

Although several organic compounds were detected in surface soil at AOC 646, none were detected in subsurface soil. Organics detected in the surface soil did not exceed applicable soil-to-groundwater SSLs at AOC 646. Based on the absence of organics in the surface and subsurface soil at levels exceeding SSLs at AOC 646, the soil-to-groundwater migration pathway for organic compounds is considered invalid. Several inorganic compounds were detected in the surface and subsurface soil at AOC 646, but none were detected at concentrations exceeding groundwater protection SSLs. Based on the absence of concentrations of inorganic constituents in the surface and subsurface soil exceeding the groundwater protection SSLs at AOC 646, the soil-to-groundwater pathway for inorganic analytes is considered invalid. One VOC, trichloroethene, was detected in surface soil at AOC 646, but did not exceed the applicable soil-to-air volatilization screening levels. Consequently, the soil-to-air volatilization migration pathway for volatiles is considered invalid.

10.13.5 Human Health Risk Assessment

10.13.5.1 Site Background and Investigative Approach

AOC 646 is the operational storage area for the Chicora Tank Farm, Building 3906Q.

During the investigation, a total of four soil borings were advanced to identify potential impacts resulting from the activities listed above. Surface soil samples from all four boring locations were used to quantitatively assess the direct contact soil exposure pathways. Subsurface soil is addressed separately in the previous section, Fate and Transport Assessment. Section 10.13.3 provides a summary of the sampling effort for AOC 646 soil.

10.13.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.13.7, benzo(a)pyrene equivalents were identified as surface soil COPCs. Arsenic, beryllium, and thallium were reported in surface soil at maximum concentrations exceeding their respective RBCs but lower than their respective background concentrations. These inorganic parameters were therefore eliminated from consideration in the HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

10.13.5.3 Exposure Assessment

Exposure Setting

AOC 646 is in the Chicora Tank Farm, located approximately 1,500 feet southwest of the main base in an urban residential setting. The Chicora Tank Farm facility is/was under investigation by the State of South Carolina's UST program. All potable water is provided through the city's water supply. Groundwater is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (current site workers are not anticipated to spend all of their time at this site).

Table 10.13.7
Chemicals Present in Site Samples
AOC 646 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Background	Units	Number Exceeding RBC	Bkgd
Carcinogenic PAHs													
B(a)P Equiv.	*	2	4	44.239	117.1625	80.7	855.07	855.07	88	NA	UG/KG	1	
Benzo(a)anthracene		1	4	50	50	50.0	360	370	880	NA	UG/KG		
Benzo(b)fluoranthene		2	4	42	71	56.5	370	370	880	NA	UG/KG		
Chrysene		2	4	39	67.5	53.3	370	370	88000	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		1	4	43	43	43.0	360	370	880	NA	UG/KG		
Benzo(k)fluoranthene		1	4	69.5	69.5	69.5	360	370	8800	NA	UG/KG		
Benzo(a)pyrene	*	2	4	40	100	70.0	370	370	88	NA	UG/KG	1	
TCDD Equivalents													
Dioxin Equiv.		4	4	0.0682	0.3167	0.20	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		4	4	1.83	5.98	4.7	NA	NA	NA	NA	NG/KG		
1234678-HpCDF		4	4	0.786	3.92	2.5	NA	NA	NA	NA	NG/KG		
123478-HxCDF		2	4	0.579	0.807	0.69	0.153	0.218	NA	NA	NG/KG		
234678-HxCDF		3	4	0.238	0.726	0.53	0.203	0.203	NA	NA	NG/KG		
OCDD		4	4	17.5	68.7	49.5	NA	NA	NA	NA	NG/KG		
OCDF		4	4	0.734	7.5	3.6	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		4	4	5315	6860	6345	NA	NA	7800	18700	MG/KG		
Arsenic (As)		4	4	2.95	4.9	3.7	NA	NA	0.43	17.2	MG/KG	4	
Barium (Ba)		4	4	22.7	27.75	25.0	NA	NA	550	109	MG/KG		
Beryllium (Be)		3	4	0.21	0.405	0.28	0.12	0.12	0.15	1.2	MG/KG	3	
Calcium (Ca)	N	4	4	909	9650	3604	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		4	4	6.9	9.75	8.7	NA	NA	39	42.8	MG/KG		
Cobalt (Co)		4	4	0.4	2	0.87	NA	NA	470	6.6	MG/KG		
Copper (Cu)		4	4	0.88	5.3	3.3	NA	NA	27000	260	MG/KG		
Iron (Fe)	N	4	4	3830	7350	5371	NA	NA	NA	NA	MG/KG		
Lead (Pb)		4	4	7.05	30.05	17.0	NA	NA	400	181	MG/KG		
Magnesium (Mg)	N	4	4	258	363	321	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		4	4	10.85	38	26.7	NA	NA	180	325	MG/KG		
Mercury (Hg)		4	4	0.085	0.23	0.13	NA	NA	2.3	1.03	MG/KG		
Nickel (Ni)		4	4	1.65	3.75	2.8	NA	NA	160	20.6	MG/KG		
Potassium (K)	N	1	4	225	225	225	218	224	NA	NA	MG/KG		
Selenium (Se)		3	4	0.4	0.45	0.42	0.33	0.33	39	1.22	MG/KG		
Sodium (Na)	N	4	4	149.5	262	188	NA	NA	NA	NA	MG/KG		
Thallium (Tl)		3	4	0.44	0.76	0.57	0.38	0.38	0.63	0.85	MG/KG	1	
Vanadium (V)		4	4	8.25	15.85	12.1	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		4	4	4.9	21.2	15.1	NA	NA	2300	519	MG/KG		
Pesticides													
Aldrin		1	4	2.2	2.2	2.2	1.4	1.5	38	NA	UG/KG		
beta-BHC		1	4	2	2	2.0	1.4	1.5	350	NA	UG/KG		
2,4-D		1	4	37	37	37.0	67	70	78000	NA	UG/KG		
Dieldrin		2	4	3.3	3.4	3.4	2.7	2.8	40	NA	UG/KG		
Endrin aldehyde		1	4	3.6	3.6	3.6	2.7	3	2300	NA	UG/KG		
Semivolatile Organics													
Benzo(g,h,i)perylene		1	4	54	54	54.0	360	370	230000	NA	UG/KG		
Butylbenzylphthalate		1	4	45	45	45.0	370	370	1600000	NA	UG/KG		
Fluoranthene		3	4	50	74.5	65.2	370	370	310000	NA	UG/KG		
Phenanthrene		1	4	40	40	40.0	370	370	230000	NA	UG/KG		
Pyrene		3	4	39	76.5	59.2	370	370	230000	NA	UG/KG		
Volatile Organics													
Trichloroethene		3	4	1	2	1.3	5	5	58000	NA	UG/KG		

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram

Therefore, future worker assessment is considered to be conservatively representative of current site users. The adolescent trespasser was evaluated relative to the child resident scenario. Exposure to the adolescent trespasser is expected to occur on a much less frequent basis than the child resident, and as a result, the child resident scenario of considered to be conservatively representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for current and future site workers use are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. Table 10.13.8 presents the justification for exposure pathways assessed in this HHRA.

Table 10.13.8
Exposure Pathways Summary — AOC 646
NAVBASE — Zone G
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Workers/ Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 646.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 646.

Table 10.13.8
Exposure Pathways Summary — AOC 646
NAVBASE — Zone G
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

Since less than ten samples were collected in surface soil, the maximum detected concentration was used as the exposure point concentration for surface soil COPCs, as discussed in Section 7 of this RFI.

Quantification of Exposure

Chronic daily intakes for ingestion and dermal contact surface soil pathways are shown on Tables 10.13.9 and 10.13.10, respectively.

10.13.5.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.13.11 presents toxicological information specific to COPCs identified at AOC 646. This information was used in the quantification of risk/hazard associated with surface soil contaminants. A brief toxicological profile is provided below:

Benzo(a)pyrene equivalents include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of these PAHs have not been well established. There are no RfDs for these PAHs due to a lack of data. All PAHs listed are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed

Table 10.13.9
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Semivolatile Organics							
Benzo(a)pyrene equivalent	1	0.117	1.60E-07	1.50E-06	1.83E-07	5.72E-08	2.04E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.13.10
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Semivolatile Organics								
Benzo(a)pyrene Equivalent	0.117	1	0.01	6.57E-08	2.17E-07	4.11E-08	4.69E-08	1.68E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.13.11
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 646
Naval Base, Charleston, Zone G
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*					
Chemical	**Oral Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**		**Inhalation Slope Factor (kg-day/mg)**		**Weight of Evidence**	**Tumor Type**
Benzo(a)pyrene equivalents	NA	NA	NA	NA	NA	NA	NA	NA	7.3	a	3.1	b	B2	mutagen

Notes:

a = Integrated Risk Information System (IRIS)

b = EPA NCEA - Cincinnati (provisional)

NA = Not applicable or not available

relative to that of benzo(a)pyrene, having an oral SF 7.3 (mg/kg-day)$^{-1}$. Toxicity Equivalency Factors, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified based on animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). The basis for the benzo(a)pyrene B2 classification is listed in IRIS as human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question. The USEPA classification and quantitative estimates of exposure reflect a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and are presented as the risk per mg/kg-day. The unit risk is a quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

The basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced

tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. The basis for the benzo(a)anthracene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. The basis for the benzo(k)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen, et al., 1986).

10.13.5.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was computed separately to address child and adult exposure. Tables 10.13.12 and 10.13.13 present the computed risk associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 646 surface soils is 1E-06. The dermal pathway ILCR is 6E-07. Benzo(a)pyrene equivalents were the sole contributors to ILCR projections for the ingestion and dermal pathways. Since the residential risk estimate, considered a highly conservative estimate of the potential adolescent trespasser risk only marginally exceeds the deminimus risk target of 1E-06, risk estimates for the adolescent trespasser are not anticipated to exceed 1E-06.

Table 10.13.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Semivolatile Organics							
Benzo(a)pyrene equivalent	NA	7.3	ND	ND	1.3E-06	ND	1.5E-07
SUM Hazard Index/ILCR			ND	ND	1E-06	ND	1E-07

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.13.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Semivolatile Organics								
Benzo(a)pyrene equivalent	0.5	NA	14.6	ND	ND	6.0E-07	ND	2.4E-07
SUM Hazard Index/ILCR				ND	ND	6E-07	ND	2E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Hypothetical Site Workers

Site worker ILCRs are 1E-07 for the ingestion pathway and 2E-07 for the dermal contact pathway. Benzo(a)pyrene equivalents were sole contributors to ILCR projections for the ingestion and dermal pathways.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.13.14 presents the COCs identified for AOC 646 surface soil.

Future Site Residents

Benzo(a)pyrene equivalents were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections.

Future Site Workers

No soil pathway COCs were identified for the site worker scenario.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion, residential soil RBCs and background concentrations were compared to each reported

Table 10.13.14
Summary of Risk and Hazard-based COCs
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs
Surface Soil	Incidental	**Semivolatile Organics**						
	Ingestion	Benzo(a)pyrene equivalents	ND	ND	1.3E-06	ND	1.5E-07	2
	Dermal	**Semivolatile Organics**						
	Contact	Benzo(a)pyrene equivalents	ND	ND	6.0E-07	ND	2.4E-07	
Surface Soil Pathway Sum			ND	ND	2E-06	ND	4E-07	

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

COC concentration. Benzo(a)pyrene equivalents were detected at concentrations exceeding their RBC (88 μg/kg) in one of four surface soil samples.

10.13.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. If this area were to be used as a residential site, the surface coverings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current and future site workers and future site residents.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentration was used as the exposure point concentration for this site. Use of a maximum detected concentration represent a conservative assumption when applied as the EPC, such that it is unlikely for the maximum detected concentration to be representative of all soil constituents throughout the site. However, given only four samples collected for this site, it is possible that the maximum detected concentration does not adequately represent the maximum concentration present at this site; therefore underestimating actual exposure.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

A conservative screening process was used to identify COPCs for AOC 646. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC). Arsenic, beryllium, and thallium were detected at maximum concentrations exceeding their corresponding RBCs and were eliminated based on comparison to their corresponding reference concentrations. Wilcoxon rank sum test anaylsis also indicated that site concentrations of these inorganics were within background concentrations.

10.13.5.7 Risk Summary

The risk and hazard posed by contaminants at AOC 646 were assessed for the future site worker and the future site resident under reasonable maximum exposure assumptions. For surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.13.15 presents the risk summary for each soil pathway/receptor group evaluated for AOC 646.

Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 646 are benzo(a)pyrene equivalents. Figure 10.13-3 illustrates point risk estimates for AOC 646 based on soil exposure pathways under

Table 10.13.15
Summary of Risk and Hazard
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	1E-06	ND	1E-07
	Dermal Contact	ND	ND	6E-07	ND	2E-07
Sum of All Pathways		ND	ND	2E-06	ND	4E-07

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

LEGEND

- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

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FIGURE 10.13-3
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 646

a future residential scenario. Table 10.13.16 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Benzo(a)pyrene equivalents were the sole contributors to point risk estimates for AOC 646, contributing to risk above 1E-06 at one surface soil sample location (646SB002). Risk estimates ranged from 7E-07 (646SB004) to 2E-06 (646SB002). The mean risk estimate is 7E-07, assuming a deminimus risk of 1E-07 for the samples with nondetects for benzo(a)pyrene equivalents.

Soil — Site Worker Scenario

No soil pathway COCs were identified for the site worker scenario.

10.13.5.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.13.17 for surface soils.

10.13.6 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 646, COCs requiring further evaluation through the CMS process have been identified for soil. The site is currently in an urban residential setting and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and

Table 10.13.16
Point Estimate of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
646	001	B(a)P Equiv.	ND	UG/KG	NA		NA	
646	002	B(a)P Equiv.	117.1625	UG/KG	NA		1.94	100
646	003	B(a)P Equiv.	ND	UG/KG	NA		NA	
646	004	B(a)P Equiv.	44.239	UG/KG	NA		0.73	100

Table 10.13.17
Remedial Goal Options Surface Soil
AOC 646
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Semivolatile Organics										
Benzo(a)pyrene Equivalents	7.3	NA	0.117	ND	ND	ND	0.060	0.60	6.0	NA

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

BEQs were identified as soil pathway COCs for AOC 646. Table 10.13.18 presents cumulative and COC-specific exposure risks and hazard quotients. Table 10.13.19 presents potential corrective measures for AOC 646.

To determine the leaching potential of contaminants from the subsurface soil media to groundwater, contaminant concentrations in subsurface soil were compared against generic SSLs based on a DAF of 20. This comparison did not indicate contaminant concentrations above the SSLs, therefore there exists no leaching potential at AOC 646. For further information regarding indirect exposure pathways associated with subsurface soil refer to Section 10.13.4, Fate and Transport Assessment for AOC 646.

Potential corrective measures for soil are presented below.

Table 10.13.18
Zone G
AOC 646
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Surface Soil				
BEQs	3.9E-07	1.9E-06	ND	ND
Cumulative	3.9E-07	1.9E-06	ND	ND

Note:
ND = Not determined

Table 10.13.19
Zone G
AOC 646
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

10.14 AOC 706, Area Behind Building 246

A RFI site, AOC 706 is located behind Building 246, the former Hazardous Waste Storage and Transit Facility. Building 246 and its surrounding paved area were constructed in 1986. Prior to this, the land parcel appears to have been an open lot surrounded by trees, accessed from Bainbridge Avenue. Previous investigations revealed the presence of Aroclor-1260 in surface soils above detection limits, however, all concentrations were below USEPA Region III RBCs.

10.14.1 Site Geology and Hydrogeology

The soil boring and groundwater monitoring well locations associated with the AOC 706 RFI are shown in Figure 10.14-1. Appendix A contains the boring log and the monitoring well construction diagram for the well installed at AOC 706. Based on the one monitoring well boring, the stratigraphy at AOC 706 consists of clayey fill with asphalt and ROC to approximately 8 ft bgs, overlying intervals of silty and clayey sand with shell hash and phosphate nodules. The sand extends to a depth of approximately 14 ft bgs. Organic clay was encountered near the total depth of the boring at 14 ft bgs. No samples for grain size analysis were collected from the monitoring well boring. The total depth monitoring well 706001 is 14 ft bgs.

The groundwater elevation at AOC 706 is approximately 4.4 ft msl. Figures 10.14-2 and 10.14-3 depict the shallow groundwater potentiometric surface and inferred flow direction at low and high tide respectively. Only slight differences in the static water level and the overall flow pattern at the AOC 706 area were observed between high and low tide. Shallow groundwater at AOC 706 flows generally to the south, toward Shipyard Creek, at an approximate horizontal flow velocity of 0.051 ft/day. No slug tests were performed on this site.

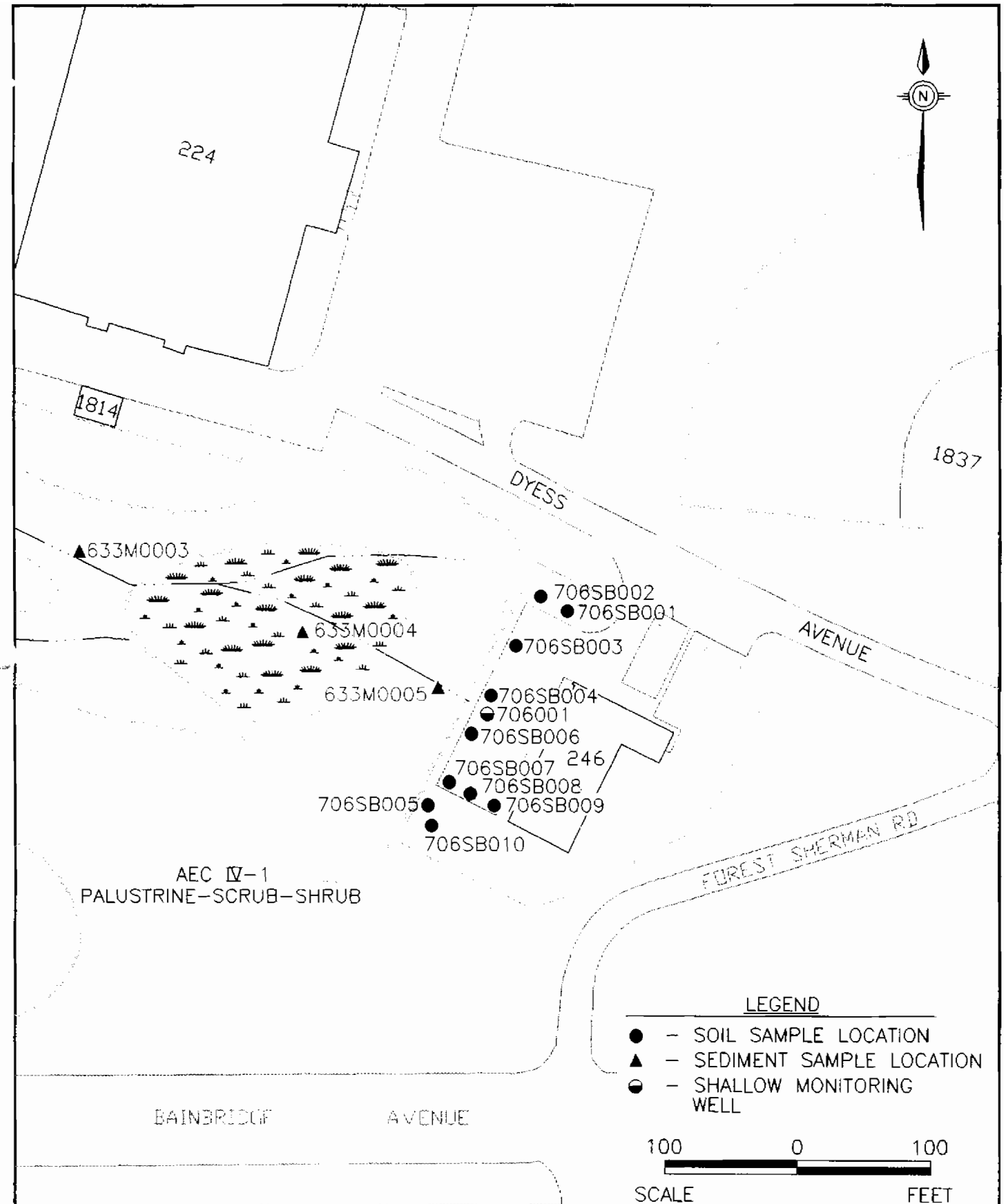

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FIGURE 10.14-1
SAMPLING LOCATIONS
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 12/31/97 | DWG NAME: 2907FS05

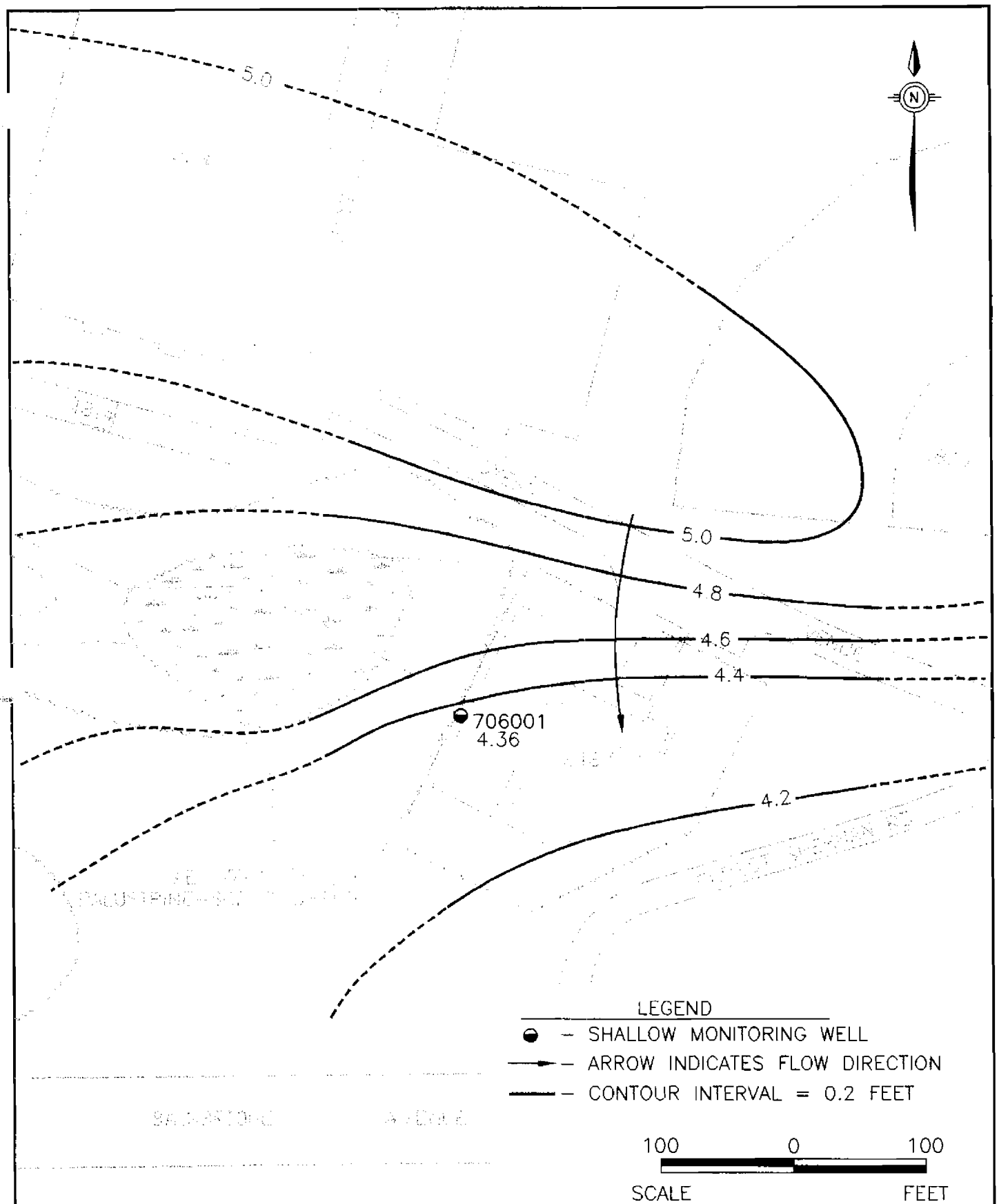

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FIGURE 10.14-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/04/98 | DWG NAME: 2907SGLT

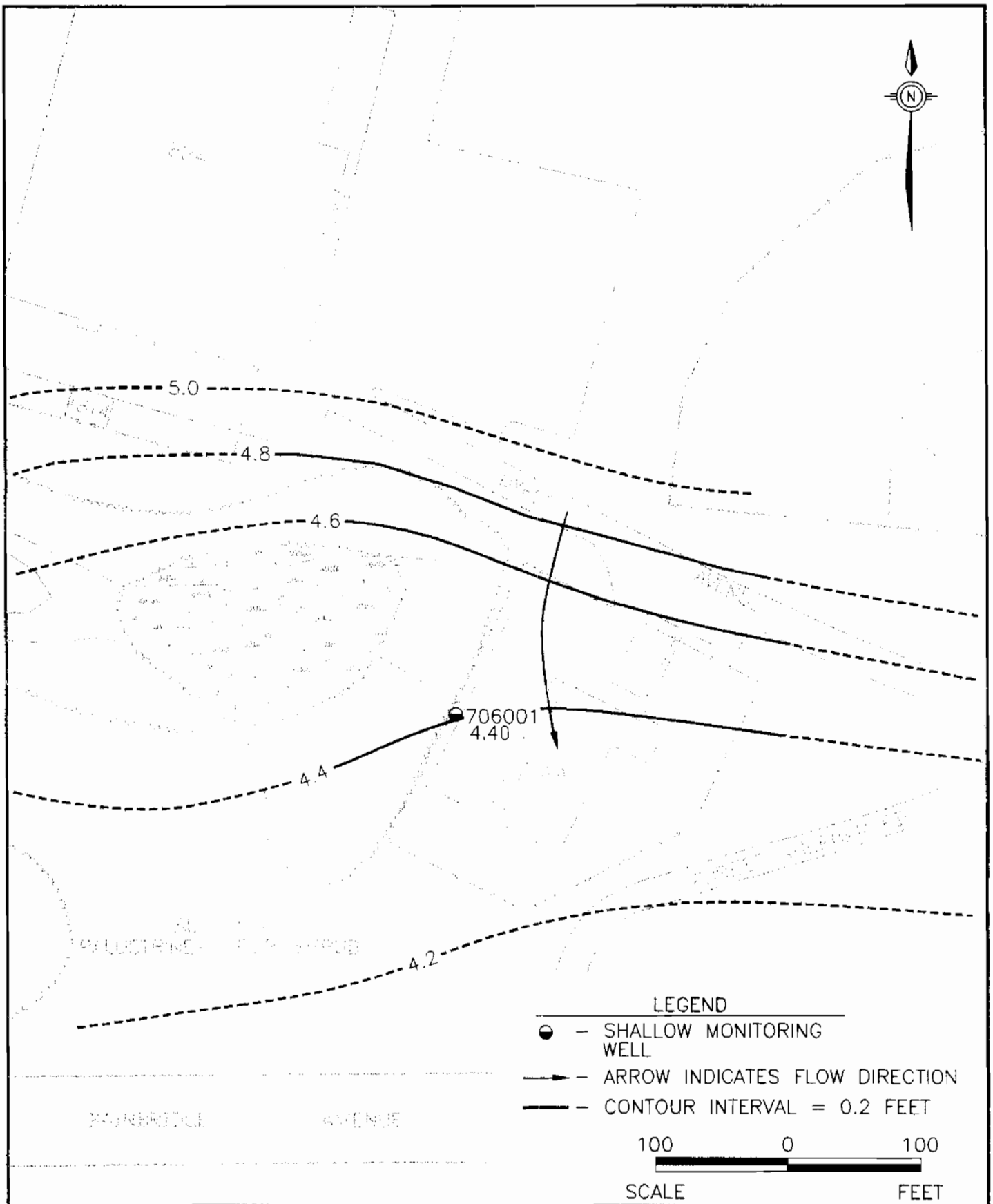

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FIGURE 10.14-3
SHALLOW GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/04/98 | DWG NAME: 2907SGHT

10.14.2 Field Investigation Approach

The objective of the field investigation at AOC 706 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used for soil sampling; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the analytical data report for samples collected in Zone G.

10.14.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing ten soil borings within the AOC 706 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. During the field investigation, ten soil borings were advanced, as depicted in Figure 10.14-1. Seven borings included both upper and lower sampling intervals, while three borings included the upper interval only. Where not collected, the lower interval sample was not collected due to a shallow water table. In accordance with the approved final RFI work plan, soil samples were analyzed for metals, pesticides/PCBs, SVOCs, and VOCs at DQO Level III. In addition, one upper interval duplicate soil sample was collected for Appendix IX analyses at DQO Level IV. Table 10.14.1 summarizes the AOC 706 soil samples and analyses.

Table 10.14.1
Zone G
AOC 706
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
706SB001	706SB00101 706SB00102	Upper Lower	8/30/96	Note 1/cyanides	
706SB002	706SB00201 706CB00201* 706SB00202	Upper Lower	8/30/96	Note 1 Note 2 cyanide	*Duplicate sample
706SB003	706SB00301 706SB00302	Upper Lower	9/09/96	Note 1	
706SB004	706SB00401 706SB00402	Upper Lower	9/03/96	Note 1	
706SB005	706SB00501	Upper	9/20/96	Note 1	Lower interval not sampled due to water table
706SB006	706SB00601 706SB00602	Upper Lower	9/03/96	Note 1	
706SB007	706SB00701 706SB00702	Upper Lower	9/03/96	Note 1	
706SB008	706SB00801	Upper	9/04/96	Note 1	Lower interval not sampled due to water table
706SB009	706SB00901 706SB00902	Upper Lower	9/09/96	Note 1	
706SB010	706SB01001	Upper	9/04/96	Note 1	Lower interval not sampled due to water table

Notes:
1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs) at DQO Level III
2 = Appendix IX suite: SW-846 (metals, pesticides/PCBs, herbicides, OP-pesticides, dioxins, SVOCs, VOCs); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample

10.14.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.14.2. Inorganic analytical results for soil are summarized in Table 10.14.3. Table 10.14.4 summarizes all analytes detected in soil at AOC 706. Appendix D contains a complete analytical data report for all Zone G samples collected.

Volatile Organic Compounds in Soil

Three VOCs were detected in surface soil, and five VOCs were detected in subsurface soil. All VOCs were detected at concentrations far below their respective RBCs and SSLs.

Semivolatile Organic Compounds in Soil

Eleven SVOCs were detected in surface soil at AOC 706, all at concentrations below their respective RBCs. Twenty-five SVOCs were detected in subsurface soil at AOC 706. One SVOC, pentachlorophenol, exceeded its SSL in subsurface soil. Figure 10.14-4 presents pentachlorophenol concentrations detected in subsurface soil at AOC 706.

Pesticides and PCBs in Soil

Five pesticides were detected in surface soil at AOC 706, at concentrations far below their respective RBCs. Aroclor-1260 was also detected in AOC 706 surface soil at a concentration below its respective RBC.

Six pesticides were detected in subsurface soil at AOC 706, at concentrations far below their respective SSLs. Aroclor-1260 was detected in AOC 706 subsurface soil at a concentration exceeding its SSL. Figure 10.14-5 presents Aroclor-1260 concentrations detected in subsurface soil at AOC 706.

Table 10.14.2
Zone G
AOC 706
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 10 Samples plus 1 Duplicate Sample/Lower Interval - 7 Samples) (µg/kg)						
Benzene	Upper	1/10	1.00	1.00	22000	0
	Lower	1/7	2.00	2.00	30	0
Carbon disulfide	Upper	1/10	2.00	2.00	780000	0
	Lower	1/7	2.00	2.00	32000	0
Chlorobenzene	Upper	0/10	ND	ND	160000	0
	Lower	1/7	2.00	2.00	1000	0
Toluene	Upper	0/10	ND	ND	1600000	0
	Lower	1/7	2.00	2.00	12000	0
Trichloroethene	Upper	0/10	ND	ND	58000	0
	Lower	2/7	2.00	2.00	60	0
1,2,3-Trichloropropane	Upper	1/1	6.00	6.00	91	0
	Lower	0/0	NA	NA	0.006	0
Semivolatile Organic Compounds (Upper Interval - 10 Samples plus 1 Duplicate Sample/Lower Interval - 7 Samples) (µg/kg)						
BEQs[1]	Upper	3/10	5.22 - 80.0	54.4	88	0
	Lower	0/0	NA	NA	NA	NA
Benzo(a)anthracene	Upper	1/10	50.0	50.0	880	0
	Lower	5/7	85.0 - 920	557	2000	0
Benzo(b)fluoranthene	Upper	2/10	49.0 - 130	89.5	880	0
	Lower	4/7	210 - 810	420	5000	0

Table 10.14.2
Zone G
AOC 706
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Benzo(k)fluoranthene	Upper	2/10	32.0 - 79.0	55.5	8800	0
	Lower	5/7	120 - 2000	692	49000	0
Benzo(a)pyrene	Upper	2/10	67.0 - 72.0	69.5	88	0
	Lower	6/7	76.0 - 1200	521	8000	0
Chrysene	Upper	1/10	59.0	59.0	88000	0
	Lower	6/7	100 - 1400	560	160000	0
Dibenz(a,h)anthracene	Upper	0/10	ND	ND	88	0
	Lower	5/6	74.0 - 360	190	2000	0
Indeno(1,2,3-cd)pyrene	Upper	0/10	ND	ND	880	0
	Lower	5/7	98.0 - 730	348	14000	0
Acenaphthene	Upper	0/10	ND	ND	470000	0
	Lower	2/7	65.0 - 87.0	76.0	570000	0
Acenaphthylene	Upper	0/10	ND	ND	230000	0
	Lower	2/7	98.0 - 110	104	293000	0
Anthracene	Upper	0/10	ND	ND	2300000	0
	Lower	3/7	200 - 240	213	12000000	0
Benzo(g,h,i)perylene	Upper	0/10	ND	ND	230000	0
	Lower	6/7	77.0 - 780	328	4.66E08	0
Benzoic acid	Upper	2/10	83.0 - 170	127	31000000	0
	Lower	4/7	68.0 - 170	113	400000	0

Table 10.14.2
Zone G
AOC 706
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Butylbenzylphthalate	Upper	0/10	ND	ND	1600000	0
	Lower	1/7	97.0	97.0	930000	0
4-Chloro-3-methylphenol	Upper	0/10	ND	ND	NL	0
	Lower	1/7	170	170	6300000	0
Dibenzofuran	Upper	0/10	ND	ND	31000	0
	Lower	2/7	49.0 - 54.0	51.5	240000	0
Di-n-butylphthalate	Upper	0/10	ND	ND	780000	0
	Lower	1/7	66.0	66.0	2300000	0
Di-n-octylphthalate	Upper	0/10	ND	ND	160000	0
	Lower	1/7	69.0	69.0	10000000	0
Fluoranthene	Upper	3/10	45.0 - 88.0	68.3	310000	0
	Lower	5/7	88.0 - 1400	800	4300000	0
Fluorene	Upper	0/10	ND	ND	310000	0
	Lower	2/7	48.0 - 100	74.0	560000	0
2-Methylnaphthalene	Upper	1/10	74.0	74.0	310000	0
	Lower	3/7	77.0 - 290	151	126000	0
4-Methylphenol(p-Cresol)	Upper	1/10	52.0	52.0	39000	0
	Lower	1/7	120	120	1380	0
Naphthalene	Upper	1/10	51.0	51.0	310000	0
	Lower	3/7	70.0 - 210	121	84000	0

Table 10.14.2
Zone G
AOC 706
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Pentachlorophenol	Upper	0/10	ND	ND	5300	0
	Lower	1/7	62.0	62.0	30	1
Phenanthrene	Upper	0/10	ND	ND	230000	0
	Lower	4/7	100 - 620	428	1380000	0
Pyrene	Upper	4/10	46.0 - 91.0	72.8	230000	0
	Lower	6/7	96.0 - 1500	784	4200000	0
Pesticides and PCBs (Upper Interval - 10 Samples plus 1 Duplicate Sample/Lower Interval - 7 Samples) (µg/kg)						
alpha-Chlordane	Upper	1/10	7.70	7.70	1800	0
	Lower	1/7	11.0	11.0	10000	0
gamma-Chlordane	Upper	3/10	1.40 - 7.70	3.93	1800	0
	Lower	2/7	2.60 - 13.0	7.80	10000	0
4,4'DDD	Upper	1/10	5.60	5.60	2700	0
	Lower	3/7	81.0 - 110	96.3	16000	0
4,4'-DDE	Upper	2/10	7.50 - 58.0	32.8	1900	0
	Lower	4/7	21.0 - 140	79.8	54000	0
4,4'-DDT	Upper	1/10	4.40	4.40	1900	0
	Lower	4/7	9.00 - 140	66.8	32000	0
Endrin aldehyde	Upper	0/10	ND	ND	2300	0
	Lower	1/7	5.10	5.10	1000	0
Aroclor-1260	Upper	1/10	64.0	64.0	320	0
	Lower	3/7	70.0 - 1100	563	1000	1

Table 10.14.2
Zone G
AOC 706
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Dioxins (Upper Interval - 1 Duplicate Sample) (ng/kg)						
Dioxin(2,3,7,8-TCDD TEQ)[1]	Upper	1/1	5.30	5.30	1000	0
	Lower	0/0	NA	NA	1900	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable
µg/kg	=	Micrograms per kilogram
ng/kg	=	Nanograms per kilogram

Table 10.14.3
Zone G
AOC 706
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 10 Samples plus 1 Duplicate Samples/Lower Interval - 7 Samples) (mg/kg)						
Aluminum (Al)	Upper	10/10	4030 - 10055	6100	7800	2
	Lower	7/7	4770 - 28800	16700	1000000	0
Antimony (Sb)	Upper	3/10	0.68 - 4.20	1.96	3.10	1
	Lower	6/7	1.00 - 82.4	29.0	5	3
Arsenic (As)	Upper	10/10	0.490 - 10.8	2.40	0.430	10
	Lower	6/7	9.40 - 22.3	16.7	29	0
Barium (Ba)	Upper	10/10	6.70 - 40.25	16.1	550	0
	Lower	7/7	12.5 - 325	144	1600	0
Beryllium (Be)	Upper	8/10	0.11 - 0.44	0.191	0.150	5
	Lower	7/7	0.15 - 1.5	0.864	63	0
Cadmium (Cd)	Upper	8/10	0.07 - 5.045	0.759	3.90	1
	Lower	6/7	0.540 - 6.20	2.50	8	0
Calcium (Ca)	Upper	10/10	1370 - 43000	13100	NL	NA
	Lower	7/7	3250 - 28500	50.7	NL	NA
Chromium (Cr)	Upper	10/10	3.80 - 15.9	7.94	39.0	0
	Lower	7/7	5.30 - 88.7	50.7	1000000	0
Cobalt (Co)	Upper	9/10	0.390 - 2.10	1.05	470	0
	Lower	7/7	0.490 - 7.60	5.23	2000	0

Table 10.14.3
Zone G
AOC 706
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Copper (Cu)	Upper	10/10	4.70 - 112.05	22.9	27000	0
	Lower	7/7	2.70 - 2210	621	920	2
Iron (Fe)	Upper	10/10	669 - 11000	3350	2300	4
	Lower	7/7	1240 - 36200	25400	NL	NA
Lead (Pb)	Upper	10/10	4.70 - 71.55	18.8	400	0
	Lower	7/7	4.60 - 905	313	400	3
Magnesium (Mg)	Upper	10/10	158 - 1730	694	NL	NA
	Lower	7/7	273 - 5690	3430	NL	NA
Manganese (Mn)	Upper	10/10	7.70 - 154.5	50.2	180	0
	Lower	7/7	9.50 - 551	322	1100	0
Mercury (Hg)	Upper	2/10	0.070 - 0.225	0.148	2.30	0
	Lower	5/7	0.51 - 2.40	1.46	2.1	1
Nickel (Ni)	Upper	10/10	1.00 - 8.30	3.18	160	0
	Lower	7/7	1.40 - 49.5	26.7	130	0
Potassium (K)	Upper	6/10	261 - 553.5	390	NL	NA
	Lower	6/7	771 - 2860	1850	NL	NA
Selenium (Se)	Upper	6/10	0.39 - 0.66	0.546	39.0	0
	Lower	6/7	0.97 - 1.80	1.28	5	0
Silver (Ag)	Upper	1/10	0.24	0.240	39	0
	Lower	3/7	0.74 - 2.50	1.35	34	0

Table 10.14.3
Zone G
AOC 706
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Sodium (Na)	Upper	9/10	159 - 312	240	NL	NA
	Lower	7/7	212 - 4350	2320	NL	NA
Thallium (Tl)	Upper	0/10	ND	ND	0.630	0
	Lower	6/7	0.59 - 1.60	0.992	0.95	4
Tin (Sn)	Upper	1/10	6.40	6.40	4700	0
	Lower	3/7	27.7 - 182	89.0	11000	0
Vanadium (V)	Upper	10/10	4.00 - 24.0	9.97	55.0	0
	Lower	7/7	6.10 - 75.4	47.9	6000	0
Zinc (Zn)	Upper	10/10	7.10 - 238	67.7	2300	0
	Lower	7/7	8.40 - 2560	916	12000	0

Notes:

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples

ND = Not detected

NL = Not listed

NA = Not applicable

mg/kg = Milligrams per kilogram

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Benzene	706SB009	1	22000	NA	2	30	NA
Carbon Disulfide	706SB002	ND	780000	NA	2	32000	NA
	706SB005	2			NT		
Chlorobenzene	706SB009	ND	160000	NA	2	1000	NA
Toluene	706SB009	ND	1600000	NA	2	12000	NA
Trichloroethene	706SB007	ND	58000	NA	2	60	NA
	706SB009	ND			2		
1,2,3-Trichloropropane	706SB002	6	91	NA	ND	0.006	NA
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	706SB001	ND	88.0	NA	NA	NL	NA
	706SB002	5.22			NA		
	706SB004	ND			NA		
	706SB006	ND			NA		
	706SB007	77.8			NA		
	706SB009	80			NA		
Benzo(a)anthracene	706SB001	ND	880.0	NA	180	2000	NA
	706SB004	ND			920		
	706SB006	ND			920		
	706SB007	50			85		
	706SB009	ND			680		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(a)pyrene	706SB001	ND	88.0	NA	270	8000	NA
	706SB002	ND			76		
	706SB004	ND			1200		
	706SB006	ND			840		
	706SB007	72			100		
	706SB009	67			640		
Benzo(b)fluoranthene	706SB001	ND	880	NA	210	5000	NA
	706SB002	49			ND		
	706SB006	ND			810		
	706SB007	ND			120		
	706SB009	130			540		
Benzo(k)fluoranthene	706SB001	ND	8800	NA	170	49000	NA
	706SB002	32			ND		
	706SB004	ND			2000		
	706SB006	ND			640		
	706SB007	79			120		
	706SB009	ND			530		
Chrysene	706SB001	ND	88000	NA	200	160000	NA
	706SB002	ND			140		
	706SB004	ND			1400		
	706SB006	ND			860		
	706SB007	59			100		
	706SB009	ND			660		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Dibenz(a,h)anthracene	706SB001	ND	88	NA	94	2000	NA
	706SB004	ND			360		
	706SB006	ND			280		
	706SB007	ND			74		
	706SB009	ND			140		
Indeno(1,2,3-cd)pyrene	706SB001	ND	880	NA	170	14000	NA
	706SB004	ND			730		
	706SB006	ND			500		
	706SB007	ND			98		
	706SB009	ND			240		
Acenaphthene	706SB001	ND	470000	NA	87	570000	NA
	706SB009	ND			65		
Acenaphthylene	706SB004	ND	230000	NA	98	293000	NA
	706SB009	ND			110		
Anthracene	706SB004	ND	2300000	NA	200	12000000	NA
	706SB006	ND			240		
	706SB009	ND			200		
Benzo(g,h,i)perylene	706SB001	ND	230000	NA	190	4.66E08	NA
	706SB002	ND			77		
	706SB004	ND			780		
	706SB006	ND			560		
	706SB007	ND			140		
	706SB009	ND			220		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzoic acid	706SB004	ND	31000000	NA	170	400000	NA
	706SB006	ND			92		
	706SB007	83			120		
	706SB009	170			68		
Butylbenzylphthalate	706SB007	ND	1600000	NA	97	930000	NA
4-Chloro-3-methylphenol	706SB001	ND	39000	NA	170	6300000	NA
Di-n-butylphthalate	706SB007	ND	780000	NA	66	2300000	NA
Di-n-octylphthalate	706SB007	ND	160000	NA	69	10000000	NA
Dibenzofuran	706SB004	ND	31000	NA	49	240000	NA
	706SB009	ND			54		
Fluoranthene	706SB001	ND	310000.0	NA	210	4300000	NA
	706SB004	45			1100		
	706SB006	ND			1400		
	706SB007	88			88		
	706SB009	72			1200		
Fluorene	706SB004	ND	310000	NA	48	560000	NA
	706SB009	ND			100		
2-Methylnaphthalene	706SB003	74	310000	NA	ND	126000	NA
	706SB004	ND			77		
	706SB006	ND			85		
	706SB009	ND			290		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
4-Methylphenol (p-Cresol)	706SB003	52	39000	NA	ND	1380	NA
	706SB006	ND			120		
Naphthalene	706SB003	51	310000	NA	ND	84000	NA
	706SB004	ND			83		
	706SB006	ND			70		
	706SB009	ND			210		
Pentachlorophenol	706SB004	ND	5300	NA	62	30	NA
Phenanthrene	706SB001	ND	230000.0	NA	100	1380000	NA
	706SB004	ND			550		
	706SB006	ND			620		
	706SB009	ND			440		
Pyrene	706SB001	ND	230000.0	NA	350	4200000	NA
	706SB002	46			440		
	706SB003	91			ND		
	706SB004	ND			920		
	706SB006	ND			1500		
	706SB007	70			96		
	706SB009	84			1400		
Pesticides/PCBs (μg/kg)							
alpha-Chlordane	706SB006	ND	1800	NA	11	10000	NA
	706SB010	7.7			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
gamma-Chlordane	706SB001	2.7	1800	NA	2.6	10000	NA
	706SB002	1.4			ND		
	706SB006	ND			13		
	706SB010	7.7			NT		
4,4'-DDD	706SB001	ND	2700	NA	81	16000	NA
	706SB002	5.6			110		
	706SB006	ND			98		
4,4'-DDE	706SB001	ND	1900	NA	130	54000	NA
	706SB002	58			21		
	706SB004	ND			28		
	706SB006	ND			140		
	706SB010	7.5			NT		
4,4'-DDT	706SB001	ND	1900	NA	18	32000	NA
	706SB002	4.4			9		
	706SB004	ND			100		
	706SB006	ND			140		
Endrin aldehyde	706SB001	ND	2300	NA	5.1	1000	NA
Aroclor-1260	706SB004	ND	320	NA	1100	1000	NA
	706SB006	ND			520		
	706SB007	ND			70		
	706SB008	64			NT		
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	706SB002	5.3	1000	NA	NA	1900	NA

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	706SB001	8170	7800.0	18700	23400	1000000	23600
	706SB002	10055			26400		
	706SB003	6120			4770		
	706SB004	4210			8620		
	706SB005	4360			NT		
	706SB006	4960			9710		
	706SB007	6180			28800		
	706SB008	4030			NT		
	706SB009	5760			15000		
	706SB010	7140			NT		
Antimony (Sb)	706SB001	ND	3.1	2.89	33.8	5	NL
	706SB002	4.2			4		
	706SB003	0.68			ND		
	706SB004	ND			82.4		
	706SB006	ND			49.9		
	706SB007	ND			2.8		
	706SB009	ND			1		
	706SB010	1			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Arsenic (As)	706SB001	2.4	0.43	17.2[a]	21.5	29	15.5[a]
	706SB002	3.8			20.2		
	706SB003	1			ND		
	706SB004	1.3			9.4		
	706SB005	1.6			NT		
	706SB006	0.75			14		
	706SB007	1.2			22.3		
	706SB008	0.49			NT		
	706SB009	0.63			12.7		
	706SB010	10.8			NT		
Barium (Ba)	706SB001	17.1	550.0	109	243	1600	64.5
	706SB002	40.25			62.4		
	706SB003	13.6			12.5		
	706SB004	10.4			325		
	706SB005	13.2			NT		
	706SB006	6.7			166		
	706SB007	11.5			49.4		
	706SB008	8.3			NT		
	706SB009	13.2			152		
	706SB010	26.6			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Beryllium (Be)	706SB001	ND	0.15	1.20	1.2	63	1.63
	706SB002	ND			1.3		
	706SB003	0.13			0.15		
	706SB004	0.17			0.45		
	706SB005	0.16			NT		
	706SB006	0.14			0.59		
	706SB007	0.22			1.5		
	706SB008	0.11			NT		
	706SB009	0.16			0.86		
	706SB010	0.44			NT		
Cadmium (Cd)	706SB001	0.23	3.9	1.07	3.6	8	0.48
	706SB002	5.045			0.62		
	706SB003	0.08			ND		
	706SB004	0.15			6.2		
	706SB005	0.1			NT		
	706SB006	0.07			3.2		
	706SB007	0.13			0.54		
	706SB009	ND			0.81		
	706SB010	0.27			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC[a] (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL[a] (DAF=20)	Subsurface Background
Calcium (Ca)	706SB001	7330	NL	NL	14300	NL	NL
	706SB002	5160			28500		
	706SB003	3310			3250		
	706SB004	43000			15100		
	706SB005	1440			NT		
	706SB006	11100			14700		
	706SB007	38300			9260		
	706SB008	1370			NT		
	706SB009	8260			20700		
	706SB010	12000			NT		
Chromium (Cr)	706SB001	9.3	39 VI	42.8	88.7	1000000	43.4[a]
	706SB002	14.25	7800 III		46.1		
	706SB003	6.2			5.3		
	706SB004	5.5			81.5		
	706SB005	4.8			NT		
	706SB006	4.8			56.5		
	706SB007	8.2			47.8		
	706SB008	3.8			NT		
	706SB009	6.6			29.1		
	706SB010	15.9			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co)	706SB001	0.99	470.0	6.60	7.6	2000	8.14
	706SB002	1.9			6.5		
	706SB003	1.2			0.49		
	706SB004	0.96			5.2		
	706SB005	0.44			NT		
	706SB006	0.39			4.8		
	706SB007	0.81			7.6		
	706SB009	0.63			4.4		
	706SB010	2.1			NT		
Copper (Cu)	706SB001	33.7	27000	260	1030	920	32.6
	706SB002	112.05			84.9		
	706SB003	15.1			2.7		
	706SB004	7.5			2210		
	706SB005	6.1			NT		
	706SB006	8.2			777		
	706SB007	4.8			90.5		
	706SB008	5.7			NT		
	706SB009	4.7			151		
	706SB010	30.7			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Iron (Fe)	706SB001	3640	2300.0	NL	36200	NL	NL
	706SB002	7035			28600		
	706SB003	2140			1240		
	706SB004	1890			28600		
	706SB005	2400			NT		
	706SB006	865			31900		
	706SB007	2190			34200		
	706SB008	669			NT		
	706SB009	1680			17000		
	706SB010	11000			NT		
Lead(Pb)	706SB001	19.9	400.0	181	631	400	66.3
	706SB002	71.55			68.8		
	706SB003	15.1			4.6		
	706SB004	12.2			905		
	706SB005	8.4			NT		
	706SB006	6.1			406		
	706SB007	7			61		
	706SB008	4.9			NT		
	706SB009	4.7			112		
	706SB010	38			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Magnesium (Mg)	706SB001	757	NL	NL	5320	NL	NL
	706SB002	928.5			5690		
	706SB003	473			273		
	706SB004	938			2310		
	706SB005	285			NT		
	706SB006	400			2220		
	706SB007	1730			4700		
	706SB008	158			NT		
	706SB009	338			3510		
	706SB010	930			NT		
Manganese (Mn)	706SB001	52.7	180.0	325	551	1100	291
	706SB002	154.5			322		
	706SB003	16.2			9.5		
	706SB004	55.6			258		
	706SB005	16.7			NT		
	706SB006	11.7			447		
	706SB007	40.7			463		
	706SB008	7.7			NT		
	706SB009	16.9			204		
	706SB010	129			NT		
Mercury (Hg)	706SB001	0.07	2.3	1.03	1.4	2.1	0.31
	706SB002	0.225			1.2		
	706SB004	ND			2.4		
	706SB006	ND			1.8		
	706SB007	ND			0.51		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Nickel (Ni)	706SB001	3.9	160.0	20.6	41.8	130	18.3
	706SB002	8.3			18.8		
	706SB003	2.5			1.4		
	706SB004	2.7			48.7		
	706SB005	1.4			NT		
	706SB006	1.8			49.5		
	706SB007	2.8			14.5		
	706SB008	1			NT		
	706SB009	1.9			12.3		
	706SB010	5.5			NT		
Potassium (K)	706SB001	395	NL	NL	2430	NL	NL
	706SB002	553.5			2860		
	706SB003	298			ND		
	706SB004	ND			771		
	706SB006	ND			833		
	706SB007	327			2480		
	706SB009	261			1710		
	706SB010	507			NT		
Selenium (Se)	706SB001	0.66	39.0	1.22	1.8	5	1.26
	706SB002	0.605			1.3		
	706SB003	0.39			ND		
	706SB004	ND			1.2		
	706SB005	0.5			NT		
	706SB006	ND			1.1		
	706SB007	ND			0.97		
	706SB008	0.58			NT		
	706SB009	ND			1.3		
	706SB010	0.54			NT		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Silver (Ag)	706SB001	ND	39.0	NL	0.74	34	NL
	706SB004	ND			2.5		
	706SB006	ND			0.8		
	706SB010	0.24			NT		
Sodium (Na)	706SB001	312	NL	NL	4080	NL	NL
	706SB002	282			4350		
	706SB003	177			212		
	706SB004	216			1210		
	706SB006	248			1300		
	706SB007	203			2170		
	706SB008	159			NT		
	706SB009	273			2950		
	706SB010	292			NT		
Thallium (Tl)	706SB001	ND	0.63	0.85	1.6	0.95	0.95
	706SB002	ND			0.98		
	706SB004	ND			0.59		
	706SB006	ND			0.98		
	706SB007	ND			0.6		
	706SB009	ND			1.2		
Tin (Sn)	706SB001	ND	4700	9.67	57.2	11000	2.96
	706SB004	ND			182		
	706SB005	6.4			NT		
	706SB006	ND			27.7		

Table 10.14.4
Zone G
AOC 706
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V)	706SB001	12.1	55.0	60.9	73	6000	72.5
	706SB002	16.35			69.4		
	706SB003	7			6.1		
	706SB004	6.1			37.6		
	706SB005	6.9			NT		
	706SB006	4.8			36.7		
	706SB007	9.5			75.4		
	706SB008	4			NT		
	706SB009	8.9			37.4		
	706SB010	24			NT		
Zinc (Zn)	706SB001	66.5	2300.0	519	1580	12000	145
	706SB002	194.5			269		
	706SB003	34			8.4		
	706SB004	15.5			2560		
	706SB005	238			NT		
	706SB006	7.1			1240		
	706SB007	13.2			167		
	706SB008	10.8			NT		
	706SB009	8			585		
	706SB010	89.2			NT		

Notes:

a	=	Background value for non-clay samples
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
I	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
ND	=	Not detected
NT	=	Not taken
NL	=	Not listed
NA	=	Not applicable
µg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram
ng/kg	=	Nanograms per kilogram

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations

Other Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in one surface soil duplicate sample below the RBC for this parameter.

Inorganic Elements in Soil

Twenty-three metals were detected in surface soil samples collected at AOC 706. Antimony and cadmium were detected at concentrations that exceeded both their respective RBCs and background concentrations for Zone G surface soil. The essential nutrient, iron was detected at a concentration exceeding its RBC; however, no background concentration is available for iron in surface soil. Figure 10.14-6 presents antimony detected in surface soil at AOC 706. Figure 10.14-7 presents cadmium detected in surface soil.

Twenty-four metals were detected in subsurface soil samples collected at AOC 706. Antimony, copper, lead, mercury and thallium were detected at concentrations that exceeded both their respective SSLs and background concentrations for Zone G subsurface soil. Figures 10.14-8 through 10.14-12 present antimony, copper, lead, mercury, and thallium detected in subsurface soil, respectively, at AOC 706.

10.14.4 Groundwater Sampling and Analysis

Although the work plan proposed no monitoring wells at AOC 706, inorganic results from initial soil sampling revealed elevated metals concentrations which might be of concern at this site. Therefore, a shallow well was installed at this location to assess potential leaching of inorganics to groundwater. This well was installed at approximately 14 ft bgs in the upper sand of the Wando Formation. The sample collected was analyzed for metals and SVOCs at DQO Level III. Table 10.14.5 summarizes groundwater sampling and analyses at this site.

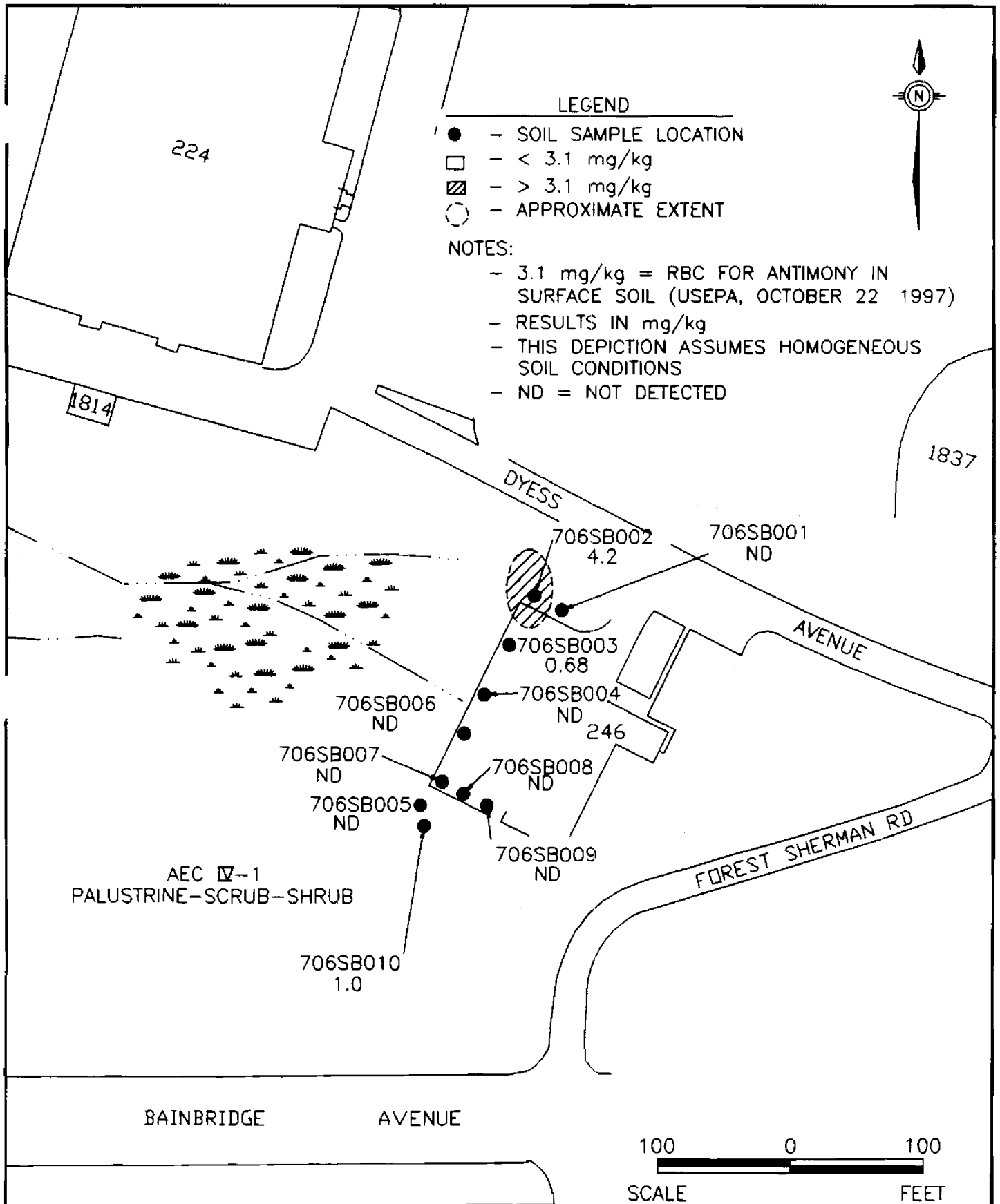

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FIGURE 10.14-6
ANTIMONY IN SURFACE SOIL
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/03/98 | DWG NAME: 2907M052

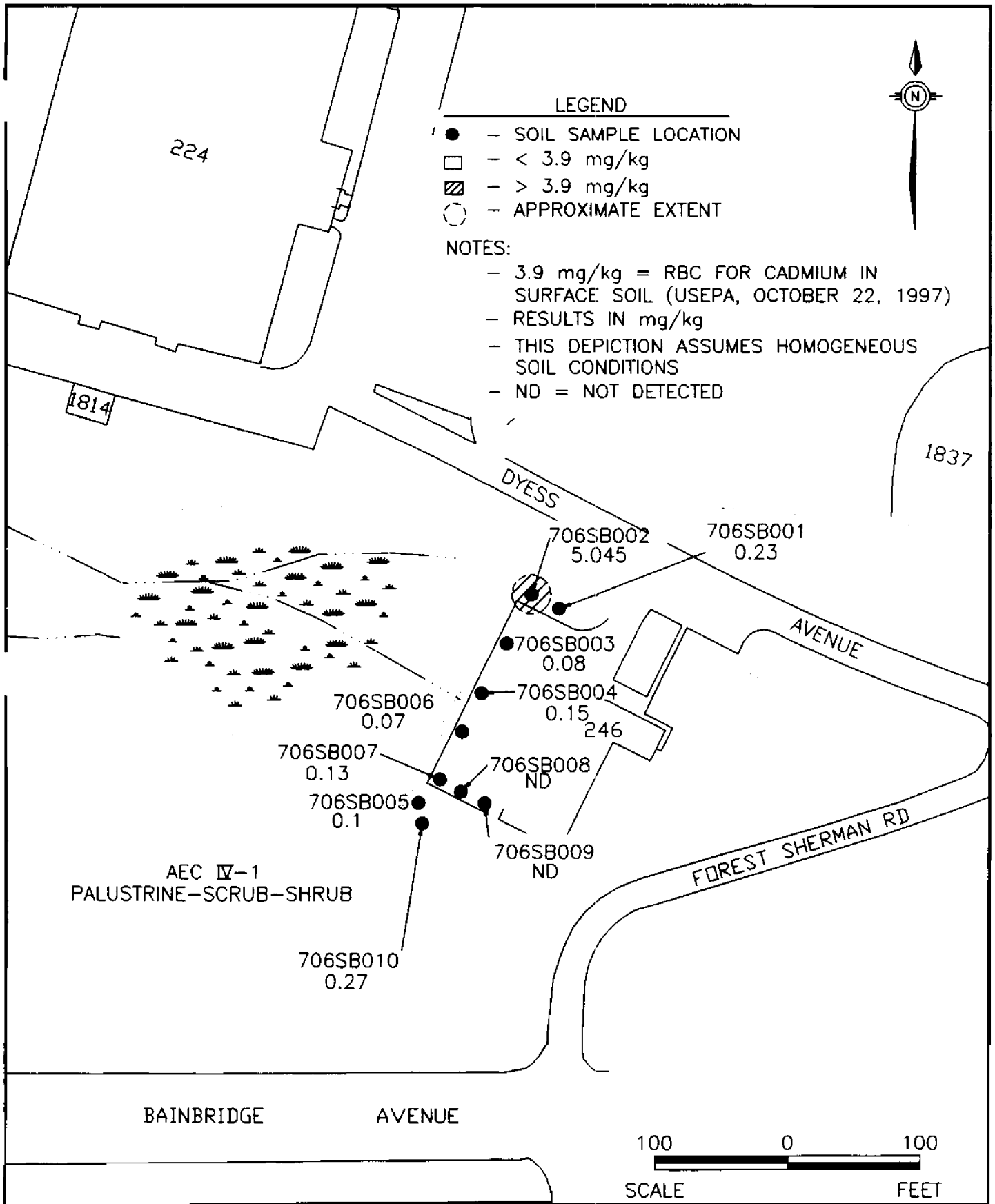

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FIGURE 10.14-7
CADMIUM IN SURFACE SOIL
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/03/98 | DWG NAME: 2907M053

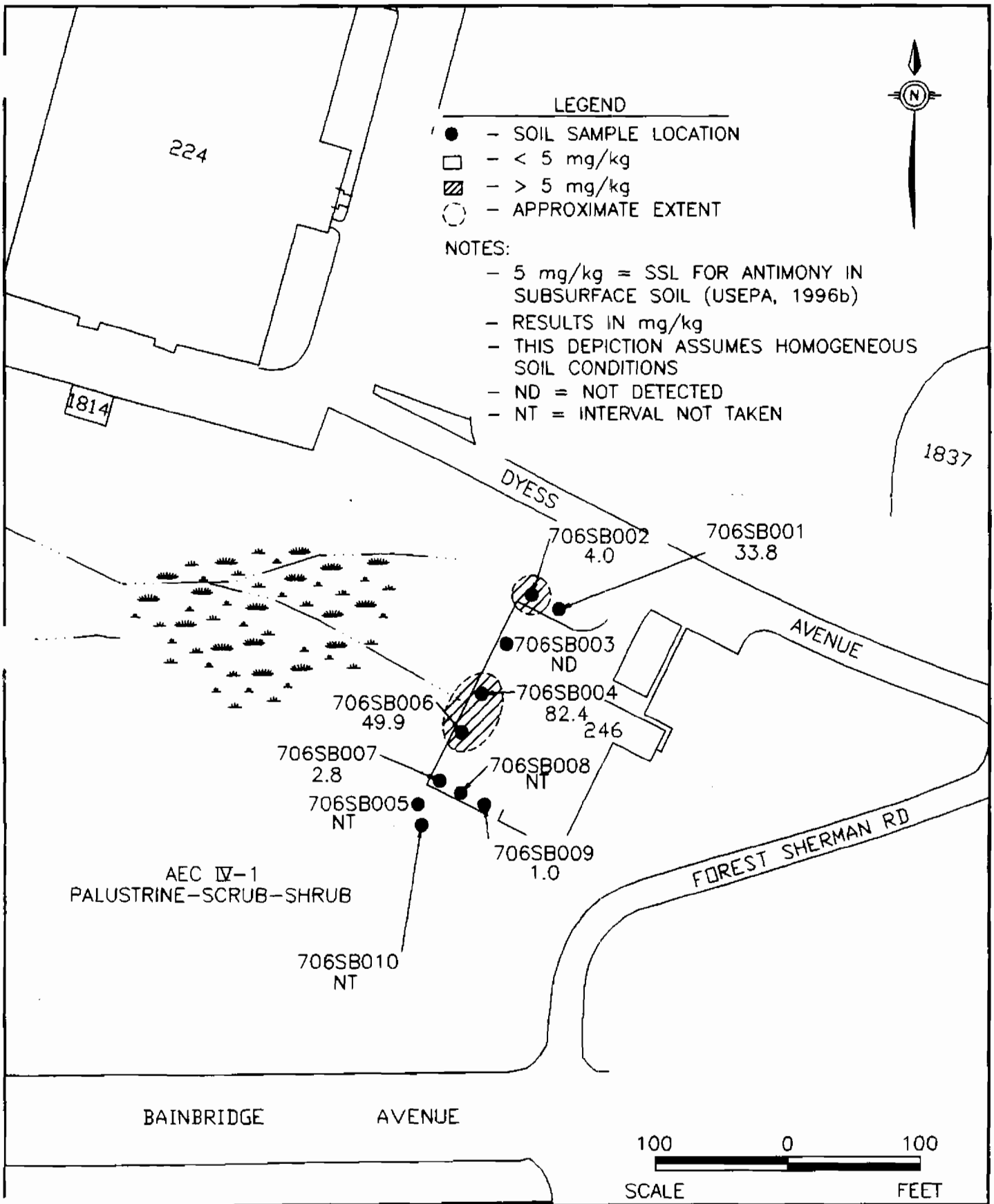

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FIGURE 10.14-8
ANTIMONY IN SUBSURFACE SOIL
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/03/98 | DWG NAME: 2907M054

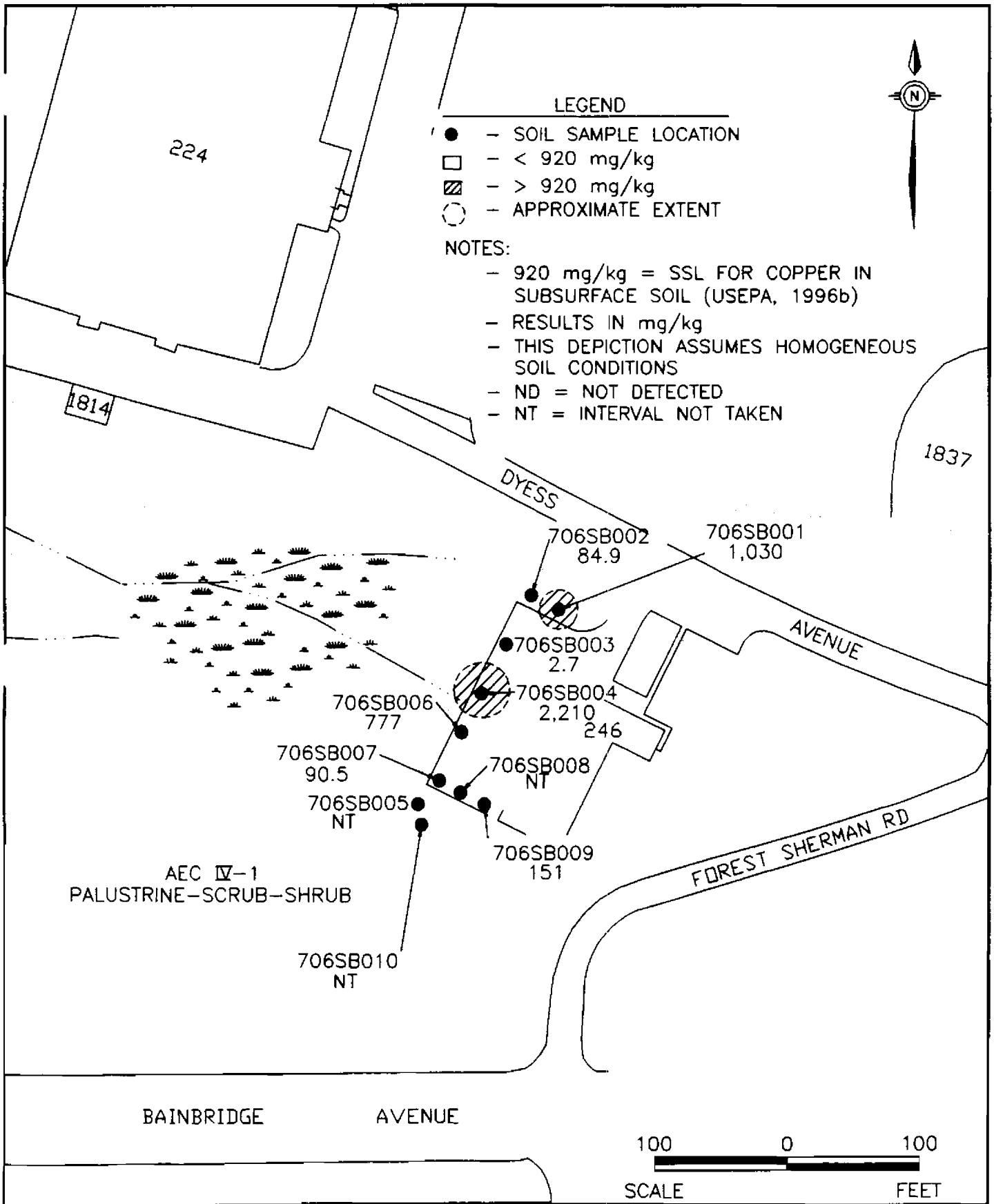

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FIGURE 10.14-9
COPPER IN SUBSRUFACE SOIL
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/03/98 | DWG NAME: 2907M055

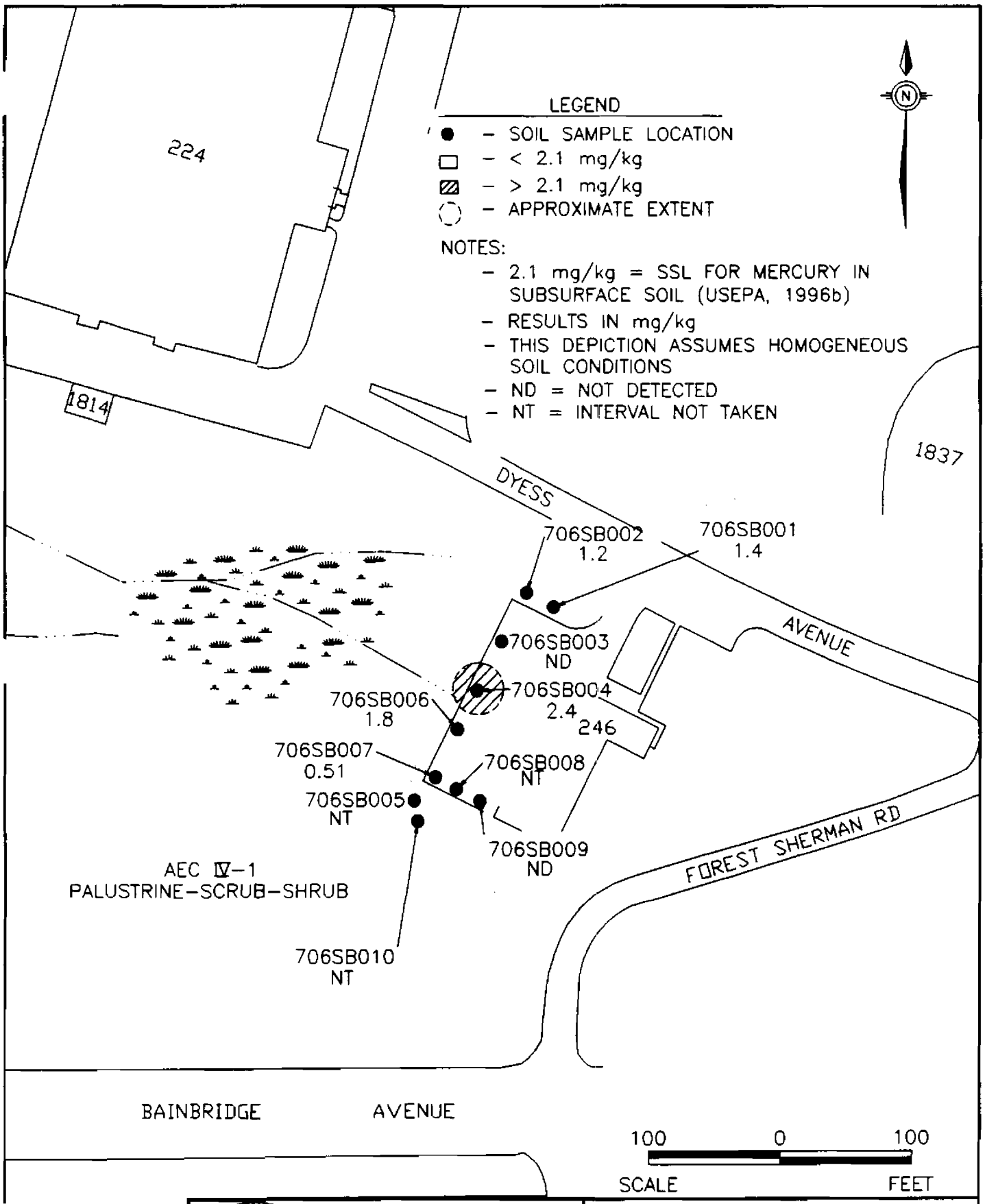

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FIGURE 10.14-11
MERCURY IN SUBSURFACE SOIL
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/03/98 | DWG NAME: 2907M057

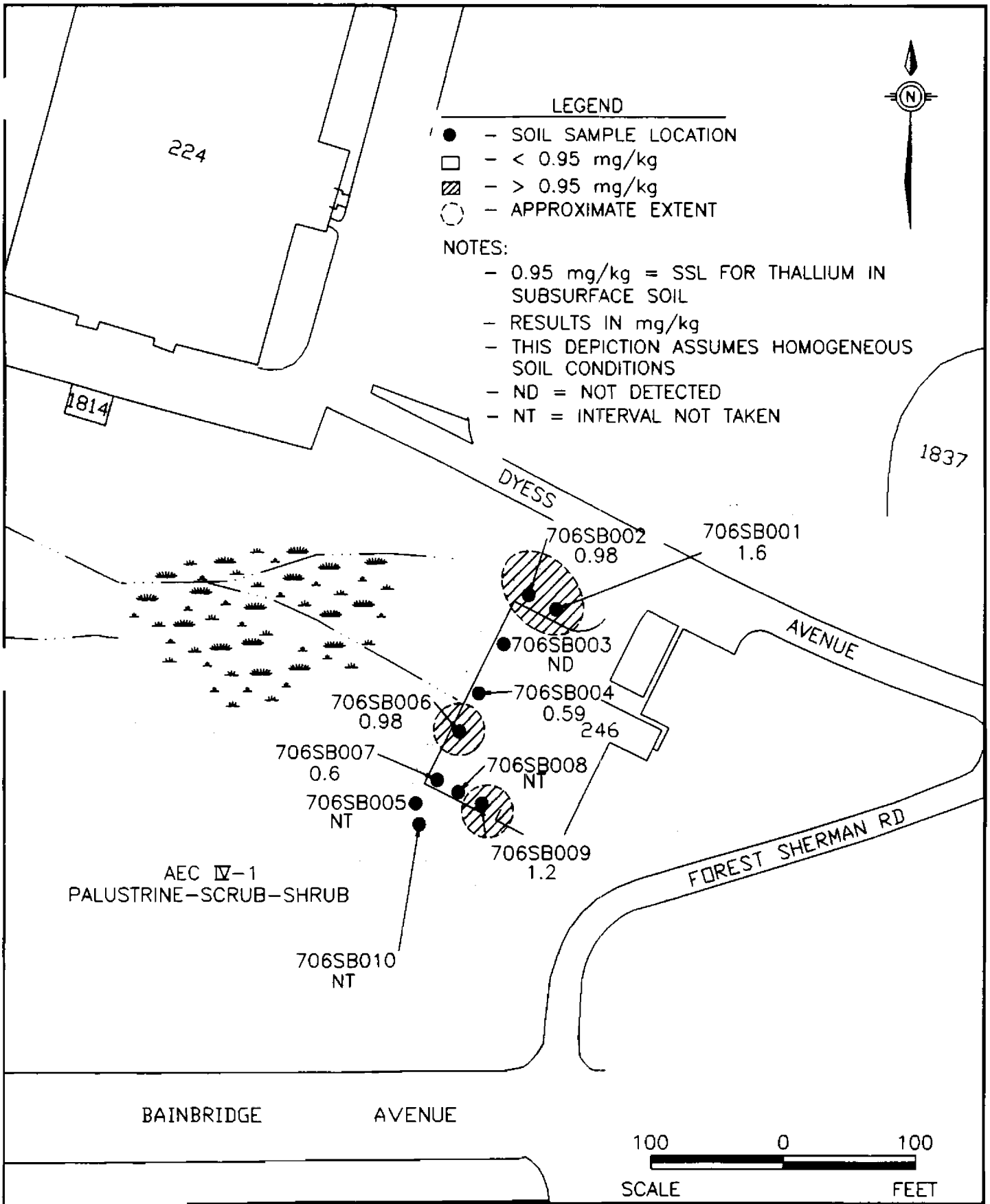

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FIGURE 10.14-12
THALLIUM IN SUBSURFACE SOIL
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/03/98 | DWG NAME: 2907M058

Table 10.14.5
Zone G
AOC 706
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
706001	Shallow	70600101	04/30/97	See Note	

Note:
SW-846 (metals, SVOCs) at DQO Level III.

10.4.4.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater are summarized in Table 10.14.6. Inorganic analytical results for groundwater are summarized in Table 10.14.7. Table 10.14.8 summarizes all analytes detected in groundwater at AOC 706. Appendix D contains a complete analytical data report for all Zone G samples collected.

Semivolatile Organic Compounds in Groundwater

One SVOC, 4-methylphenol, was detected in shallow groundwater at AOC 706, at a concentration far below its respective tap water RBC.

Inorganic Elements in Groundwater

Fifteen metals were detected in AOC 706 groundwater samples. Concentrations of barium and thallium exceeded both their respective RBC and shallow groundwater background concentrations for Zone G groundwater. The essential nutrient iron was detected above the tap water RBC, no background concentration was determined for iron. Figure 10.14-13 presents the barium concentrations in shallow groundwater at AOC 706. Figure 10.14-14 presents the thallium concentrations in shallow groundwater at the site.

Table 10.14.6
Zone G
AOC 706
Organic Compound Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (1 Shallow Sample) (μg/L)							
4-Methylphenol(p-Cresol)	Shallow	1/1	1.00	1.00	18	NL	0

Notes:
NL = Not listed
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
μg/L = Micrograms per liter

Table 10.14.7
Zone G
AOC 706
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Inorganics (1 Shallow Sample) (μg/L)							
Antimony (Sb)	Shallow	1/1	3.80	3.80	1.5	6	1
Arsenic (As)	Shallow	1/1	7.30	7.30	0.045	50	1
Barium (Ba)	Shallow	1/1	539	539	260	2000	1
Cadmium (Cd)	Shallow	1/1	0.40	0.40	1.8	5	0
Calcium (Ca)	Shallow	1/1	195000	195000	NL	NL	NA
Chromium (Cr)	Shallow	1/1	5.20	5.20	18	100	0
Cobalt (Co)	Shallow	1/1	3.40	3.40	220	NL	0
Iron (Fe)	Shallow	1/1	23300	23300	1100	300	NA
Magnesium (Mg)	Shallow	1/1	809000	809000	NL	NL	NA
Manganese (Mn)	Shallow	1/1	1100	1100	84	50	1
Nickel (Ni)	Shallow	1/1	13.7	13.7	73	100	0
Potassium (K)	Shallow	1/1	221000	221000	NL	NL	NA
Sodium (Na)	Shallow	1/1	7100000	7100000	NL	NL	NA
Thallium (Tl)	Shallow	1/1	9.00	9.00	0.29	2	1

Table 10.14.7
Zone G
AOC 706
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Vanadium (V)	Shallow	1/1	2.60	2.60	26	NL	0

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
μg/L = Micrograms per liter
NL = Not listed
NA = Not applicable

Table 10.14.8
Zone G
AOC 706
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Semivolatile Organic Compounds (μg/L)							
4-Methylphenol	706001	NI	1	ND	18	NL	NA
Inorganics (μg/L)							
Aluminum (Al)	706001	NI	ND	216	3700	50	692
Antimony (Sb)	706001	NI	3.8	ND	1.5	6	3.9
Arsenic (As)	706001	NI	7.3	6.8	0.045	50	17.8
Barium (Ba)	706001	NI	539	422	260	2000	31
Beryllium (Be)	706001	NI	ND	0.6	0.016	4	ND
Cadmium (Cd)	706001	NI	0.4	2.0	1.8	5	0.53
Calcium (Ca)	706001	NI	195000	194000	NL	NL	NL
Chromium (Cr)	706001	NI	5.2	2.3	18	100	3.88
Cobalt (Co)	706001	NI	3.4	1.9	220	NL	1.45
Iron (Fe)	706001	NI	23300	24200	1100	300	NL
Magnesium (Mg)	706001	NI	809000	683000	NL	NL	NL
Manganese (Mn)	706001	NI	1100	781	84	50	2906
Nickel (Ni)	706001	NI	13.7	1.6	73	100	4.08

Table 10.14.8
Zone G
AOC 706
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Potassium (K)	706001	NI	221000	224000	NL	NL	NL
Sodium (Na)	706001	NI	7100000	7460000	NL	NL	NL
Thallium (Tl)	706001	NI	9	ND	0.29	2	NL
Vanadium (V)	706001	NI	2.6	1.8	26	NL	15.4

Notes:
NI = Not installed
NL = Not listed
ND = Not detected
µg/L = Micrograms per liter
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed both the RBC and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations. Background values for groundwater are based on two sampling rounds in two wells at each depth

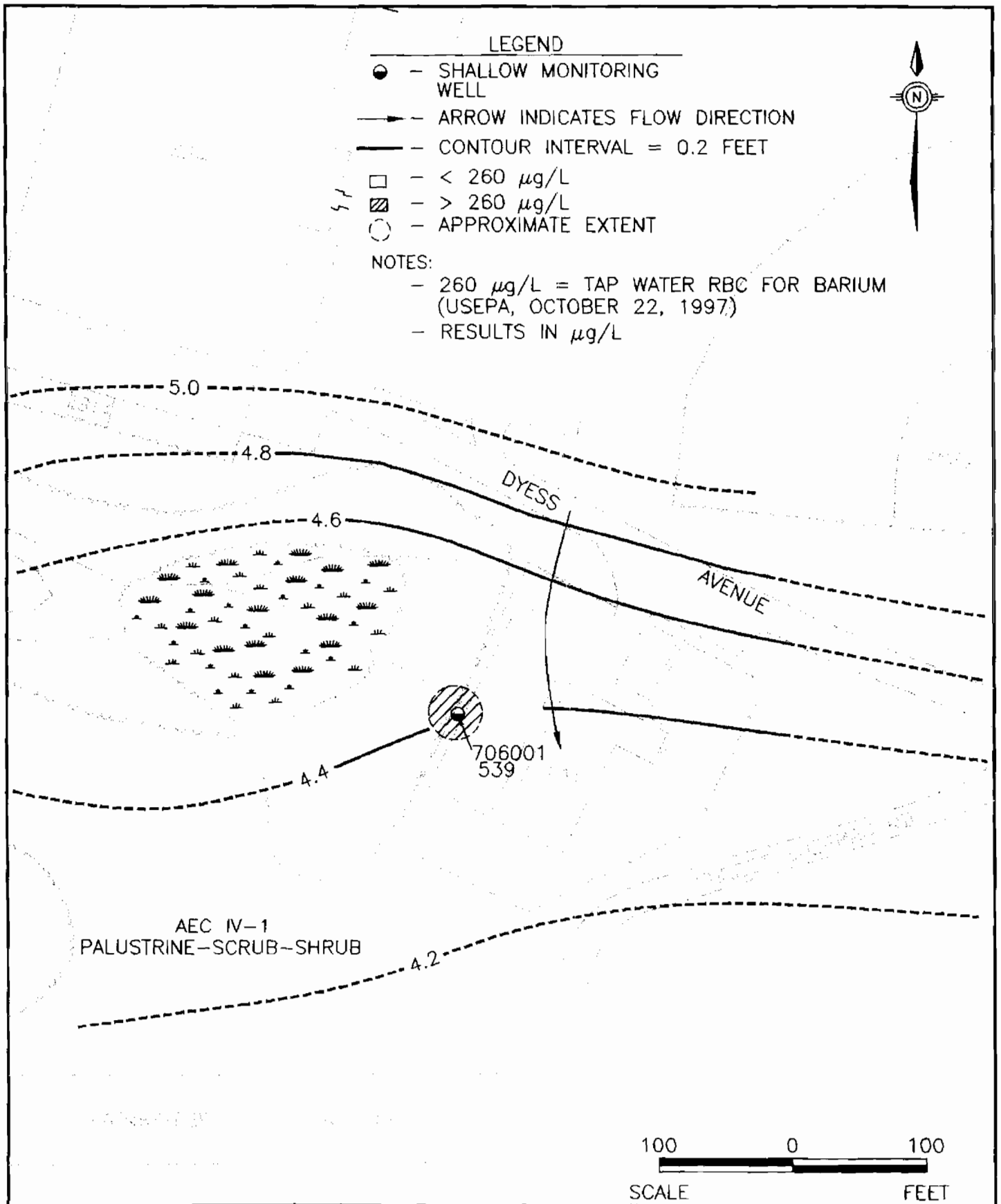

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FIGURE 10.14–13
BARIUM IN SHALLOW GROUNDWATER
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/04/98 | DWG NAME: 2907M121

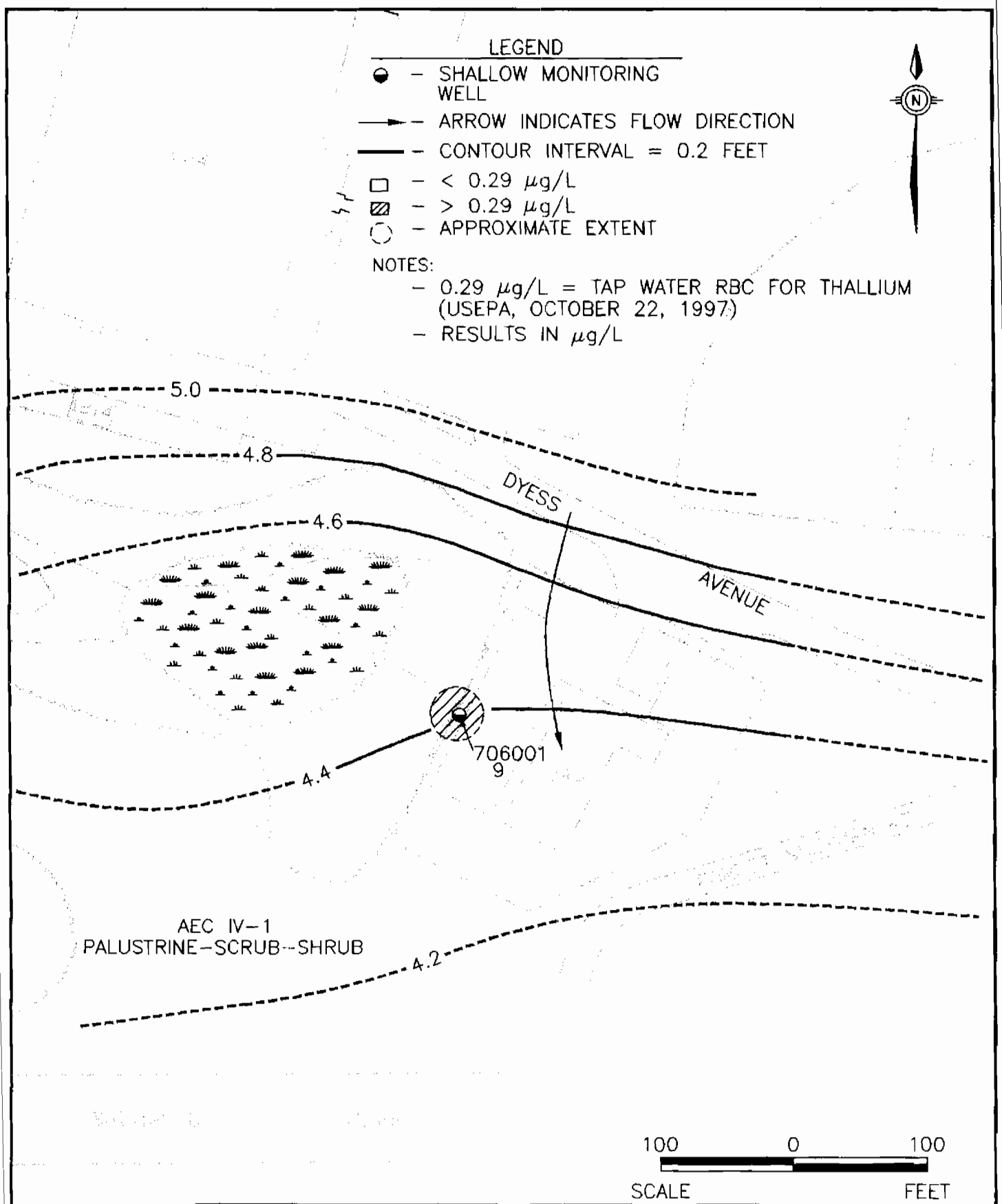

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FIGURE 10.14–14
THALLIUM IN SHALLOW GROUNDWATER
AOC #706
AREA BEHIND BUILDING 246

DWG DATE: 02/05/98 | DWG NAME: 2907M120

10.14.5 Fate and Transport Assessment

Environmental media sampled as part of the AOC 706 investigation included surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for AOC 706 include soil-to-groundwater, groundwater-to-surface water, and emission of volatiles from surface soil to air.

10.14.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.14.9 compares maximum detected organic constituent concentration in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

Three organic constituents were detected in AOC 706 surface or subsurface soil at concentrations exceeding groundwater protection SSLs. Those organics found to exceed their respective SSLs include 1,2,3-trichloropropane in the surface soil, and pentachlorophenol and Aroclor-1260 in the subsurface soil. 1,2,3-trichloropropane was detected at one duplicate sample only. However, the soil-to-groundwater pathway at AOC 706 for 1,2,3-trichloropropane is not considered to be significant based on the absence of this organic in the subsurface soil. Pentachlorophenol was not detected in the surface soil, but at location 706SB004, did exceed the groundwater protection SSL in the subsurface soil. There was no detection of pentachlorophenol in the shallow groundwater sampling results for this location, suggesting that the soil-to-groundwater pathway for pentachlorophenol is insignificant. Aroclor-1260 was also detected above the groundwater protection SSL at location 706SB004. This organic was detected in both surface and subsurface soil, but only slightly exceeded the SSL (1100 μg/kg) in the subsurface soil sample at 706SB004. No groundwater analytical results were available for Aroclor-1260.

Table 10.14.9
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 706
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Benzene	1	2	NA	NA	30	0.36	109	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	ND	2	NA	NA	1000	39	105	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	2	2	NA	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Toluene	ND	2	NA	NA	12000	750	37	UG/KG	UG/L	NO	NO	NO
Trichloroethene	ND	2	NA	NA	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
1,2,3-Trichloropropene	6	ND	NA	NA	0.029	0.0015	NA	UG/KG	UG/L	YES	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	87	ND	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	ND	110	ND	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	ND	240	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	170	170	ND	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	ND	780	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	50	920	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	72	1200	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	130	810	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	79	2000	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	59	1400	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	ND	360	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	ND	730	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	ND	97	ND	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
4-Chloro-3-methylphenol	ND	170	ND	NA	6300	180	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	54	ND	NA	50000	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	ND	66	ND	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Di-n-octylphthalate	ND	69	ND	NA	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	88	1400	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	100	ND	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	74	290	ND	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	52	120	1	NA	1380	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	51	210	ND	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	ND	62	ND	NA	30	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Phenanthrene	ND	620	ND	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	91	1500	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	64	1100	NA	NA	1000	0.034	0.03	UG/KG	UG/L	YES	NO	NO
alpha-Chlordane	7.7	11	NA	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	7.7	13	NA	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	5.6	110	NA	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	58	140	NA	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	4.4	140	NA	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	ND	5.1	NA	NA	1000	11	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	5.2983	NA	NA	NA	1900	0.45	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	10055	28800	ND	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	4.2	82.4	3.8	NA	5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	10.8	22.3	7.3	NA	29	17.8	36	MG/KG	UG/L	NO	NO	NO
Barium	40.3	325	539	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.44	1.5	ND	NA	63	0.016	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	5.05	6.2	0.4	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	15.9	88.7	5.2	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	2.1	7.6	3.4	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	112	2210	ND	NA	920	130000	8.33	MG/KG	UG/L	YES	NO	NO
Lead	71.6	905	ND	NA	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	155	551	1100	NA	1100	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.23	2.4	ND	NA	2.1	11	0.025	MG/KG	UG/L	YES	NO	NO
Nickel	8.3	49.5	13.7	NA	130	730	21.7	MG/KG	UG/L	NO	NO	NO
Selenium	0.66	1.8	ND	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.24	2.5	ND	NA	34	180	2.9	MG/KG	UG/L	NO	NO	NO
Thallium	ND	1.6	9	NA	0.95	2.9	21.3	MG/KG	UG/L	YES	YES	NO
Tin	6.4	182	ND	NA	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	24	75.4	2.6	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	238	2560	ND	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

Organic contaminants exceeding SSLs at AOC 706 are consistent with the historical use of this area as a hazardous material/wastes and PCB storage and handling facility. The vertical distribution of pentachlorophenol and Aroclor-1260 are not typically indicative of a surface spill or release, thus provenance is somewhat enigmatic. Based on the potential for leaching, the soil-to-groundwater pathway does have some merit and should be considered further. It should be noted, however, that the limited number of samples (1) exhibiting an exceedance of the Aroclor-1260 SSL suggests a limited residual mass in the soil at AOC 706.

Inorganic contaminants detected in soil at levels exceeding groundwater protection SSLs at AOC 706 include antimony, copper, lead, mercury, and thallium. Without exception, concentrations of these constituents indicate a remarkable enrichment of contamination as a function of depth. The exceedances for antimony, copper, lead, and mercury were consistently noted in locations 706SB001, 706SB004, and 706SB006. Thallium, however, exceeded SSLs in locations 706SB001, 706SB002, 706SB006, and 706SB009. The presence of these inorganics could be consistent with site history, but would depend on the exact nature of the materials stored and handled at this facility. Metals can be common constituents in spent lubrication and/or cooling oil, but the absence of significant concentrations of associated semivolatile compounds in soil would not suggest soils as a provenance. The vertical distribution of these inorganics suggests either a subsurface source is contributing to the increase in concentration with depth, or the movement of the metals has been enhanced in association with a mobilizing agent (for example, release of an acid). The somewhat limited horizontal distribution suggests that the affected area is small, and that residual mass is not significant in size. Notably, of these inorganics, only antimony and thallium were detected in the shallow groundwater, and only thallium was present above groundwater RBCs. This suggests that the mobility of these inorganics through leaching is less than the SSLs would suggest. The general absence of these metals at deleterious levels in site groundwater supports the conclusion that the soil-to-groundwater pathway for inorganics is not significant. It should be noted that thallium is present throughout Zone G soils, and is

consistently detected in Zone G groundwater as well; this ubiquitous nature of occurrence would imply that thallium is associated with naturally occurring soil conditions and not directly attributed to a particular site(s) as its source.

10.14.5.2 Soil-to-Air Cross-Media Transport

Table 10.14.10 lists the VOCs detected in surface soil samples collected at AOC 706, along with the corresponding soil-to-air volatization criteria. Three volatile organic compounds: benzene, carbon disulfide, and 1,2,3-trichloropropane, were detected in surface soil at AOC 706. One VOC, 1,2,3-trichloropropane, exceeded the applicable soil-to-air volatization screening levels at sampling location 706SB002. The site area near and around this location is grassed and maintained. Consequently, the soil-to-air volatilization pathway for 1,2,3-trichloropropane is expected to be significant, particularly for maintenance personnel mowing, at AOC 706.

10.14.5.3 Groundwater-to-Surface Water

Table 10.14.9 compares maximum detected organic constituent concentrations in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Only thallium was present in groundwater at concentrations exceeding the groundwater RBC screening criteria. Thallium was present only in the first-quarter sampling event, and was not detected in the second-quarter sampling event. The absence of this constituent in the second-quarter of sampling results, in conjunction with the non-use of the resource, invalidates the groundwater risk-based pathway.

Table 10.14.10
Soil-to-Air Volatilization Screening Analysis
NAVBASE Charleston, Zone G: AOC 706
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Benzene	1	800	UG/KG	NO
Carbon disulfide	2	720000	UG/KG	NO
1,2,3-Trichloropropane	6	0.03	UG/KG	YES

Notes:
* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996.
NA - Not available

10.14.5.4 Fate and Transport Summary

Three organic constituents-1,2,3-trichloropropane, pentachlorophenol, and Aroclor-1260 were present above their respective SSLs in either surface or subsurface soil at AOC 706. The 1,2,3-trichloropropane was absent in subsurface soil, and the pentachlorophenol was absent in the groundwater at the site. Although the Aroclor-1260 was detected in both the surface and subsurface soil, it only slightly exceeded the SSL at one subsurface location. The organic constituents detected in soil at this AOC are consistent with the historical use of this facility as a storage and handling facility for hazardous materials/wastes and PCBs. It should be noted that the vertical distribution of the pentachlorophenol and Aroclor-1260 is not indicative of a surface release, thus provenance is somewhat enigmatic. Based on the slight potential for leaching of Aroclor-1260 and the potential for its presence in groundwater, the soil-to-groundwater migration pathway has some merit and should be considered. Several inorganics exceeded SSLs in soil (antimony, copper, lead, mercury, and thallium) overall these analytes exhibited enrichment as a function of depth. The SSL exceedances were consistently noted at locations 706SB001, 706SB002, 706SB004, 706SB006, and 706SB009. Inorganic contamination could be consistent with the previous use of the site, depending on the nature of the materials stored/handled. The vertical and horizontal distribution suggests either a subsurface source or enhanced mobility in association with a mobilizing agent such as an acid. The general absence of these metals at deleterious levels in the site groundwater supports the conclusion that this pathway is not significant. Thallium is the only constituent present in groundwater at concentrations exceeding the risk-based pathway criteria. Its absence in second-quarter results and the non-use of the resource for human consumption invalidates pathway for groundwater. One volatile organic compound detected in surface soil at AOC 706 exceeded the soil-to-air volatization screening levels, thus this migration pathway is considered valid and may be particularly significant for workers mowing the area.

10.14.6 Human Health Risk Assessment

10.14.6.1 Site Background and Investigative Approach

AOC 706 is located behind Building 246, the former hazardous waste and transit facility. The Building and surrounding pavement were put in place in 1986, and prior to this the area was an unpaved open lot surrounded by trees. An earlier investigation identified the presence of PCBs in surface soils, and the RFI was intended to confirm and delineate the extent of contamination.

During the RFI, a total of 10 soil borings were advanced to identify potential impacts resulting from the activities listed above. Surface soil data from all ten soil borings were used to quantitatively assess direct contact soil exposure pathways in the HHRA. Subsurface soil detections were assessed in Section 10.14.5, Fate and Transport. One monitoring well was installed in the shallow aquifer. Data from the first-quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.14.3 and 10.14.4 provide summaries of the sampling effort for AOC 706 soil and groundwater.

10.14.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.14.11, antimony and cadmium were the only COPCs identified in surface soil. The maximum concentrations of aluminum, arsenic, and beryllium exceeded their respective RBCs but did not exceed their respective Zone G background concentrations. Aluminum, arsenic, and beryllium were therefore eliminated from consideration in the HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

Table 10.14.11
Chemicals Present in Site Samples
AOC 706 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Reference	Units	Number Exceeding RBC	Ref.
PCBs													
Aroclor-1260		1	10	64	64	64.0	67	85	320	NA	UG/KG		
Carcinogenic PAHs													
B(a)P Equiv.		3	10	5.22	80	54.4	901.29	947.51	88	NA	UG/KG		
Benzo(a)anthracene		1	10	50	50	50.0	380	410	880	NA	UG/KG		
Benzo(b)fluoranthene		2	10	49	130	89.5	390	410	880	NA	UG/KG		
Chrysene		1	10	59	59	59.0	380	410	88000	NA	UG/KG		
Benzo(k)fluoranthene		2	10	32	79	55.5	380	410	8800	NA	UG/KG		
Benzo(a)pyrene		2	10	67	72	69.5	390	410	88	NA	UG/KG		
TCDD Equivalents													
Dioxin Equiv.		1	1	5.2981	5.2981	5.3	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		1	1	68.9	68.9	68.9	NA	NA	NA	NA	NG/KG		
123678-HxCDD		1	1	3.01	3.01	3.0	NA	NA	NA	NA	NG/KG		
123789-HxCDD		1	1	3.8	3.8	3.8	NA	NA	NA	NA	NG/KG		
123678-HxCDF		1	1	2.2	2.2	2.2	NA	NA	NA	NA	NG/KG		
123478-HxCDF		1	1	9.36	9.36	9.4	NA	NA	NA	NA	NG/KG		
234678-HxCDF		1	1	3.79	3.79	3.8	NA	NA	NA	NA	NG/KG		
OCDD		1	1	400	400	400	NA	NA	NA	NA	NG/KG		
OCDF		1	1	4.64	4.64	4.6	NA	NA	NA	NA	NG/KG		
23478-PeCDF		1	1	2.71	2.71	2.7	NA	NA	NA	NA	NG/KG		
12378-PeCDF		1	1	3.37	3.37	3.4	NA	NA	NA	NA	NG/KG		
2378-TCDF		1	1	4.65	4.65	4.7	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		10	10	4030	10055	6099	NA	NA	7800	18700	MG/KG	2	
Antimony (Sb)	*	3	10	0.68	4.2	2.0	0.35	0.68	3.1	2.89	MG/KG	1	1
Arsenic (As)		10	10	0.49	10.8	2.4	NA	NA	0.43	17.2	MG/KG	10	
Barium (Ba)		10	10	6.7	40.25	16.1	NA	NA	550	109	MG/KG		
Beryllium (Be)		8	10	0.11	0.44	0.19	0.22	0.23	0.15	1.2	MG/KG	5	
Cadmium (Cd)	*	8	10	0.07	5.045	0.76	0.05	0.05	3.9	1.07	MG/KG	1	1
Calcium (Ca)	N	10	10	1370	43000	13127	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		10	10	3.8	15.9	7.9	NA	NA	39	42.8	MG/KG		
Cobalt (Co)		9	10	0.39	2.1	1.0	0.35	0.35	470	6.6	MG/KG		
Copper (Cu)		10	10	4.7	112.05	22.9	NA	NA	27000	260	MG/KG		
Iron (Fe)	N	10	10	669	11000	3351	NA	NA	NA	NA	MG/KG		
Lead (Pb)		10	10	4.7	71.55	18.8	NA	NA	400	181	MG/KG		
Magnesium (Mg)	N	10	10	158	1730	694	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		10	10	7.7	154.5	50.2	NA	NA	180	325	MG/KG		
Mercury (Hg)		2	10	0.07	0.225	0.15	0.04	0.16	2.3	1.03	MG/KG		
Nickel (Ni)		10	10	1	8.3	3.2	NA	NA	160	20.6	MG/KG		
Potassium (K)	N	6	10	261	553.5	390	231	245	NA	NA	MG/KG		
Selenium (Se)		6	10	0.39	0.86	0.55	0.35	0.37	39	1.22	MG/KG		
Silver (Ag)		1	10	0.24	0.24	0.24	0.22	0.24	39	NA	MG/KG		
Sodium (Na)	N	9	10	159	312	240	149	149	NA	NA	MG/KG		
Tin (Sn)		1	10	8.4	8.4	8.4	0.64	2.8	4700	9.67	MG/KG		
Vanadium (V)		10	10	4	24	10.0	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		10	10	7.1	238	87.7	NA	NA	2300	519	MG/KG		
Pesticides													
alpha-Chlordane		1	10	7.7	7.7	7.7	1.3	1.6	1800	NA	UG/KG		
gamma-Chlordane		3	10	1.4	7.7	3.9	1.5	1.6	1800	NA	UG/KG		
4,4'-DDD		1	10	5.6	5.6	5.6	2.9	3.2	2700	NA	UG/KG		
4,4'-DDE		2	10	7.5	58	32.8	2.9	3.1	1900	NA	UG/KG		
4,4'-DDT		1	10	4.4	4.4	4.4	2.9	3.2	1900	NA	UG/KG		
Semivolatile Organics													
Benzoic acid		2	10	83	170	127	1900	2000	31000000	NA	UG/KG		
Fluoranthene		3	10	45	88	68.3	390	410	310000	NA	UG/KG		
2-Methylnaphthalene		1	10	74	74	74.0	380	410	310000	NA	UG/KG		
4-Methylphenol		1	10	52	52	52.0	380	410	39000	NA	UG/KG		
Naphthalene		1	10	51	51	51.0	380	410	310000	NA	UG/KG		
Pyrene		4	10	46	91	72.8	390	410	230000	NA	UG/KG		
Volatile Organics													
Benzene		1	10	1	1	1.0	5	6	22000	NA	UG/KG		
Carbon disulfide		1	10	2	2	2.0	6	6	780000	NA	UG/KG		
1,2,3-Trichloropropane		1	1	6	6	6.0	NA	NA	91	NA	UG/KG		

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram

Groundwater

As shown in Table 10.14.12, barium and thallium were identified as COPCs in shallow groundwater for AOC 706. Antimony, arsenic, and manganese were reported in groundwater at maximum concentrations exceeding their respective RBCs but below their respective background concentrations. These inorganics were therefore eliminated from consideration in the HHRA. Wilcoxon rank sum test analysis results did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

10.14.6.3 Exposure Assessment

Exposure Setting

AOC 706 is located in an open area on the former naval base, approximately 1,250 feet southwest of the water front along the Cooper River. Most of the site is covered with asphalt, or occupied by Building 246 which would prevent direct contact with soil and would inhibit migration of potential contaminants to groundwater or air. The site is entirely surrounded by a perimeter fence. All potable water is provided through the city's water supply. Groundwater is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, or adolescent trespassers. Future site resident and site worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (most of the site is paved). Therefore, future worker assessment is considered to be conservatively representative of current site workers. The perimeter fence would

Table 10.14.12
Chemicals Present In Site Samples
AOC 708 - Groundwater
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Reference	Units	Number Exceeding RBC	Ref.
Inorganics													
Antimony (Sb)		1	1	3.8	3.8	3.8	NA	NA	1.5	4.85	UG/L	1	
Arsenic (As)		1	1	7.3	7.3	7.3	NA	NA	0.045	17.8	UG/L	1	
Barium (Ba)	*	1	1	539	539	539	NA	NA	260	31	UG/L	1	1
Cadmium (Cd)		1	1	0.4	0.4	0.40	NA	NA	1.8	0.53	UG/L		
Calcium (Ca)	N	1	1	195000	195000	195000	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	1	5.2	5.2	5.2	NA	NA	18	3.88	UG/L		1
Cobalt (Co)		1	1	3.4	3.4	3.4	NA	NA	220	1.45	UG/L		1
Iron (Fe)	N	1	1	23300	23300	23300	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	809000	809000	809000	NA	NA	NA	NA	UG/L		
Manganese (Mn)		1	1	1100	1100	1100	NA	NA	84	2906	UG/L	1	
Nickel (Ni)		1	1	13.7	13.7	13.7	NA	NA	73	4.08	UG/L		1
Potassium (K)	N	1	1	221000	221000	221000	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	7100000	7100000	7100000	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	1	1	9	9	9.0	NA	NA	0.29	NA	UG/L	1	
Vanadium (V)		1	1	2.6	2.6	2.6	NA	NA	26	15.4	UG/L		
Semivolatile Organics													
4-Methylphenol		1	1	1	1	1.0	NA	NA	18	NA	UG/L		

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - microgram per liter

inhibit the access of potential adolescent trespassers under a current use scenario. Since the future use of the site is uncertain, the adolescent trespasser was qualitatively addressed relative to the child resident. The future site resident scenario was built on the premise that existing buildings and pavement would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for current and future site workers are the same as those for the future site worker with respect to soil. Uniform exposure was assumed for all sample locations. The groundwater pathway for the hypothetical future site residents is incidental ingestion of groundwater. No VOCs were analyzed for in first-quarter groundwater samples at AOC 706, therefore the inhalation of volatiles resulting from domestic and process uses of groundwater pathway was not addressed for this site. Table 10.14.13 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

Section 7 of this RFI discusses the determination of exposure point concentrations. As presented on Table 10.14.14, the exposure point concentrations for soil COPCs were set equal to the 95% UCL. First-quarter data from the only monitoring well installed for AOC 706 were used as exposure point concentrations, for groundwater COPCs.

Quantification of Exposure

Chronic daily intakes (CDIs) for ingestion and dermal contact with soils are shown in Tables 10.14.15 and 10.14.16, respectively. The CDIs for groundwater ingestion are presented in Table 10.14.17.

Table 10.14.13
Zone G
AOC 706
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Workers/ Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 706, inhibiting fugitive dust generation. Additionally, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 706.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 706.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 706, inhibiting fugitive dust generation. Additionally, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at AOC 706, however, this pathway was considered as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	VOCs were not analyzed for in AOC 706 groundwater.

Table 10.14.13
Zone G
AOC 706
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.14.14
Summary of Statistical Analysis
Surface Soil COPCs; AOC 706
Naval Base Charleston, Zone G
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)
Inorganics							
Antimony (Sb)	10	-1.029	1.072	3.257	2.0	4.2	2.0 UCL
Cadmium (Cd)	10	-1.996	1.504	4.216	3.5	5.0	3.5 UCL

NOTES:

mean Arithmetic mean of the logtransformed data
n Number of samples analyzed
SD Standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA Not applicable
EPC Exposure point concentration
UCL 95 percentile upper confidence level mean
MAX Maximum reported concentration

Table 10.14.15
Chronic Daily Intakes
'ncidental Ingestion of Surface Soil
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics							
Antimony (Sb)	1	2.0	2.79E-06	2.60E-05	3.18E-06	9.95E-07	3.55E-07
Cadmium (Cd)	1	3.5	4.78E-06	4.46E-05	5.46E-06	1.71E-06	6.09E-07

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.14.16
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics								
Antimony (Sb)	2.0	1	0.001	1.14E-07	3.77E-07	7.15E-08	8.16E-08	2.91E-08
Cadmium (Cd)	3.5	1	0.001	1.96E-07	6.46E-07	1.23E-07	1.40E-07	5.00E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.14.17
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics						
Barium (Ba)	0.539	1.48E-02	3.45E-02	8.12E-03	5.27E-03	1.88E-03
Thallium (Tl)	0.009	2.47E-04	5.75E-04	1.36E-04	8.81E-05	3.15E-05

NOTES:
lwa Lifetime weighted average
CDI Chronic Daily Intake
H-CDI Noncarcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

10.14.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.14.18 presents toxicological information specific to each COPC identified at AOC 706. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Antimony is absorbed slowly through the gastrointestinal tract, which is also the target organ of this element. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaassen, et al., 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1000, and a modifying factor of 1 (IRIS).

Barium is used in various alloys, paints, soap, and manufacture processes. Barium sulfate is used to aid x-ray diagnosis. This element is relatively abundant in nature and is found in plant and animal tissue. For example, brazil nuts contain 3 to 4 mg per gram of nuts. The fatal absorbed dose of barium is approximately 1000 mg (for humans). Assuming an absorption efficiency of five percent for barium, 20,000 mg ingested barium could be fatal. Major toxic effects of this element are muscle stimulation, central nervous system effects, and effects on the heart. The major critical effect is increased blood pressure. USEPA determined the oral RfD and the inhalation RfD to be 0.07 and 1.43E-4 mg/kg-day, respectively (Dreisbach, et al., 1987) (Klaassen, et al., 1986), based on a medium confidence level. The oral uncertainty factor for barium is 3 and the oral modifying factor is 1. Barium has been issued a carcinogenic weight-of-evidence classification of "D."

Table 10.14.18

Toxicological Reference Information

for Chemicals of Potential Concern

AOC 706

Naval Base, Charleston, Zone G

Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*				
Chemical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
Antimony	0.0004	a	L	whole body/blood increased mortality	1,000	NA		NA	NA	NA	NA	NA		D	NA
Barium	0.07	a	M	increased blood pressure	3	0.000143	b	NA	NA	NA	NA	NA		D	NA
Cadmium	0.001	a	H	proteinuria	10	NA		NA	NA	NA	NA	6.3	a	B1	lung
Thallium	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA	NA		D	NA

Notes:

a = Integrated Risk Information System (IRIS)

b = Health Effects Assessment Summary Tables (HEAST)

NA = Not applicable or not available

H = High confidence

L = Low confidence

M = Medium confidence

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS, the classification is based on limited evidence from occupational epidemiologic studies consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 0.00008 mg/kg-day (Klaassen, et al, 1986) (Dreisbach, et al, 1987). The uncertainty factor used for thallium is 3000.

10.14.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.14.19 and 10.14.20 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The hazard indices for the adult and child residents were calculated to be 0.01 and 0.1, respectively, for the ingestion pathway. The hazard indices for the adult and child resident were calculated to be 0.002 and 0.008, respectively, for the dermal pathway. The ingestion and dermal hazard indices for the child resident were considered to be conservatively representative of future adolescent trespassers.

Hypothetical Site Workers

The ingestion and dermal hazard indices for the site worker were calculated to be 0.004 and 0.002 for the ingestion and dermal pathways, respectively.

Table 10.14.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics							
Antimony (Sb)	0.0004	NA	0.0070	0.065	ND	0.0025	ND
Cadmium (Cd)	0.001	NA	0.0048	0.045	ND	0.0017	ND
SUM Hazard Index/ILCR			0.01	0.1	ND	0.004	ND

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.14.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics								
Antimony (Sb)	0.2	8E-05	NA	0.0014	0.0047	ND	0.0010	ND
Cadmium (Cd)	0.2	0.0002	NA	0.0010	0.0032	ND	0.0007	ND
SUM Hazard Index/ILCR				0.002	0.008	ND	0.002	ND

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under residential and site worker scenarios based on the results of the first-quarter sampling event. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the surficial aquifer, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.14.21 presents the risk and hazard for the ingestion pathway. Since no VOCs were analyzed for in AOC 706 groundwater, the inhalation pathway was not addressed at this site.

Hypothetical Site Residents

The hazard indices for the adult and child resident are 3 and 8, respectively. Thallium was the primary contributor to hazard index estimates associated with AOC 706 groundwater under the residential scenario. Barium was a secondary contributor.

Hypothetical Site Workers

The hazard index for the site worker is 1. Thallium was the primary contributors to hazard index projections associated with AOC 706 groundwater under the site worker scenario.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 706 or other areas of Zone G. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range

Table 10.14.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
AOC 706
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics							
Barium (Ba)	0.07	NA	0.21	0.49	ND	0.075	ND
Thallium (Tl)	8E-05	NA	3.1	7.2	ND	1.1	ND
SUM Hazard Index/ILCR			3	8	ND	1	ND

Notes:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.14.22 presents the COCs identified for AOC 706 surface soil and shallow groundwater.

Surface Soils

Future Site Residents

No COCs were identified for the soil pathway under the residential scenario.

Future Site Workers

No COCs were identified for the soil pathway under the site worker scenario.

First-quarter Groundwater

Future Site Residents

Barium and thallium were identified as groundwater COCs for AOC 706, based on their contributions to residential hazard projections.

Future Site Workers

Thallium was identified as a groundwater COC for AOC 706, based on its contributions to site worker hazard projections.

Table 10.14.22
Summary of Risk and Hazard-based COCs
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs	
Surface Soil	Incidental Ingestion	**Inorganics**							
		Antimony (Sb)	0.0070	0.065	ND	0.0025	ND		
		Cadmium (Cd)	0.0048	0.045	ND	0.0017	ND		
	Dermal Contact	**Inorganics**							
		Antimony (Sb)	0.0014	0.0047	ND	0.0010	ND		
		Cadmium (Cd)	0.0010	0.0032	ND	0.00070	ND		
Surface Soil Pathway Sum			0.01	0.1	ND	0.006	ND		
Groundwater Pathways	Ingestion	**Inorganics**							
		Barium (Ba)	0.21	0.49	ND	0.075	ND	1	
		Thallium (Tl)	3.1	7.2	ND	1.1	ND	1	3
Groundwater Pathway Sum			3	8	ND	1	ND		
Sum of All Pathways			3	8	ND	1	ND		

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

The extent of the COCs identified in groundwater is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, tap water RBCs were compared to each reported concentration for each COC identified above. Barium and thallium were each detected at a concentration exceeding their respective tap water RBC in the first-quarter groundwater sample (706001), and don't appear to be associated with the PCB storage activities at AOC 706. Second-quarter groundwater concentration of barium was consistent with first-quarter results, however, thallium was not detected in the second-quarter groundwater sample.

10.14.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone G or alternatively recreational use. If this area were to be redeveloped as a residential site or a recreational site, the buildings and pavement would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the RFI would not be likely under a true future use scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at AOC 706 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone G. This system is slated

to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Exposure point concentrations for soil were set equal to the 95% UCL on the arithmetic mean for each COPC. Use of 95% UCLs represent conservative assumptions when applied as the EPC, such that it is unlikely that the UCL would be exceeded by the true mean site concentration of each COPC. Groundwater EPCs were calculated using the COPC concentrations reported for the first-quarter groundwater sample collected from the AOC 706 monitoring well. Since there was only one monitoring well installed, there is no clear appreciation of the spatial distribution or frequency of groundwater COPCs. Therefore, without additional monitoring wells, risk and/or hazard may be either underestimated or overestimated.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty and variability inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for AOC 706. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood

of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration near its RBCs (e.g., within 10% of its RBC). Aluminum, arsenic, and beryllium were reported in soil samples at maximum concentrations exceeding their RBC and were eliminated from consideration in the HHRA based on comparison to their background concentrations. Wilcoxon rank sum test analysis did not result in the inclusion of any parameter which had been screened out on the basis of background comparisons.

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC). Concentrations of antimony, arsenic, and manganese were reported in the first-quarter groundwater sample at concentrations exceeding their RBCs and were eliminated from consideration in the HHRA based on comparison to their background concentrations. Wilcoxon rank sum test analysis did not result in the inclusion of any parameter which had been screened out on the basis of background comparisons.

Groundwater is not currently used as a potable water source at AOC 706, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

10.14.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 706 were assessed for the site worker and the future site resident under reasonable maximum exposure assumptions. In surface soils, the

incidental ingestion and dermal contact pathways were assessed in this HHRA. The groundwater pathway was based on ingestion of shallow groundwater represented by first-quarter groundwater data. Table 10.14.23 presents the risk summary for each soil pathway/receptor group evaluated for AOC 706.

Soil — Residential Scenario

No residential soil pathway COCs were identified for AOC 706. Figure 10.14-15 illustrates point hazard estimates for AOC 706 surface soil pathways under a future residential scenario. Table 10.14.24 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk/hazard estimates are spatially distributed across the site. Hazard index estimates ranged from 0.002 (706SB006) to 0.3 (706SB002).

Soil — Site Worker Scenario

No industrial soil pathway COCs were identified for AOC 706.

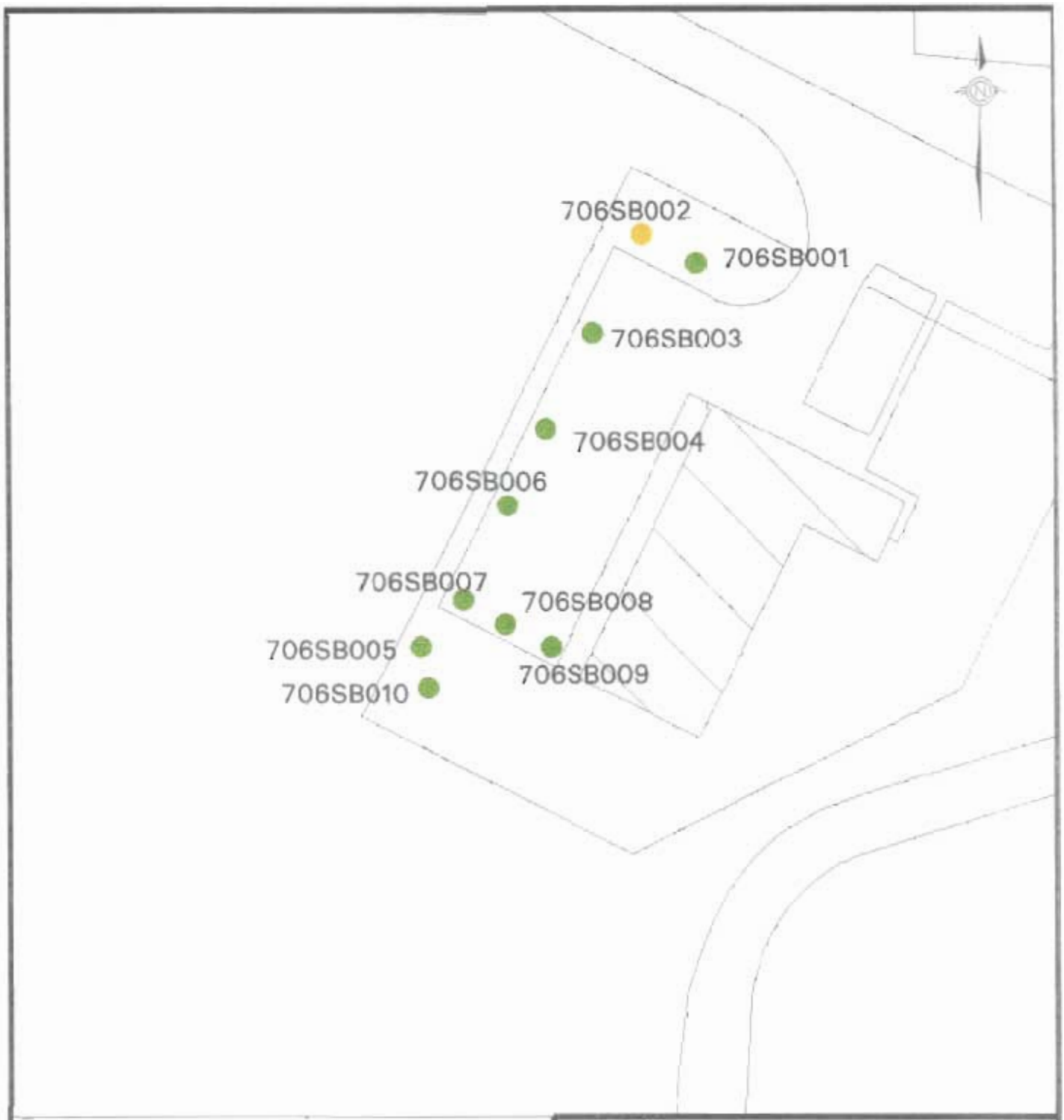
Groundwater — Residential Scenario

Residential groundwater pathway COCs identified for AOC 706 include barium and thallium. Table 10.14.25 summarizes the risk and hazard contribution of each COPC identified. Thallium was the primary contributor to hazard index projection and was associated with a hazard index of 8 based on the first-quarter groundwater sample results. Figure 10.14-16 illustrates point hazard estimates for the groundwater pathways under a residential scenario.

Table 10.14.23
Summary of Risk and Hazard
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.01	0.1	ND	0.004	ND
	Dermal Contact	0.002	0.008	ND	0.002	ND
Groundwater	Ingestion	3	8	ND	1	ND
Sum of All Pathways		3	8	ND	1	ND

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 100

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

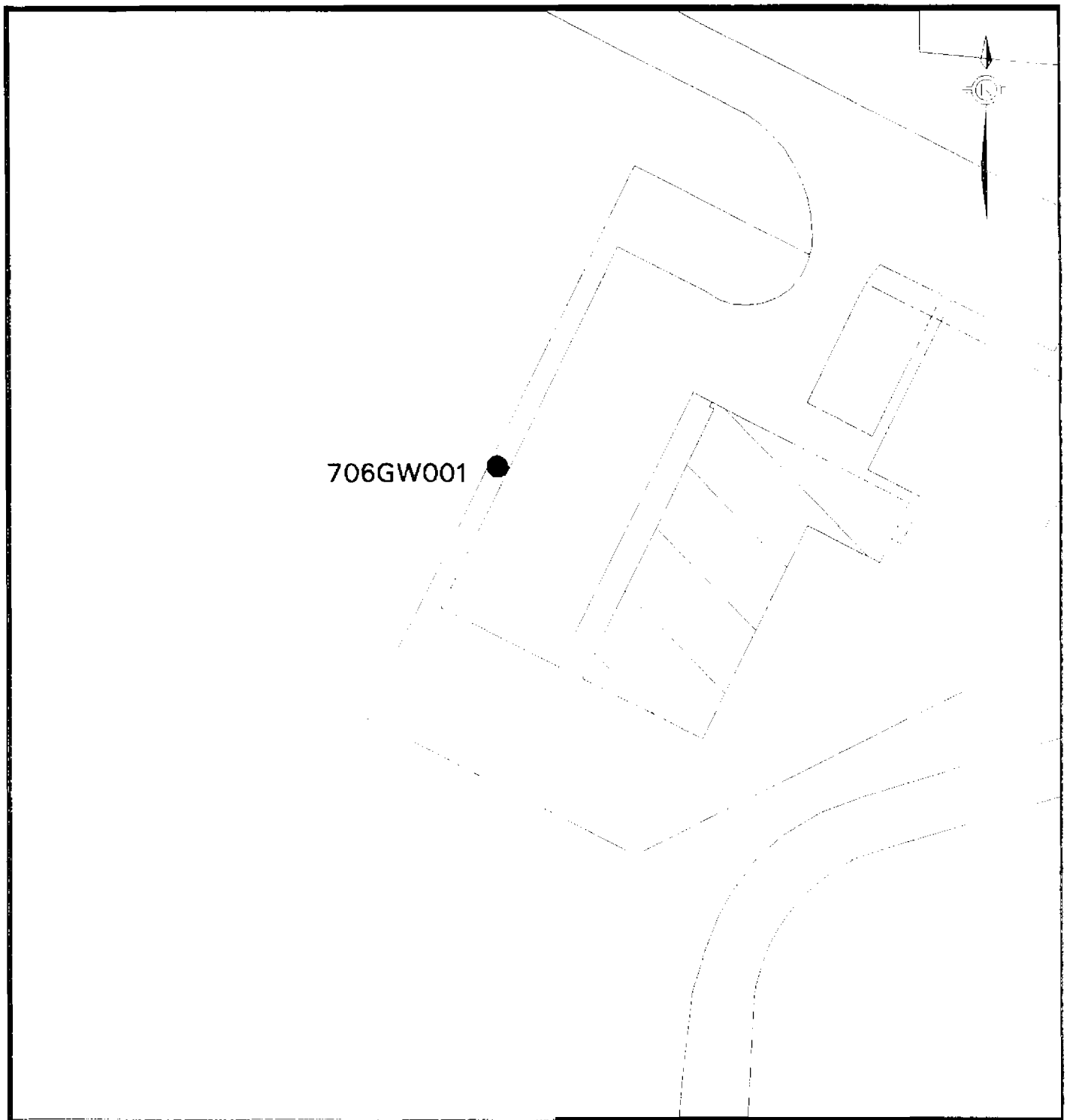
FIGURE 10.14-15
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 706

Table 10.14.24
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
706	001	Antimony (Sb)	ND	MG/KG	NA		NA	
706	001	Cadmium (Cd)	0.23	MG/KG	0.0063	100.00	NA	
		Total			0.0063		NA	
706	002	Antimony (Sb)	4.2	MG/KG	0.1440	51.00	NA	
706	002	Cadmium (Cd)	5.045	MG/KG	0.1384	49.00	NA	
		Total			0.2823		NA	
706	003	Antimony (Sb)	0.68	MG/KG	0.0233	91.40	NA	
706	003	Cadmium (Cd)	0.08	MG/KG	0.0022	8.60	NA	
		Total			0.0255		NA	
706	004	Antimony (Sb)	ND	MG/KG	NA		NA	
706	004	Cadmium (Cd)	0.15	MG/KG	0.0041	100.00	NA	
		Total			0.0041		NA	
706	005	Antimony (Sb)	ND	MG/KG	NA		NA	
706	005	Cadmium (Cd)	0.1	MG/KG	0.0027	100.00	NA	
		Total			0.0027		NA	
706	006	Antimony (Sb)	ND	MG/KG	NA		NA	
706	006	Cadmium (Cd)	0.07	MG/KG	0.0019	100.00	NA	
		Total			0.0019		NA	
706	007	Antimony (Sb)	ND	MG/KG	NA		NA	
706	007	Cadmium (Cd)	0.13	MG/KG	0.0036	100.00	NA	
		Total			0.0036		NA	
706	008	Antimony (Sb)	ND	MG/KG	NA		NA	
706	008	Cadmium (Cd)	ND	MG/KG	NA		NA	
		Total			NA		NA	
706	009	Antimony (Sb)	ND	MG/KG	NA		NA	
706	009	Cadmium (Cd)	ND	MG/KG	NA		NA	
		Total			NA		NA	
706	010	Antimony (Sb)	1	MG/KG	0.0343	82.24	NA	
706	010	Cadmium (Cd)	0.27	MG/KG	0.0074	17.76	NA	
		Total			0.0417		NA	

Table 10.14.25
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
706	001	Barium (Ba)	539	UG/L	0.49		NA	
706	001	Thallium (Tl)	9	UG/L	7.19		NA	
		Total			7.68		NA	



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 100

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.14-16
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 706

AMC /home3/projects/charleston_dir/zone_g_ekdnak_dir

10.14.6.8 Remedial Goal Options

Soil

No RGOs were calculated for surface soil since no COCs were identified.

Groundwater

Groundwater residential-based RGOs were based on the resident child scenario and worker-based RGOs were based on the site worker scenario, as shown on Table 10.14.26.

10.14.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 706, COCs requiring further evaluation through the CMS process have been identified for groundwater. The site is currently in an industrial area and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Barium and thallium were identified as groundwater COCs for AOC 706. Table 10.14.27 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for groundwater are presented in Table 10.14.26. Potential corrective measures for groundwater are presented in Table 10.14.28.

Table 10.14.26
Remedial Goal Options Groundwater
AOC 706
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Inorganics											
Barium (Ba)	NA	0.07	0.539	0.11	1.1	3.3	ND	ND	ND	0.031	2
Thallium (Tl)	NA	8E-05	0.009	0.00013	0.0013	0.0038	ND	ND	ND	NA	0.002

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.14.27
Zone G
AOC 706
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Groundwater				
Barium	ND	ND	0.075	0.49
Thallium	ND	ND	1.1	7.2
Cumulative	ND	ND	1.2	7.7

Note:
ND = Not determined

Table 10.14.28
Zone G
AOC 706
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Groundwater	Barium and Thallium	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting.

10.15 SWMU 24, Waste Oil Reclamation Facility

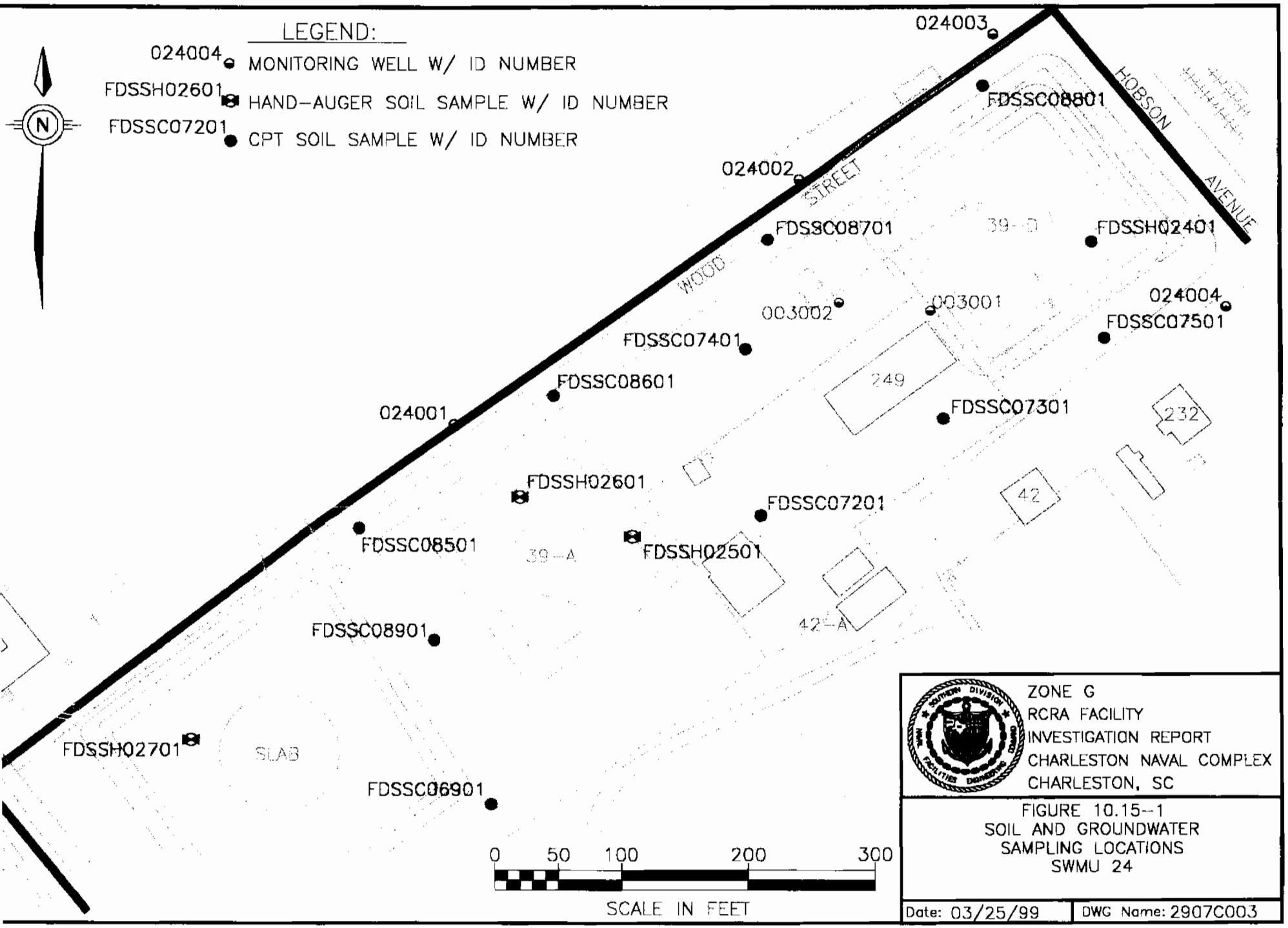
SWMU 24, the waste oil reclamation facility for the CNC, consists of tanks 39-A and 39-D. This area is located south of Hobson Avenue and east of Wood Street. Included in this area is SWMU 3, the pesticide mixing area. SWMU 3 is discussed in Section 10.11 of the Zone F RFI. SWMU 24 was originally investigated under the petroleum program as part of the Fuel Distribution System (FDS) but was returned to the RCRA program to assess inorganics detected in the area groundwater. Tanks 39-A and 39-D operated as waste oil settling tanks. Waste oil containing water and presumably other impurities was delivered to these tanks via the pipeline system. The tanks were used both to separate and store the water and oil phases. The waste water was subsequently discharged to the sanitary sewer system. Materials stored and potentially released include waste oil and other petroleum products.

10.15.1 Site Geology

The soil boring, Cone Penetrometer Testing (CPT) and monitoring well locations for SWMU 24 are shown on Figure 10.15-1. Appendix A contains the soil boring logs and monitoring well construction diagrams for the wells installed at SWMU 24.

Based on soil descriptions from four SWMU 24 and three SWMU 3 monitoring well borings, the stratigraphy in this area generally consists of clay and clayey sand with some silty sand horizons to a depth of approximately 13 feet bgs. No petroleum odor or elevated organic vapors were observed in any of the borings.

The groundwater elevation varies across the site between generally 3 and 4.5 feet msl. Figures 10.15-2 and 10.15-3 depict the shallow groundwater potentiometric surface and the inferred flow direction at low and high-tide respectively. Shallow groundwater flow was consistent in direction and gradient during both tidal events. A hydrologic high exists across the site which creates a groundwater flow divide.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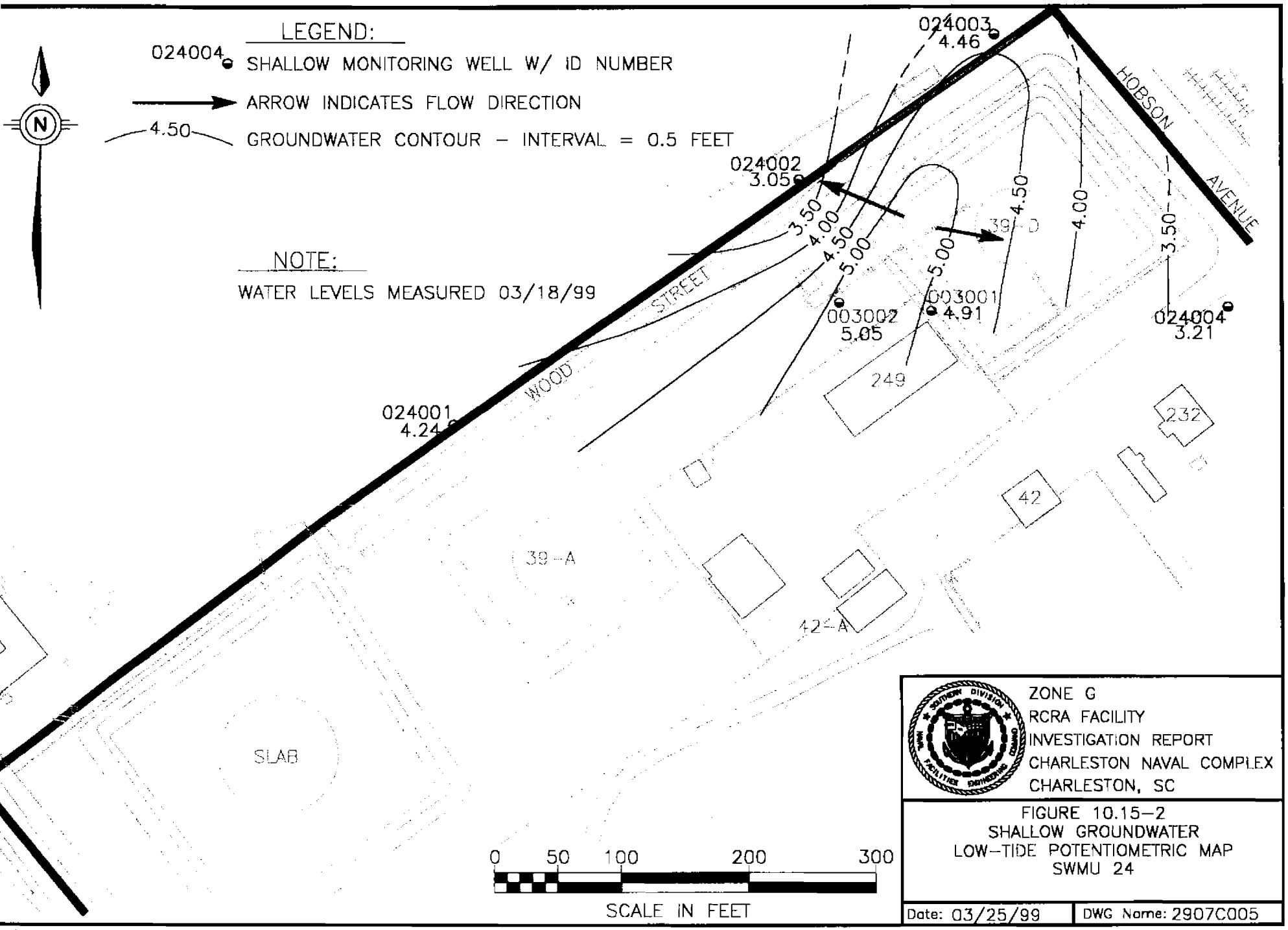
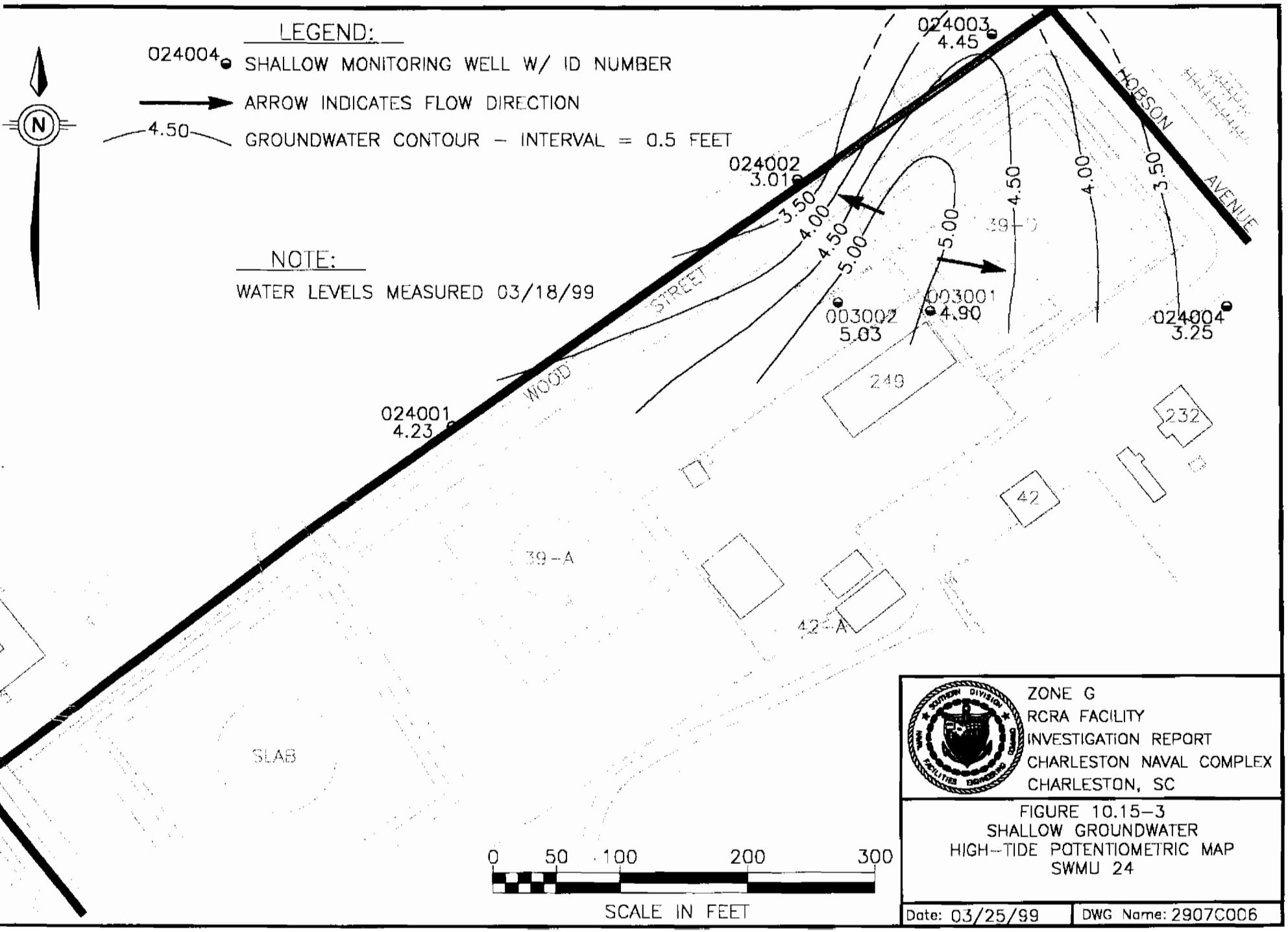
024004 MONITORING WELL W/ ID NUMBER
FDSSH02601 HAND-AUGER SOIL SAMPLE W/ ID NUMBER
FDSSC07201 CPT SOIL SAMPLE W/ ID NUMBER
N
024003
FDSSC08801
HOBSON
AVENUE
024002
WOOD
STREET
FDSSC08701
39-D
FDSSH02401
003002
003001
024004
FDSSC07501
FDSSC07401
249
FDSSC08601
024001
FDSSC07301
232
FDSSH02601
FDSSC07201
42
FDSSC08501
39-A
FDSSH02501
42-A
FDSSC08901
FDSSH02701
SLAB
FDSSC06901
0 50 100 200 300
SCALE IN FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 10.15--1
SOIL AND GROUNDWATER
SAMPLING LOCATIONS
SWMU 24
Date: 03/25/99
DWG Name: 2907C003


LEGEND:
024004 SHALLOW MONITORING WELL W/ ID NUMBER
ARROW INDICATES FLOW DIRECTION
4.50 GROUNDWATER CONTOUR – INTERVAL = 0.5 FEET
NOTE:
WATER LEVELS MEASURED 03/18/99
N
024003
4.46
024002
3.05
024001
4.24
003002
5.05
003001
4.91
024004
3.21
3.50
4.00
4.50
5.00
WOOD STREET
HOBSON AVENUE
249
232
42
39-A
42-A
SLAB
0 50 100 200 300
SCALE IN FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 10.15-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
SWMU 24
Date: 03/25/99
DWG Name: 2907C005



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 10.15–3
SHALLOW GROUNDWATER
HIGH–TIDE POTENTIOMETRIC MAP
SWMU 24

Date: 03/25/99 | DWG Name: 2907C006

10.15.2 Field Investigation Approach

The objective of the field investigation at SWMU 24 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination detected; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required.

Media sampled within the investigation area included surface and subsurface soil and shallow groundwater. Section 3 of the Zone G RFI report details the methods used during the field investigation. Included in this section are descriptions of the hand auger and CPT procedures used for soil sampling collection; the hollow stem auger drilling procedures used for shallow monitoring well installation; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the data report for samples collected in Zone G.

10.15.3 Soil Sampling and Analysis

The approved Final RFI work plan proposed screening of the fuel distribution pipeline system to detect probable areas which may require additional study to achieve the investigation objectives. Ten CPT and four hand auger soil samples were collected during the screening investigation of the FDS at the SWMU 24 area. The hand auger samples were collected from zero to one feet bgs. The CPT samples were collected from the depths approximating the burial depth of pipelines, approximately four to eleven feet bgs. All samples were analyzed for total petroleum hydrocarbons (TPH). Samples which exhibited an odor or elevated TPH were also analyzed for VOCs, SVOCs, pesticides/PCBs and metals at DQO III. Table 10.15.1 summarizes the SWMU 24 soil samples and analyses.

Table 10.15.1
Zone G
SWMU 24
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
FDSSH024	FDSSH02401 FDSCH02401*	0 - 1	10/21/96	Note 1 Note 2	
FDSSH025	FDSSH02501	0 - 1	10/21/96	Note 2	
FDSSH026	FDSSH02601	0 - 1	10/21/96	Note 1	
FDSSH027	FDSSH02701	0 - 1	10/21/96	Note 2	
FDSSC069	FDSSC06901	6.5 - 8.5	09/30/96	Note 2	
FDSSC072	FDSSC07201	9 - 11	10/01/96	Note 2	
FDSSC073	FDSSC07301	9 - 11	10/01/96	Note 2	
FDSSC074	FDSSC07401	9 - 11	10/01/96	Note 2	
FDSSC075	FDSSC07501	8 - 10	10/01/96	Note 2	
FDSSC085	FDSSC08501	5 - 7	10/01/96	Note 2	
FDSSC086	FDSSC08601 FDSCC08601*	5 - 7	10/02/96	Note 2 Note 2	
FDSSC087	FDSSC08701	4 - 6	10/02/96	Note 2	
FDSSC088	FDSSC08801	9 - 11	10/02/96	Note 2	

Table 10.15.1
Zone G
SWMU 24
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
FDSSC089	FDSSC08901	7 - 9	10/02/96	Note 2	

Notes:

1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs); cyanide; TPH-DRO; TPH-GRO at DQO Level III
2 = TPH-DRO and TPH-GRO
* = Duplicate sample collected

10.15.3.1 Nature of Contamination in Subsurface Soil

Organic compound analytical results for soil are summarized in Table 10.15.2. Inorganic analytical results for subsurface soil are summarized in Table 10.15.3. Table 10.15.4 summarizes all analytes detected in soil at the site. Appendix D contains a complete analytical data report for all Zone G samples collected.

Volatile Organic Compounds in Soil

Two VOCs were detected in surface soil samples. Ethylbenzene and xylene were detected in surface soil at concentrations far below their respective residential soil RBCs. No subsurface soil samples were analyzed for VOCs.

Semivolatile Organic Compounds in Soil

Eighteen SVOCs were detected in surface soil samples. Concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene and dibenz(a,h)anthracene were detected at concentrations exceeding their respective RBCs in sample FDSSH026. Figure 10.15-4 presents the distribution of total BEQs detected in surface soil. No subsurface soil samples were analyzed for SVOCs.

Pesticides and PCBs in Soil

No pesticides or PCBs were detected in surface soil samples at SWMU 24. SWMU 3, a former pesticide mixing area located between Tanks 39-A and 39-D, exhibited four pesticides at concentrations exceeding their respective RBCs in surface soil samples. No SWMU 3 subsurface soil samples contained concentrations of pesticides which exceeded SSLs.

Aroclor-1248 was detected in one surface soil location at SWMU 3 above its RBC. No PCBs were detected at SWMU 24.

Table 10.15.2
Zone G
SWMU 24
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (μg/kg)						
Ethylbenzene	Upper	1/2	3	3	780,000	0
	Lower	0/0	NT	NT	13,000	0
Xylene (Total)	Upper	1/2	1	1	16,000,000	0
	Lower	0/0	NT	NT	140,000	0
Semivolatile Organic Compounds (μg/kg)						
BEQs[1]	Upper	2/2	51.5 - 2,501	1,276	87	1
	Lower	0/0	NA	NA	1,600	NA
Benzo(a)anthracene	Upper	2/2	38 - 2,500	1,269	870	1
	Lower	0/0	NT	NT	2,000	0
Benzo(a)pyrene	Upper	2/2	42 - 1,700	871	87	1
	Lower	0/0	NT	NT	8,000	0
Benzo(b)fluoranthene	Upper	2/2	51 - 1,600	825.5	870	1
	Lower	0/0	NT	NT	5,000	0
Benzo(k)fluoranthene	Upper	2/2	58 - 1,700	879	8,700	0
	Lower	0/0	NT	NT	49,000	0

Table 10.15.2
Zone G
SWMU 24
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Chrysene	Upper	2/2	57 - 3,200	1,628.5	87,000	0
	Lower	0/0	NT	NT	160,000	0
Dibenz(a,h)anthracene	Upper	1/2	290	290	87	1
	Lower	0/0	NT	NT	2,000	0
Indeno(1,2,3-cd)pyrene	Upper	1/2	810	810	870	0
	Lower	0/0	NT	NT	14,000	0
Acenaphthene	Upper	1/2	200	200	470,000	0
	Lower	0/0	NT	NT	570,000	0
Anthracene	Upper	1/2	640	640	2,300,000	0
	Lower	0/0	NT	NT	12,000,000	0
Benzo(g,h,i)perylene	Upper	1/2	860	860	310,000	0
	Lower	0/0	NT	NT	1.14E+08	0
bis(2-Ethylhexyl)phthalate (BEHP)	Upper	1/2	55	55	46,000	0
	Lower	0/0	NT	NT	3,600,000	0
Di-n-butylphthalate	Upper	1/2	64	64	780,000	0
	Lower	0/0	NT	NT	2,300,000	0

Table 10.15.2
Zone G
SWMU 24
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Fluoranthene	Upper	2/2	74 - 3,400	1,737	310,000	0
	Lower	0/0	NT	NT	4,300,000	0
Fluorene	Upper	1/2	190	190	310,000	0
	Lower	0/0	NT	NT	560,000	0
2-Methylnaphthalene	Upper	1/2	890	890	160,000	0
	Lower	0/0	NT	NT	36,000	0
Naphthalene	Upper	1/2	700	700	160,000	0
	Lower	0/0	ND	ND	61,000	0
Phenanthrene	Upper	1/2	2,500	2,500	230,000	0
	Lower	0/0	ND	ND	1,300,000	0
Pyrene	Upper	2/2	96 - 7,500	3,798	230,000	0
	Lower	0/1	ND	ND	1,300,000	0
TPH-GRO (μg/kg)						
Gasoline	Upper	1/4	20	20	NA	0
	Lower	6/10	8 - 35	13.1	NA	0

Notes:

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995)

* = Residential RBCs (THQ = 0.1) were used as a reference concentration for upper interval samples.
Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples

NA = Not Applicable/Not Available

ND = Not Detected/Not Determined

NL = Not Listed

NT = Not Taken

µg/kg = Micrograms per kilogram

Table 10.15.3
Zone G
SWMU 24
Inorganic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Background Conc. (μg/kg)	Number of Samples Exceeding Reference
Inorganics (μg/kg)							
Aluminum (Al)	Upper	2/2	4,500 - 7,850	6,175	7,800	18,700	1
	Lower	0/0	NT	NT	1,000,000	23,600	0
Arsenic (As)	Upper	1/2	3.9	3.9	0.43	17.2	1
	Lower	0/0	NT	NT	29	15.5	0
Barium (Ba)	Upper	2/2	28.3 - 41.5	34.9	550	109	0
	Lower	0/0	NT	NT	1,600	64.5	0
Beryllium (Be)	Upper	2/2	0.36 - 0.52	0.44	16	1.2	0
	Lower	0/0	NT	NT	63	1.63	0
Cadmium (Cd)	Upper	1/2	0.04	0.04	3.9	1.07	0
	Lower	0/0	NT	NT	8	0.48	0
Calcium (Ca)	Upper	2/2	10,300 - 11,200	10,750	NL	NL	NA
	Lower	0/0	NT	NT	NL	NL	NA
Chromium (Cr)	Upper	2/2	6.7 - 12.5	9.6	23	42.8	0
	Lower	0/0	NT	NT	1,000,000	43.4	0

Table 10.15.3
Zone G
SWMU 24
Inorganic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Background Conc. (μg/kg)	Number of Samples Exceeding Reference
Cobalt (Co)	Upper	2/2	1.4 - 2.1	1.75	470	6.6	0
	Lower	0/0	NT	NT	2,000	8.14	0
Iron (Fe)	Upper	2/2	4,180 - 8,180	6,180	2,300	NL	2
	Lower	0/0	NT	NT	NL	NL	NA
Lead (Pb)	Upper	2/2	350 - 381	365.5	400	181	0
	Lower	0/0	NT	NT	400	66.3	0
Magnesium (Mg)	Upper	2/2	432 - 631	531.5	NL	NL	NA
	Lower	0/0	NT	NT	NL	NL	NA
Manganese (Mn)	Upper	2/2	38.9 - 109	73.95	160	325	0
	Lower	0/0	NT	NT	950	291	0
Mercury (Hg)	Upper	1/2	0.06	0.06	2.3	1.03	0
	Lower	0/0	NT	NT	2	0.31	0
Potassium (K)	Upper	1/2	267	267	NL	NL	NA
	Lower	0/0	NT	NT	NL	NL	NA

Table 10.15.3
Zone G
SWMU 24
Inorganic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Background Conc. (μg/kg)	Number of Samples Exceeding Reference
Selenium (Se)	Upper	1/2	0.47	0.47	39	1.22	0
	Lower	0/0	NT	NT	5	1.26	0
Vanadium (V)	Upper	2/2	8 - 15.5	11.75	55	60.9	0
	Lower	0/0	NT	NT	6,000	72.5	0
Zinc (Zn)	Upper	2/2	30.5 - 30.7	30.6	2,300	519	0
	Lower	0/0	NT	NT	12,000	145	0

Notes:
* = Residential RBCs (THQ = 0.1) were used as a reference concentration for upper interval samples.
Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
mg/kg = Milligrams per kilogram
All background values for Zone G are based on twice the mean of the grid sample concentrations

Table 10.15.4
Zone G
SWMU 24
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ = 0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF = 20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Ethylbenzene	FDSSH026	3	780,000	NA	NT	13,000	NA
Xylene (Total)	FDSSH026	1	16,000,000	NA	NT	140,000	NA
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	FDSSH024	51.1	87	NA	ND	1,600	NA
	FDSSH026	**2,501**			ND		
Benzo(a)anthracene	FDSSH024	38	870	NA	ND	2,000	NA
	FDSSH026	**2,500**			ND		
Benzo(a)pyrene	FDSSH024	42	87	NA	ND	8,000	NA
	FDSSH026	**1,700**			ND		
Benzo(b)fluoranthene	FDSSH024	51	870	NA	ND	5,000	NA
	FDSSH026	**1,600**			ND		
Benzo(k)fluoranthene	FDSSH024	58	8,700	NA	ND	49,000	NA
	FDSSH026	1,700			ND		
Chrysene	FDSSH024	57	87,000	NA	ND	160,000	NA
	FDSSH026	3,200			ND		
Dibenz(a,h)anthracene	FDSSH026	**290**	87	NA	ND	2,000	NA

Table 10.15.4
Zone G
SWMU 24
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ = 0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF = 20)	Subsurface Background
Indeno(1,2,3-cd)pyrene	FDSSH026	810	870	NA	ND	14,000	NA
Acenaphthene	FDSSH026	200	470,000	NA	ND	570,000	NA
Anthracene	FDSSH026	640	2,300,000	NA	ND	12,000,000	NA
Benzo(g,h,i)perylene	FDSSH026	860	310,000	NA	ND	1.14E + 08	NA
bis(2-Ethylhexyl)phthalate (BEHP)	FDSSH024	55	46,000	NA	ND	3,600,000	NA
Di-n-butylphthalate	FDSSH024	64	780,000	NA	ND	2,300,000	NA
Fluoranthene	FDSSH024 FDSSH026	74 3,400	310,000	NA	ND ND	4,300,000	NA
Fluorene	FDSSH026	190	310,000	NA	ND	560,000	NA
2-Methylnaphthalene	FDSSH026	890	160,000	NA	ND	36,000	NA
Naphthalene	FDSSH026	700	160,000	NA	ND	61,000	NA
Phenanthrene	FDSSH026	2,500	230,000	NA	ND	1,300,000	NA
Pyrene	FDSSH024 FDSSH026	96 7,500	230,000	NA	ND ND	4,200,000	NA

Table 10.15.4
Zone G
SWMU 24
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ = 0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF = 20)	Subsurface Background
TPH-GRO (μg/kg)							
Gasoline	FDSSH026	20	NA	NA	NT	NA	NA
	FDSSC069	NT			8		
	FDSSC072	NT			8		
	FDSSC073	NT			15		
	FDSSC074	NT			8		
	FDSSC088	NT			9		
	FDSSC089	NT			35		
Inorganics (mg/kg)							
Aluminum (Al)	FDSSH024	7,850	7,800	18,700	NT	1,000,000	23,600
	FDSSH026	4,500			NT		
Arsenic (As)	FDSSH024	3.9	0.43	17.2	NT	29	15.5
Barium (Ba)	FDSSH024	41.5	550	109	NT	1,600	64.5
	FDSSH026	28.3			NT		
Beryllium (Be)	FDSSH024	0.52	16	1.2	NT	63	1.63
	FDSSH026	0.36			NT		
Cadmium (Cd)	FDSSH026	0.04	3.9	1.07	NT	8	0.48
Calcium (Ca)	FDSSH024	10,300	NL	NL	NT	NL	NL
	FDSSH026	11,200			NT		

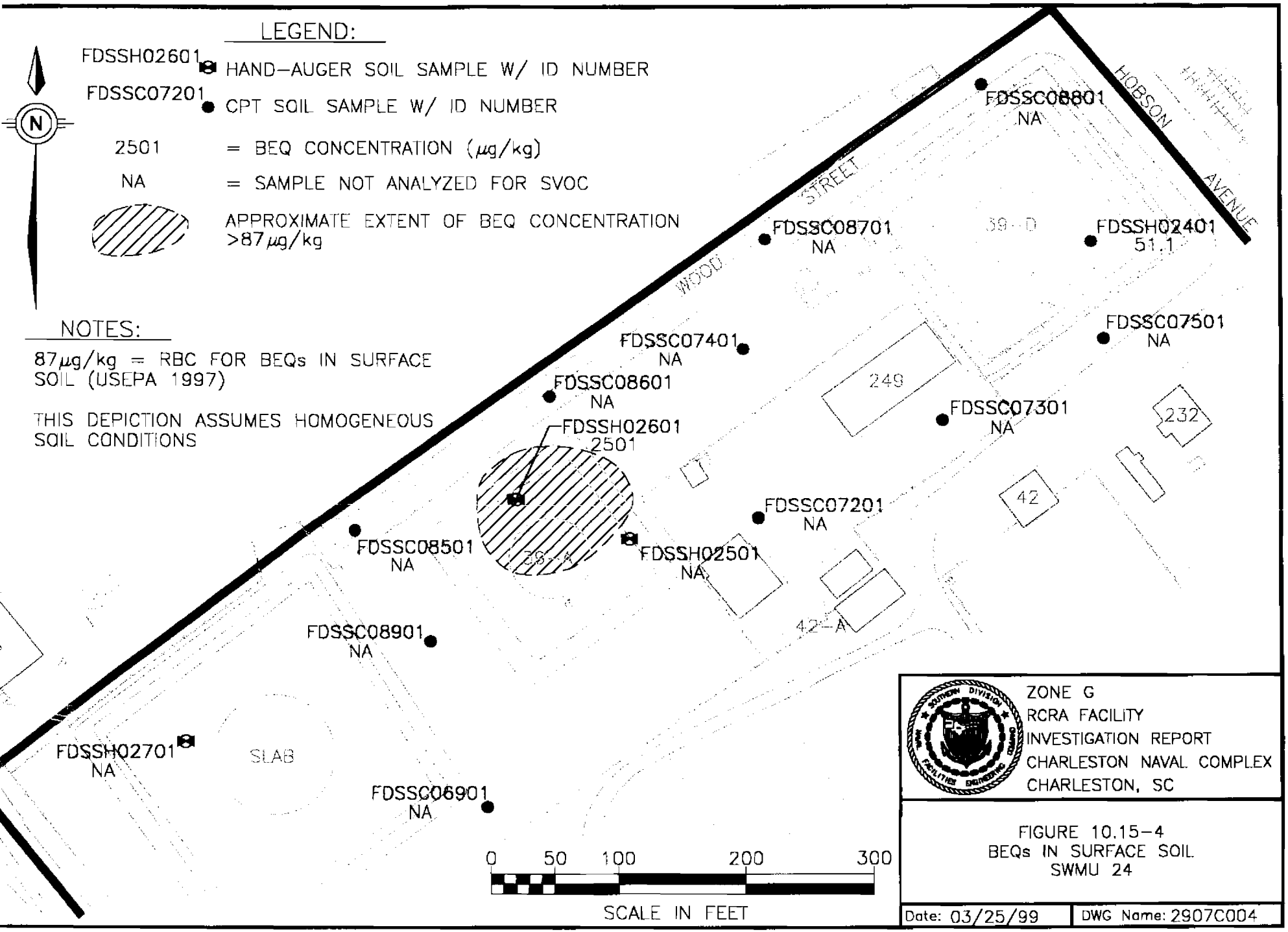
Table 10.15.4
Zone G
SWMU 24
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ = 0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF = 20)	Subsurface Background
Chromium (Cr)	FDSSH024	12.5	23	42.8	NT	1,000,000	43.4
	FDSSH026	6.7			NT		
Cobalt (Co)	FDSSH024	2.1	470	6.6	NT	2,000	8.14
	FDSSH026	1.4			NT		
Iron (Fe)	FDSSH024	8,180	2,300	NL	NT	NL	NL
	FDSSH026	4,180			NT		
Lead (Pb)	FDSSH024	350	400	181	NT	400	66.3
	FDSSH026	381			NT		
Magnesium (Mg)	FDSSH024	631	NL	NL	NT	NL	NL
	FDSSH026	432			NT		
Manganese (Mn)	FDSSH024	109	160	325	NT	950	291
	FDSSH026	38.9			NT		
Mercury (Hg)	FDSSH024	0.06	2.3	1.03	NT	2	0.31
Potassium (K)	FDSSH024	267	NL	NL	NT	NL	NL
Selenium (Se)	FDSSH026	0.47	39	1.22	NT	5	1.26
Vanadium (V)	FDSSH024	15.5	55	60.9	NT	6,000	72.5
	FDSSH026	8			NT		

Table 10.15.4
Zone G
SWMU 24
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ = 0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF = 20)	Subsurface Background
Zinc (Zn)	FDSSH024	30.7	2,300	519	NT	12,000	145
	FDSSH026	30.5			NT		

Notes:
* = Residential RBCs (THQ = 0.1) were used as a reference concentration for upper interval samples.
Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996) were used as a reference concentration for lower interval samples
¦ = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment,* Bulletin 2 (USEPA, 1995)
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
NT = Not Taken
mg/kg = Milligrams per kilogram
μg/kg = Micrograms per kilogram
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the mean of the grid sample concentrations


LEGEND:
FDSSH02601 HAND-AUGER SOIL SAMPLE W/ ID NUMBER
FDSSC07201 CPT SOIL SAMPLE W/ ID NUMBER
2501 = BEQ CONCENTRATION (µg/kg)
NA = SAMPLE NOT ANALYZED FOR SVOC
APPROXIMATE EXTENT OF BEQ CONCENTRATION >87 µg/kg
NOTES:
87µg/kg = RBC FOR BEQs IN SURFACE SOIL (USEPA 1997)
THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
N
WOOD STREET
HOBSON AVENUE
FDSSC08801 NA
FDSSC08701 NA
FDSSH02401 51.1
FDSSC07501 NA
FDSSC07401 NA
FDSSC08601 NA
FDSSH02601 2501
FDSSC07301 NA
FDSSC07201 NA
FDSSC08501 NA
FDSSH02501 NA
FDSSC08901 NA
FDSSH02701 NA
FDSSC06901 NA
249
232
42
42-A
SLAB
0 50 100 200 300
SCALE IN FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 10.15-4
BEQs IN SURFACE SOIL
SWMU 24
Date: 03/25/99
DWG Name: 2907C004

Other Organic Compounds in Soil

TPH was a screening parameter at all soil sample locations at SWMU 24. No RBC is available for TPH, because of this the VOC and SVOC analytical results are used to evaluate the site.

Inorganic Elements in Soil

Seventeen metals were detected in surface soil. Concentrations of aluminum, arsenic, and iron exceeded their respective RBCs. No metals were detected which exceeded both the RBC and the Zone G background concentrations. No background was established for iron because it is considered an essential nutrient. No subsurface samples were analyzed for inorganics.

10.15.4 Groundwater Sampling and Analysis

The approved final work plan proposed shallow monitoring wells to be installed as needed in areas of impacted soil. Based on the analytical results of soil samples collected at SWMU 24, four shallow wells were installed and sampled. Figure 10.15-1 presents the locations of these wells. The purpose of these wells was to: (1) assess groundwater quality and (2) identify contaminants which may be migrating from the site.

Groundwater samples were analyzed for VOCs, SVOCs, and metals at DQO III. Table 10.15.5 summarizes the groundwater samples and analyses at SWMU 24.

10.15.4.1 Nature of Contamination in Shallow Groundwater

Organic analytical results for groundwater are summarized in Table 10.15.6. Inorganic analytical results for groundwater are summarized in Table 10.15.7. Table 10.15.8 presents a summary of all analytes detected at SWMU 24.

Table 10.15.5
Zone G
SWMU 24
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
024001	Shallow	02400101	04/22/98	Note 1	
		02400102	10/28/98	Note 1	
024002	Shallow	02400201	04/20/98	Note 1	
		02400202	10/29/98	Note 1	
024003	Shallow	02400301	04/20/98	Note 1	
		02400302	10/29/98	Note 1	
024004	Shallow	02400401*	04/24/98	Note ½	
		02400402	10/29/98	Note 1	

Notes:
1 = SW-846 (metals, SVOCs, VOCs) at DQO Level III
2 = Appendix IX Suite: Appendix IX (pesticides/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP pesticides); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample collected

Table 10.15.6
Zone G
SWMU 24
Organic Analytical Results for Groundwater

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC*	MCL/SMCL *	Shallow Background	Number of Samples Exceeding RBC
Volatile Organic Compounds (μg/L)								
Tetrachloroethene	First (Apr. 98)	1/4	0.87	0.87	1.1	5	NA	0
	Second (Oct. 98)	0/4	ND	ND				0
Semivolatile Organic Compounds (μg/L)								
bis(2-Ethylhexyl)phthalate (BEHP)	First (Apr. 98)	0/4	ND	ND	4.8	NL	NA	0
	Second (Oct. 98)	1/4	2	2				0

Notes:
ND = Not Detected/Not Determined
NL = Not Listed
NT = Not Taken
μg/L = Micrograms per liter
* = Tap Water RBCs (THQ = 0.1) from *Risk-Based Concentration Table* (USEPA, October 1, 1998).
MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996) were used as a reference concentration

Table 10.15.7
Zone G
SWMU 24
Inorganic Analytical Results for Groundwater

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC*	MCL/SMCL*	Shallow Background	Number of Samples Exceeding RBC
Inorganics (μg/L)								
Aluminum (Al)	First (Apr. 98)	4/4	14.3 - 429	190	3,700	50	692	0
	Second (Oct. 98)	4/4	57.2 - 235	130				0
Arsenic (As)	First (Apr. 98)	3/4	6.5 - 47.2	21.4	0.045	50	17.8	3
	Second (Oct. 98)	4/4	5.6 - 86.1	29				4
Barium (Ba)	First (Apr. 98)	4/4	10.7 - 57.05	33	260	2,000	31	0
	Second (Oct. 98)	4/4	9.2 - 46.1	28				0
Calcium (Ca)	First(Apr. 98)	4/4	3,150 - 37,700	24,088	NL	NL	NL	0
	Second (Oct. 98)	4/4	3,020 - 23,100	16,230				0
Chromium (Cr)	First (Apr. 98)	0/4	ND	ND	11	100	3.88	0
	Second (Oct. 98)	1/4	0.78	0.78				0
Cobalt (Co)	First(Apr. 98)	3/4	0.91 - 2.2	1.77	220	NL	1.45	0
	Second (Oct. 98)	3/4	1.3 - 3.9	2.27				0
Iron (Fe)	First(Apr. 98)	4/4	1,750 - 4,340	2,975	1,100	300	NL	4
	Second (Oct. 98)	4/4	1,460 - 5,770	2,935				4
Magnesium (Mg)	First (Apr. 98)	4/4	1,530 - 36,950	15,440	NL	NL	NL	0
	Second (Oct. 98)	4/4	1,300 - 31,500	12,935				0
Manganese (Mn)	First(Apr. 98)	4/4	70.5 - 203	146	73	50	2,906	3
	Second (Oct. 98)	4/4	50.2 - 208	125				2

Table 10.15.7
Zone G
SWMU 24
Inorganic Analytical Results for Groundwater

Parameters	Sample Round	Detection Frequency	Detection Range	Mean	Tap Water RBC*	MCL/SMCL*	Shallow Background	Number of Samples Exceeding RBC
Nickel (Ni)	First(Apr. 98)	0/4	ND	ND	73	100	4.08	0
	Second (Oct. 98)	2/4	1.4 - 2	1.7				0
Potassium (K)	First (Apr. 98)	4/4	611 - 22,400	10,078	NL	NL	NL	0
	Second (Oct. 98)	3/4	1,990 - 21,500	11,597				0
Selenium (Se)	First (Apr. 98)	1/4	5	5	18	50	4.3	0
	Second (Oct. 98)	0/4	ND	ND				0
Sodium (Na)	First(Apr. 98)	4/4	27,300 - 344,000	124,763	NL	NL	NL	0
	Second (Oct. 98)	4/4	25,100 - 340,000	129,425				0
Vanadium (V)	First(Apr. 98)	1/4	1.15	1.15	26	NL	15.4	0
	Second (Oct. 98)	1/4	0.97	0.97				0

Notes:
ND = Not Detected/Not Determined
NL = Not Listed
NT = Not Taken
μg/L = Micrograms per liter
* = Tap Water RBCs (THQ = 0.1) from *Risk-Based Concentration Table* (USEPA, October 1, 1998).
MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996) were used as a reference concentration

Table 10.15.8
Zone G
SWMU 24
Analytes Detected in Shallow Groundwater

Parameters	Location	First Round Conc. Apr-98	Second Round Conc. Oct-98	Tap Water RBC*	MCL/SMCL*	Shallow Background
Volatile Organic Compounds (μg/L)						
Tetrachloroethene	024001	0.87	ND	1.1	5	NA
Semivolatile Organic Compounds (μg/L)						
bis(2-Ethylhexyl)phthalate (BEHP)	024002	ND	2	4.8	NL	NA
Inorganics (μg/L)						
Aluminum (Al)	024001	429	235	3,700	50	692
	024002	123	107			
	024003	14.3	119			
	024004	195	57.2			
Arsenic (As)	024001	**47.2**	**86.1**	0.045	50	17.8
	024002	6.5	5.6			
	024003	10.5	16.4			
	024004	ND	8.9			
Barium (Ba)	024001	26.6	26.9	260	2,000	31
	024002	10.7	9.2			
	024003	39	28.1			
	024004	57.05	46.1			
Calcium (Ca)	024001	21,300	19,000	NL	NL	NL
	024002	3,150	3,020			
	024003	37,700	19,800			
	024004	34,200	23,100			

Table 10.15.8
Zone G
SWMU 24
Analytes Detected in Shallow Groundwater

Parameters	Location	First Round Conc. Apr-98	Second Round Conc. Oct-98	Tap Water RBC*	MCL/SMCL*	Shallow Background
Chromium (Cr)	024002	ND	0.78	11	100	3.88
Cobalt (Co)	024001	2.2	3.9	220	NL	1.45
	024002	2.2	1.6			
	024004	0.91	1.3			
Iron (Fe)	024001	**4,340**	**5,770**	1,100	300	NL
	024002	**2,100**	**1,640**			
	024003	**3,710**	**1,460**			
	024004	**1,750**	**2,870**			
Magnesium (Mg)	024001	15,100	14,900	NL	NL	NL
	024002	1,530	1,300			
	024003	8,180	4,040			
	024004	36,950	31,500			
Manganese (Mn)	024001	203	208	73	50	2,906
	024002	70.5	59.8			
	024003	114	50.2			
	024004	194.5	183			
Nickel (Ni)	024001	ND	2	73	100	4.08
	024002	ND	1.4			
Potassium (K)	024001	13,700	11,300	NL	NL	NL
	024002	611	ND			
	024003	3,600	1,990			
	024004	22,400	21,500			
Selenium (Se)	024004	5	ND	18	50	4.3

Table 10.15.8
Zone G
SWMU 24
Analytes Detected in Shallow Groundwater

Parameters	Location	First Round Conc. Apr-98	Second Round Conc. Oct-98	Tap Water RBC*	MCL/SMCL*	Shallow Background
Sodium (Na)	024001	344,000	340,000	NL	NL	NL
	024002	27,300	25,100			
	024003	46,600	76,600			
	024004	81,150	76,000			
Vanadium (V)	024003	ND	0.97	26	NL	15.4
	024004	1.15	ND			

Notes:
NA = Not Applicable/Not Available
ND = Not Detected/Not Determined
NL = Not Listed
NT = Not Taken
µg/L = Micrograms per liter
* = Tap Water RBCs (THQ = 0.1) from *Risk-Based Concentration Table* (USEPA, October 1, 1998).
MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996) were used as a reference concentration
Bolded concentrations exceed both the RBC and the zone background. All background values for Zone G are based on twice the mean of the grid sample concentrations

Volatile Organic Compounds in Groundwater

Tetrachloroethene was detected in one well, 024001, during the initial sampling event at a concentration below its RBC of 1.1 μg/L. No VOCs were detected in the second sampling round.

Semivolatile Organic Compounds in Groundwater

Bis(2-Ethylhexyl)phthalate was the only SVOC detected in shallow groundwater at SWMU 24. This compound was only detected in the second sampling event in one well, 024002, at a concentration below its tap water RBC of 4.8 μg/L.

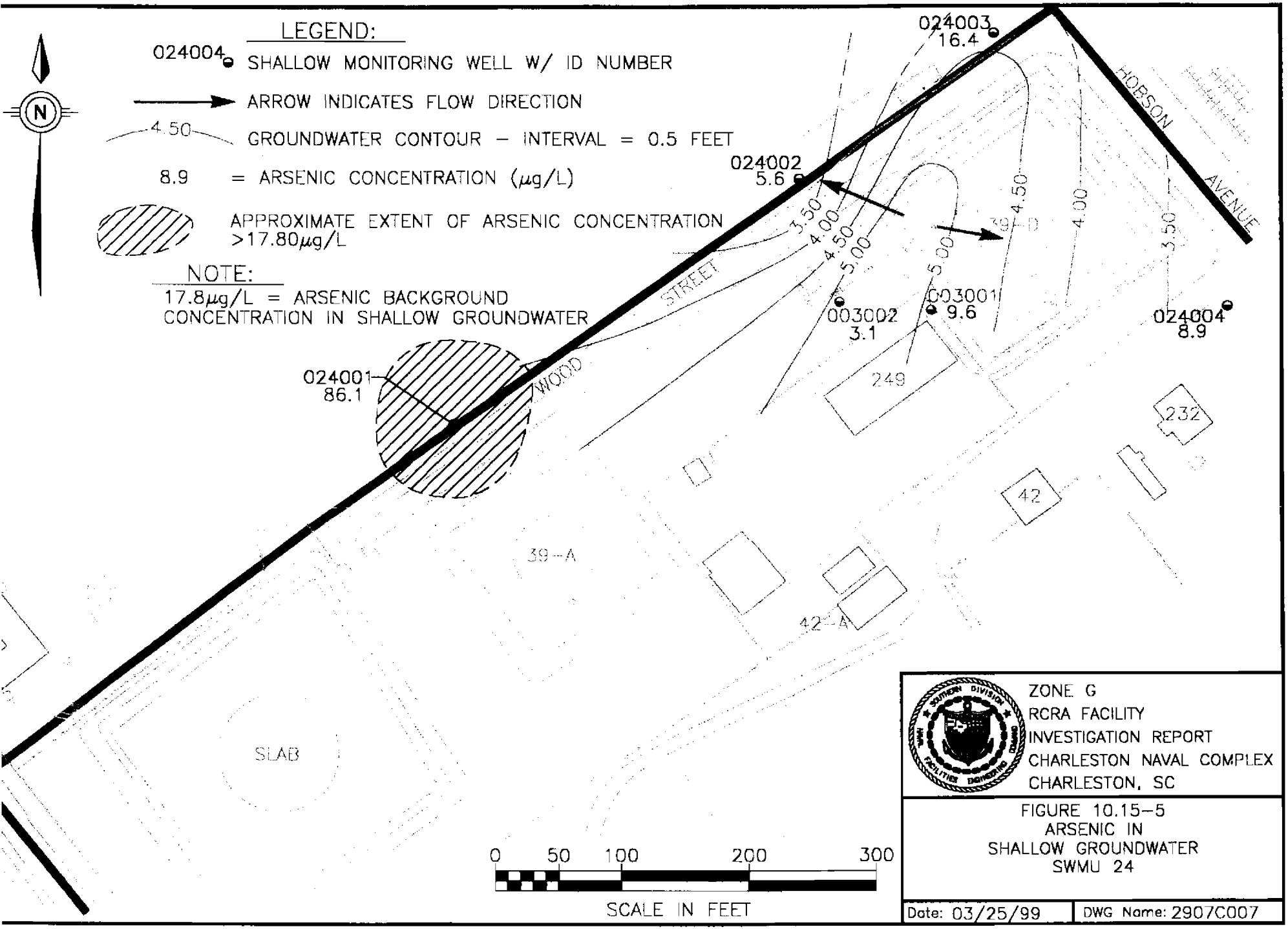
Inorganic Elements in Groundwater

Fourteen metals were detected in shallow groundwater samples at SWMU 24. Arsenic is the only metal detected at a concentration exceeding both its tap water RBC and Zone G background concentration.

Arsenic was detected in all samples collected except one. The general concentrations of arsenic appear to be increasing over time. During the initial sampling event only one sample, collected from monitoring well 024001, exceeded the RBC of 0.045 μg/L and the Zone G background concentration of 17.8 μg/L. This detection was only slightly below the MCL of 50 μg/L. During the next event the concentration detected exceeded the RBC, background, and MCL. Figure 10.15-5 presents the distribution of arsenic in shallow groundwater at SWMU 24.

Concentrations of iron exceeded the RBC of 1,100 μg/L and the MCL of 300 μg/L in all samples collected. No background was determined for the essential nutrient iron.

Manganese was detected in all groundwater samples collected at SWMU 24. All detections from wells 024001 and 024004 exceeded the RBC of 73 μg/L and the MCL of 50 μg/L. No detections exceeded the Zone G background of 2,906 μg/L.


LEGEND:
024004 SHALLOW MONITORING WELL W/ ID NUMBER
ARROW INDICATES FLOW DIRECTION
4.50 GROUNDWATER CONTOUR – INTERVAL = 0.5 FEET
8.9 = ARSENIC CONCENTRATION (µg/L)
APPROXIMATE EXTENT OF ARSENIC CONCENTRATION >17.80µg/L
NOTE:
17.8µg/L = ARSENIC BACKGROUND CONCENTRATION IN SHALLOW GROUNDWATER
N
024003 16.4
024002 5.6
024001 86.1
003002 3.1
003001 9.6
024004 8.9
3.50
4.00
4.50
5.00
WOOD STREET
HOBSON AVENUE
249
232
42
39-A
42-A
SLAB
0 50 100 200 300
SCALE IN FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 10.15-5
ARSENIC IN
SHALLOW GROUNDWATER
SWMU 24
Date: 03/25/99
DWG Name: 2907C007

10.15.5 Fate and Transport Assessment

Environmental media sampled as part of this investigation include surface and subsurface soil and shallow groundwater. Potential constituent migration pathways investigated include soil-to-groundwater, groundwater migration to human receptors and to surface water and emission of volatiles from surface soil-to-air.

10.15.6 Soil-to-Groundwater Cross Media Transport

Table 10.15.9 compares maximum detected constituent concentrations in surface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels or (b) background concentrations. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

One organic constituent - benzo(a)anthracene - was detected in surface soil at a concentration exceeding its SSL. Benzo(a)anthracene is associated with asphaltic compounds, with incomplete combustion of fossil fuels, and as a constituent of waste oil. Notably, benzo(a)anthracene was not detected in site groundwater, effectively invalidating the pathway.

10.15.7 Groundwater Migration and Surface Water Cross-Media Transport

Table 10.15.9 compares maximum detected constituent concentrations in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the greater of (a) risk-based drinking water concentrations or (b) corresponding background

Table 10.15.9
Chemicals Detected in Surface Soil and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
Charlston Naval Complex, Zone G: SWMU 24
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Ethylbenzene	3	NA	ND	NA	13000	1300	4.3	UG/KG	UG/L	NO	NO	NO
Tetrachloroethene	ND	NA	0.87	NA	60	1.1	45	UG/KG	UG/L	NO	NO	NO
Xylene (total)	1	NA	ND	NA	140000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	200	NA	ND	NA	570000	22000	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	640	NA	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	860	NA	ND	NA	1.1E+08	730	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents	2501	NA	ND	NA	NA	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)anthracene	2500	NA	ND	NA	2000	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	1700	NA	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	1600	NA	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	1700	NA	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	3200	NA	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	290	NA	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	810	NA	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	64	NA	ND	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	55	NA	2	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	3400	NA	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	190	NA	ND	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	890	NA	ND	NA	36000	120	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	700	NA	ND	NA	61000	730	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	2500	NA	ND	NA	1300000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	7500	NA	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
TPH - GRO												
Gasoline	20	35	NA	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	7850	NA	429	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	3.9	NA	86.1	NA	29	17.8	36	MG/KG	UG/L	NO	YES	YES
Barium	41.5	NA	57.1	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.52	NA	ND	NA	63	73	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.04	NA	ND	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	12.5	NA	0.78	NA	1000000	55000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	2.1	NA	3.9	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Lead	381	NA	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	109	NA	208	NA	950	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.06	NA	ND	NA	2	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	ND	NA	2	NA	130	730	8.3	MG/KG	UG/L	NO	NO	NO
Selenium	0.47	NA	5	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Vanadium	15.5	NA	1.15	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	30.7	NA	ND	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

Notes:

* Screening Concentrations:

Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4 of RFI report

Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 1998

Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2

For inorganics, the tap water RBC value shown is the greater of the relevant screening value or the corresponding background reference value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level

MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted at the beginning of this discussion that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater, e.g. there is no end-use receptor. This comparison is made for screening only, and to develop strategies for long-term management of the groundwater should an area containing deleterious levels be identified.

One inorganic constituent - arsenic - was present at concentrations that exceeded its tap water RBC and its surface water screening concentration. During the two available quarters of sampling, arsenic has consistently been above standards in well 024001. Although arsenic was detected in soil, it was detected at concentrations well below its SSL. The arsenic distribution on this site represents a localized source (potentially aquifer matrix) that is attenuated rapidly over short horizontal distances, and is therefore not expected to be significant to the groundwater migration pathways.

10.15.8 Soil-to-Air Cross-Media Transport

Table 10.15.10 lists the VOCs detected in surface soil samples collected at SWMU 24, along with the corresponding soil-to-air volatilization criteria. Two VOCs were detected in the surface soil samples collected at this site, but none exceeded the corresponding soil-to-air volatilization screening levels. Consequently, the soil-to-air migration pathway is insignificant at SWMU 24.

10.15.9 SWMU 24 Fate and Transport Summary

Soil-to-Groundwater Pathway

One organic constituent - benzo(a)anthracene was present in surface soil at concentrations exceeding its SSL. The source is likely released waste oil from the site. However, benzo(a)anthracene was not-detected in site groundwater, thus this pathway is considered invalid.

Table 10.15.10
Soil-to-Air Volatilization Screening Analysis
Charleston Naval Complex, Zone G: SWMU 24
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Ethylbenzene	3	400000	UG/KG	NO
Xylene (total)	1	320000	UG/KG	NO

Notes:
* Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996.

Groundwater Ingestion and Migration to Surface Water Pathways

One inorganic parameter – arsenic - was detected at a concentration exceeding its tap water RBC and its surface water screening value. It was above both standards only in well 024001 for both sampling events. The limited horizontal extent of arsenic exceedances indicates a localized source that attenuates rapidly over short distances, thus arsenic is not expected to be significant with respect to this pathway.

Soil-to-Air

Two VOCs were detected in surface soil sample collected at SWMU 24, but neither exceeded the respective soil-to-air volatilization screening levels. Consequently, the soil-to-air migration pathway is insignificant at SWMU 24.

10.15.10 Human Health Risk Assessment

10.15.10.1 Site Background and Investigative Approach

SWMU 24, the waste oil reclamation facility for the CNC, consists of tanks 39-A and 39-D. This area is located south of Hobson Avenue and east of Wood Street. Included in this area is SWMU 3, the pesticide mixing area. SWMU 3 is discussed in Section 10.11 of the Zone F RFI. SWMU 24 was originally investigated under the petroleum program as part of the Fuel Distribution System (FDS) but was returned to the RCRA program to assess inorganics detected in the area groundwater. Tanks 39-A and 39-D operated as waste oil settling tanks. Waste oil containing water and presumably other impurities was delivered to these tanks via the pipeline system. The tanks were used both to separate and store the water and oil phases. The waste water was subsequently discharged to the sanitary sewer system. Materials stored and potentially released include waste oil and other petroleum products.

10.15.10.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.15.11, BEQs were identified as COPCs for surface soil. Maximum reported concentrations of aluminum, arsenic, and manganese exceeded their respective RBCs but not their respective background reference concentrations. These inorganics were, therefore, eliminated from further consideration in the SWMU 24 HHRA.

Groundwater

As shown in Table 10.15.12, arsenic was identified as a COPC in shallow groundwater for combined SWMU 24. The maximum reported concentration of manganese exceeded its RBC but not its background reference concentration. Manganese was therefore eliminated from further consideration in the SWMU 24 HHRA. Wilconox rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

10.15.10.3 Exposure Assessment

Exposure Setting

SWMU 24 is located in an industrial setting, approximately 1500 feet southwest of the waterfront along the Cooper River. The fenced site consists of two above ground tanks that are surrounded by earthen dikes. Given the current setting, SWMU 24 is unlikely to be redeveloped as a residential neighborhood and is unlikely to attract adolescent trespassers with any significant frequency. All potable water is provided through the city's water supply. Shallow groundwater at the site is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and site worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed

Table 10.15.11
Chemicals Present In Site Samples
SWMU 24 - Surface Soil
Charleston Naval Complex, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Bkgd
Carcinogenic PAHs													
B(a)P Equiv.	*	2	2	51.5	2501.2	1276	NA	NA	87	NA	UG/KG	1	
Benzo(a)anthracene	*	2	2	38	2500	1269	NA	NA	870	NA	UG/KG	1	
Benzo(a)pyrene	*	2	2	42	1700	871	NA	NA	87	NA	UG/KG	1	
Benzo(b)fluoranthene	*	2	2	51	1600	826	NA	NA	870	NA	UG/KG	1	
Benzo(k)fluoranthene		2	2	58	1700	879	NA	NA	8700	NA	UG/KG		
Chrysene		2	2	57	3200	1629	NA	NA	87000	NA	UG/KG		
Dibenz(a,h)anthracene	*	1	2	290	290	290	370	370	87	NA	UG/KG	1	
Indeno(1,2,3-cd)pyrene		1	2	810	810	810	370	370	870	NA	UG/KG		
Inorganics													
Aluminum (Al)		2	2	4500	7850	6175	NA	NA	7800	18700	MG/KG	1	
Arsenic (As)		1	2	3.9	3.9	3.9	2.4	2.4	0.43	17.2	MG/KG	1	
Barium (Ba)		2	2	28.3	41.5	34.9	NA	NA	550	109	MG/KG		
Beryllium (Be)		2	2	0.36	0.52	0.44	NA	NA	16	1.2	MG/KG		
Cadmium (Cd)		1	2	0.04	0.04	0.04	0.04	0.04	3.9	1.07	MG/KG		
Calcium (Ca)	N	2	2	10300	11200	10750	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		2	2	6.7	12.5	9.6	NA	NA	23	42.8	MG/KG		
Cobalt (Co)		2	2	1.4	2.1	1.75	NA	NA	470	6.6	MG/KG		
Iron (Fe)	N	2	2	4180	8180	6180	NA	NA	NA	NA	MG/KG		
Lead (Pb)		2	2	350	381	365.5	NA	NA	400	181	MG/KG		2
Magnesium (Mg)	N	2	2	432	631	531.5	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		2	2	38.9	109	73.95	NA	NA	160	325	MG/KG	1	
Mercury (Hg)		1	2	0.06	0.06	0.06	0.04	0.04	2.3	1.03	MG/KG		
Potassium (K)	N	1	2	267	267	267	218	218	NA	NA	MG/KG		
Selenium (Se)		1	2	0.47	0.47	0.47	0.33	0.33	39	1.22	MG/KG		
Vanadium (V)		2	2	8	15.5	11.75	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		2	2	30.5	30.7	30.6	NA	NA	2300	519	MG/KG		
Semivolatile Organics													
Acenaphthene		1	2	200	200	200	370	370	470000	NA	UG/KG		
Anthracene		1	2	640	640	640	370	370	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		1	2	860	860	860	370	370	310000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)		1	2	55	55	55	720	720	46000	NA	UG/KG		
Di-n-butylphthalate		1	2	64	64	64	720	720	780000	NA	UG/KG		
Fluoranthene		2	2	74	3400	1737	NA	NA	310000	NA	UG/KG		
Fluorene		1	2	190	190	190	370	370	310000	NA	UG/KG		
2-Methylnaphthalene		1	2	890	890	890	370	370	160000	NA	UG/KG		
Naphthalene		1	2	700	700	700	370	370	160000	NA	UG/KG		
Phenanthrene		1	2	2500	2500	2500	370	370	230000	NA	UG/KG		
Pyrene		2	2	96	7500	3798	NA	NA	230000	NA	UG/KG		
Volatile Organics													
Ethylbenzene		1	2	3	3	3	6	6	780000	NA	UG/KG		
Xylene (Total)		1	2	1	1	1	6	6	16000000	NA	UG/KG		
TPH-GRO													
Gasoline		1	4	20	20	20.0	11.2	12.2	NA	NA	UG/KG		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available
N - Essential Nutrient

Table 10.15.12
Chemicals Present in Site Samples
SWMU 24 - Groundwater
Charleston Naval Complex, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Background	Units	Number Exceeding RBC	Bkgd
Volatile Organics													
Tetrachloroethene		1	8	0.87	0.87	0.87	1	5	1.1	NA	UG/L		
Semivolatile Organics													
bis(2-Ethylhexyl)phthalate		1	8	2	2	2	10	11	4.8	NA	UG/L		
Inorganics													
Aluminum (Al)		8	8	14.3	429	160	NA	NA	3700	692	UG/L		
Arsenic (As)	*	7	8	5.6	86.1	26	3.3	3.3	0.045	17.8	UG/L	7	2
Barium (Ba)		8	8	9.2	57.05	30	NA	NA	260	31	UG/L		3
Calcium (Ca)	N	8	8	3020	37700	20159	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	8	0.78	0.78	0.78	0.7	1.3	11	3.88	UG/L		
Cobalt (Co)		6	8	0.91	3.9	2.0	0.9	1	220	1.45	UG/L		4
Iron (Fe)	N	8	8	1460	5770	2955	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	8	8	1300	36950	14188	NA	NA	NA	NA	UG/L		
Manganese (Mn)		8	8	50.2	208	135	NA	NA	73	2906	UG/L	5	
Nickel (Ni)		2	8	1.4	2	1.7	1	1.1	73	4.08	UG/L		
Potassium (K)	N	7	8	611	22400	10729	495	495	NA	NA	UG/L		
Selenium (Se)		1	8	5	5	5	3.1	4.1	18	4.3	UG/L		1
Sodium (Na)	N	8	8	25100	344000	127094	8620	18400	NA	NA	UG/L		
Vanadium (V)		2	8	0.97	1.15	1.1	0.7	2.5	26	15.4	UG/L		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/L - micrograms per liter
NA - Not applicable or not available
N - Essential Nutrient

qualitatively in relation to the future workers. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because existing site features limit their soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact with surface soil and incidental ingestion of surface soils. The exposure pathways for current and future site workers are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. The groundwater pathway for the hypothetical future site residents and site workers is ingestion of groundwater. No volatile COPC were identified for groundwater and, as a result, the inhalation pathway was not considered for SWMU 24. Table 10.15.13 presents the justification for exposure pathways assessed in this HHRA.

Table 10.15.13
Exposure Pathways Summary — SWMU 24
Charleston Naval Complex — Zone G
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant relative to other soil exposure pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or process water at SWMU 24.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or process water at SWMU 24.

Table 10.15.13
Exposure Pathways Summary — SWMU 24
Charleston Naval Complex — Zone G
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant relative to other soil exposure pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable water at SWMU 24, however, this pathway was considered as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No volatile COPCs were identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, 95% UCLs are calculated for data sets of 10 or more. As a result, the EPC for BEQs was set equal to the maximum reported concentration since there were only two soil samples analyzed for BEQs. The data from a total of 8 groundwater samples were evaluated for SWMU 24 groundwater. As a result, the EPC for arsenic was set equal to the maximum reported concentration.

Quantification of Exposure

Soil

CDIs for ingestion of soils, dermal contact with soils, calculated as described in Section 7, are shown in Tables 10.15.14 and 10.15.15, respectively.

Groundwater

The CDIs for groundwater ingestion are presented in Table 10.15.16.

10.15.10.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.15.17 presents toxicological information specific to each COPC identified at SWMU 24. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen, et al., 1986). USEPA set 0.3 μg/kg-day as the oral RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in an epidemiological study. As listed in IRIS the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the oral and inhalation SF at 1.5 $(mg/kg\text{-}day)^{-1}$. As listed in IRIS the basis for the classification is sufficient evidence from

Table 10.15.14
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Site Worker adult H-CDI (mg/kg-day)	Site Worker adult C-CDI (mg/kg-day)
Semivolatile Organics							
Benzo(a)pyrene equivalent	1	2.5	3.43E-06	3.20E-05	3.92E-06	1.22E-06	4.37E-07

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.15.15
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Site Worker adult H-CDI (mg/kg-day)	Site Worker adult C-CDI (mg/kg-day)
Semivolatile Organics								
Benzo(a)pyrene Equivalent	2.5	1	0.01	1.40E-06	4.64E-06	8.79E-07	1.00E-06	3.58E-07

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.15.16
Chronic Daily Intakes (CDI)
Ingestion of COPCs in Groundwater
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Site Worker adult H-CDI (mg/kg-day)	Site Worker adult C-CDI (mg/kg-day)
Inorganics						
Arsenic	0.0861	2.36E-03	5.50E-03	1.30E-03	8.42E-04	3.01E-04

NOTES:
lwa Lifetime weighted average
CDI Chronic Daily Intake
H-CDI Noncarcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.15.17

Toxicological Reference Information

for Chemicals of Potential Concern

SWMU 24

Charleston Naval Complex, Zone G

Charleston, South Carolina

	Non-Carcinogenic Toxicity Data									*Carcinogenic Toxicity Data*					
Chemical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
Arsenic	0.0003	a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5	a	15.1	a	A	various
Benzo(a)pyrene equiv.	NA		NA	NA	NA	NA	NA	NA	NA	7.3	a	3.1	e	B2	mutagen

Notes:

a = Integrated Risk Information System (IRIS)

b = Health Effects Assessment Summary Tables (HEAST)

c = HEAST alternative method

d = Toxicity values cross assigned from alpha-BHC

e = EPA-NCEA regional support value

NA = Not applicable or not available

H = High confidence

L = Low confidence

M = Medium confidence

human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic.

BEQs include the following list of PAHs:

Benzo(a)anthracene		TEF	0.1
Benzo(b)fluoranthene	TEF	0.1	
Dibenz(a,h)anthracene	TEF	1.0	
Benzo(k)fluoranthene	TEF	0.01	
Benzo(a)pyrene	TEF	1.0	
Indeno(1,2,3-cd)pyrene	TEF	0.1	
Chrysene		TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF of 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is animal data. Human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. (Klaassen, et al., 1986).

10.15.10.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and site worker scenarios. For these scenarios, the incidental ingestion of surface soil and dermal contact with surface soil were the evaluated exposure pathways. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.15.18 and 10.15.19 present the computed carcinogenic risks for the ingestion and dermal contact pathways, respectively.

Hypothetical Site Residents

The ILCRs (based on the adult and child lifetime weighted average) for SWMU 24 surface soils are 3E-05 for the ingestion pathway and 1E-05 for the dermal pathway. BEQs were the primary contributors to the ingestion and dermal pathways.

Table 10.15.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 24
Charleston Naval Complex - Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Site Worker adult Hazard Quotient	Site Worker adult ILCR
Semivolatile Organics							
Benzo(a)pyrene equivalent	NA	7.3	ND	ND	2.9E-05	ND	3.2E-06
SUM Hazard Index/ILCR			ND	ND	3E-05	ND	3E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.15.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Site Worker adult Hazard Quotient	Site Worker adult ILCR
Semivolatile Organics	-		-					
Benzo(a)pyrene equivalent	0.5	NA	14.6	ND	ND	1.3E-05	ND	5.2E-06
SUM Hazard Index/ILCR				ND	ND	1E-05	ND	5E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 10.15.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
SWMU 24
Charleston Naval Complex, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used $(mg/kg\text{-}day)^{-1}$	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Site Worker adult Hazard Quotient	Site Worker adult ILCR
Inorganics							
Arsenic	0.0003	1.5	7.9	18	1.9E-03	2.8	4.5E-04
SUM Hazard Index/ILCR			8	18	2E-03	3	5E-04

Notes:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Hypothetical Site Workers

Site worker ILCRs for surface soil are 3E-06 for the ingestion pathway and 5E-06 for the dermal pathway. BEQs were the primary contributors for the ingestion and dermal pathways.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under residential and site worker scenarios. The ingestion exposure pathway was evaluated assuming the site groundwater will be used as potable and/or process water and that an unfiltered well, drawing from the corresponding water bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.15.20 presents the risk and hazard for the ingestion pathway.

Hypothetical Site Residents

The ingestion ILCR for SWMU 24 shallow groundwater (based on the adult and child lifetime weighted average) is 2E-03, with arsenic as the primary contributor to ILCR projections. The HIs for the adult and child resident are 8 and 18, respectively. Arsenic is the primary contributor to ingestion HI.

Hypothetical Site Workers

The site worker ingestion ILCR for SWMU 24 shallow groundwater is 5E-04, with arsenic as the primary contributor to ILCR projections. The site worker ingestion HI is 3. Arsenic is the primary contributor to ingestion HI.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for SWMU 24 or other areas of Zone G. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. Table 10.15.21 presents the COCs identified for SWMU 24 surface soil and shallow groundwater.

Surface Soils

Future Site Residents

BEQs were identified as soil pathway COCs based on their contribution to cumulative ILCR projections.

Future Site Workers

BEQs were identified as soil pathway COCs based on their contribution to cumulative ILCR projections.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential soil RBCs were compared to each reported concentration for each COC. BEQs were detected above the residential RBC in one surface soil sample collected for SWMU 24. The highest was reported in sample FDSSH02601.

Table 10.15.21
Summary of Risk and Hazard-based COCs
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Semivolatile Organics**						
		Benzo(a)pyrene equivalents	ND	ND	2.9E-05	ND	3.2E-06	2 4
	Dermal Contact	**Semivolatile Organics**						
		Benzo(a)pyrene equivalents	ND	ND	1.3E-05	ND	5.2E-06	2 4
Surface Soil Pathway Sum			ND	ND	4E-05	ND	8E-06	
Groundwater Pathways	Ingestion	**Inorganics**						
		Arsenic	7.9	18	1.9E-03	2.8	4.5E-04	1 2 3 4
Groundwater Pathway Sum			8	18	2E-03	3	5E-04	
Sum of All Pathways			8	18	2E-03	3	5E-04	

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Groundwater

Future Site Residents

Arsenic was identified as the groundwater COCs for SWMU 24 based on its contribution to ILCR and HI projections.

Future Site Workers

Arsenic was identified as the groundwater COCs for SWMU 24 based on its contribution to ILCR and HI projections.

The extent of the COCs identified in groundwater is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, tap water RBCs were compared to each reported concentration for each COC identified above. Arsenic was detected in three of four first round groundwater samples at concentrations exceeding its RBC and in only one first round sample (NBCG024001) at a concentration exceeding its background reference concentration. Arsenic was detected in all four second round samples at concentrations above its RBC and in only one second round sample (NBCG024001) at a concentration exceeding its background reference concentration.

10.15.10.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Residential use of the site would not be expected, based on current site uses and the nature of surrounding features. Current reuse plans call for continued commercial/industrial or recreational use of Zone G. If this area were to be used as a residential site, existing features would be demolished, and the surface soil conditions would likely change — the soils could be covered with

landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at SWMU 24 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone G. This system is planned to remain in operation under the current base reuse plan. As a result, use of shallow groundwater would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Exposure point concentrations for soil COPCs were set equal to the maximum reported concentration. Groundwater risk/hazard was calculated using the maximum reported concentration of the identified COPC. It is likely that the use maximum concentrations as EPCs results in an overestimation of risk and hazard.

Frequency of Detection and Spatial Distribution

Out of the 16 surface soil samples collected for SWMU 24, two were analyzed for BEQs (FDSSH02401 and FDSSH02601). Surface soil sample FDSSH02401 is located just to the east of Tank 39-D and reported a BEQ concentration of 51.5 μg/kg which is below its residential RBC for soil. Surface soil sample FDSSH02601 is located just to the north of Tank 39-A and reported a BEQ concentration of 2,501 μg/kg. As a result, the estimated risk associated with the SWMU 24 surface soil pathways is more characteristic of the area around Tank 39-A and not Tank 39-D.

Out of the 8 groundwater samples collected for SWMU 24, only two reported arsenic concentrations above its background reference concentration of 17.8 μg/L. Both groundwater samples were collected from monitoring well 024001 (first round 47.2 μg/L, second round 86.1 μg/L). Monitoring well 024001 is located west of Tank 39-A, across Wood Street.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty and variability inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for SWMU 24. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Groundwater is not currently used as a potable water source at SWMU 24, nor is it used at CNC or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable source of potable water.

Background-related Risk

Soil

Aluminum, arsenic, and manganese were reported in SWMU 24 surface soil at concentrations above their respective RBCs. These inorganics were eliminated from consideration in the formal risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed RBCs. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of these elements.

The surface soil background concentration for arsenic (17.8 mg/kg) equates with a risk of approximately 5E-05 and a hazard quotient of approximately 0.8. The maximum reported concentration of arsenic in SWMU 24 surface soil (3.9 mg/kg) equates with a risk of approximately 1E-05 and a hazard quotient of approximately 0.2. The surface soil background concentration for aluminum (18700 mg/kg) equates with a hazard quotient of approximately 0.3. The maximum reported concentration of aluminum in SWMU 24 surface soil (7,850 mg/kg) equates with a hazard quotient of 0.1. The surface soil background concentration for manganese (325 mg/kg) equates with a hazard quotient of approximately 0.09. The maximum reported concentration of manganese in SWMU 24 surface soil (109 mg/kg) equates with a hazard quotient of 0.03.

Groundwater

Manganese was reported in SWMU 24 groundwater at concentrations above its tap water RBC and was eliminated from consideration in the formal risk assessment based on comparison to its background concentration. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of manganese. The background concentration of manganese for groundwater (2,906 μg/L) equates with a hazard quotient of approximately 3. The maximum concentration of manganese reported in SWMU 24 groundwater (208 μg/L) equates with a hazard quotient of approximately 0.2.

10.15.10.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 24 were assessed for the future site worker and the future site resident under RME assumptions. For surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The groundwater risk and hazard were based on ingestion of shallow groundwater as represented by two rounds of groundwater sampling data. Table 10.15.22 presents the risk summary for each pathway/receptor group evaluated for SWMU 24.

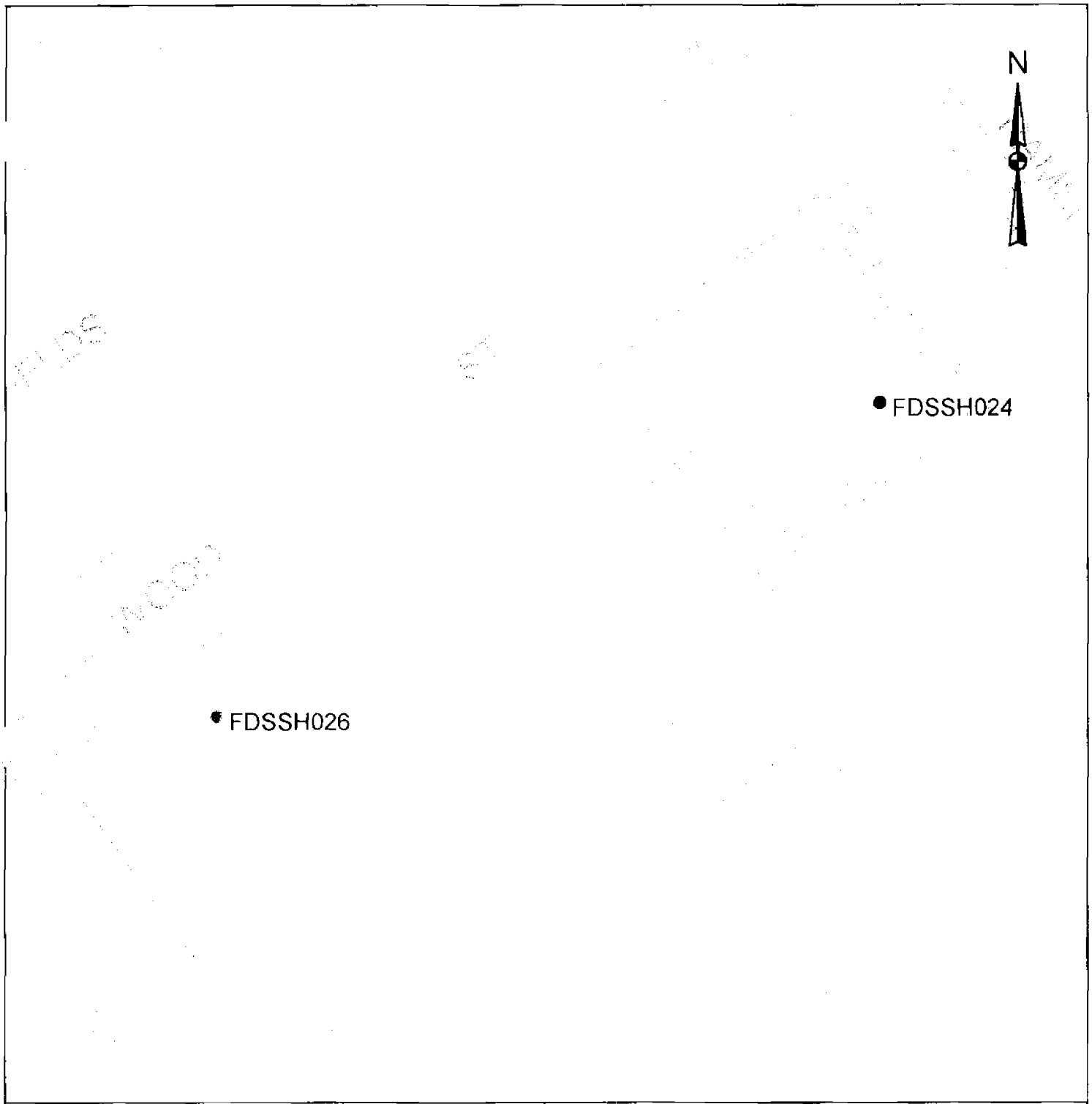
Soil — Residential Scenario

Residential soil pathway COCs identified for SWMU 24 include BEQs. Figure 10.15-6 illustrate point risk estimates for SWMU 24 surface soil pathways under a residential scenario. Table 10.15.23 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Table 10.15.22
Summary of Risk and Hazard
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	3E-05	ND	3E-06
	Dermal Contact	ND	ND	1E-05	ND	5E-06
Groundwater	Ingestion	8	18	2E-03	3	5E-04
Sum of All Pathways		8	18	2E-03	3	5E-04

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

70 0 70 140 Feet

ZONE G - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.15-6
SWMU 24

POINT RISK ESTIMATES FOR
SURFACE SOIL
RESIDENTIAL SCENARIO

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Table 10.15.23
Point Estimates of Risk - Surface Soil Pathways
Residential Scenario
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
FDS	SH024	B(a)P Equiv.	51.5	UG/KG	NA	0.85
FDS	SH026	B(a)P Equiv.	2501	UG/KG	NA	41.42

Risk estimates associated with the surface soil pathways exceeded 1E-06 at only one location (FDSSH026) with BEQs as the primary contributors. Risks estimates ranged from 9E-07 to 4E-05.

Soil — Site Worker Scenario

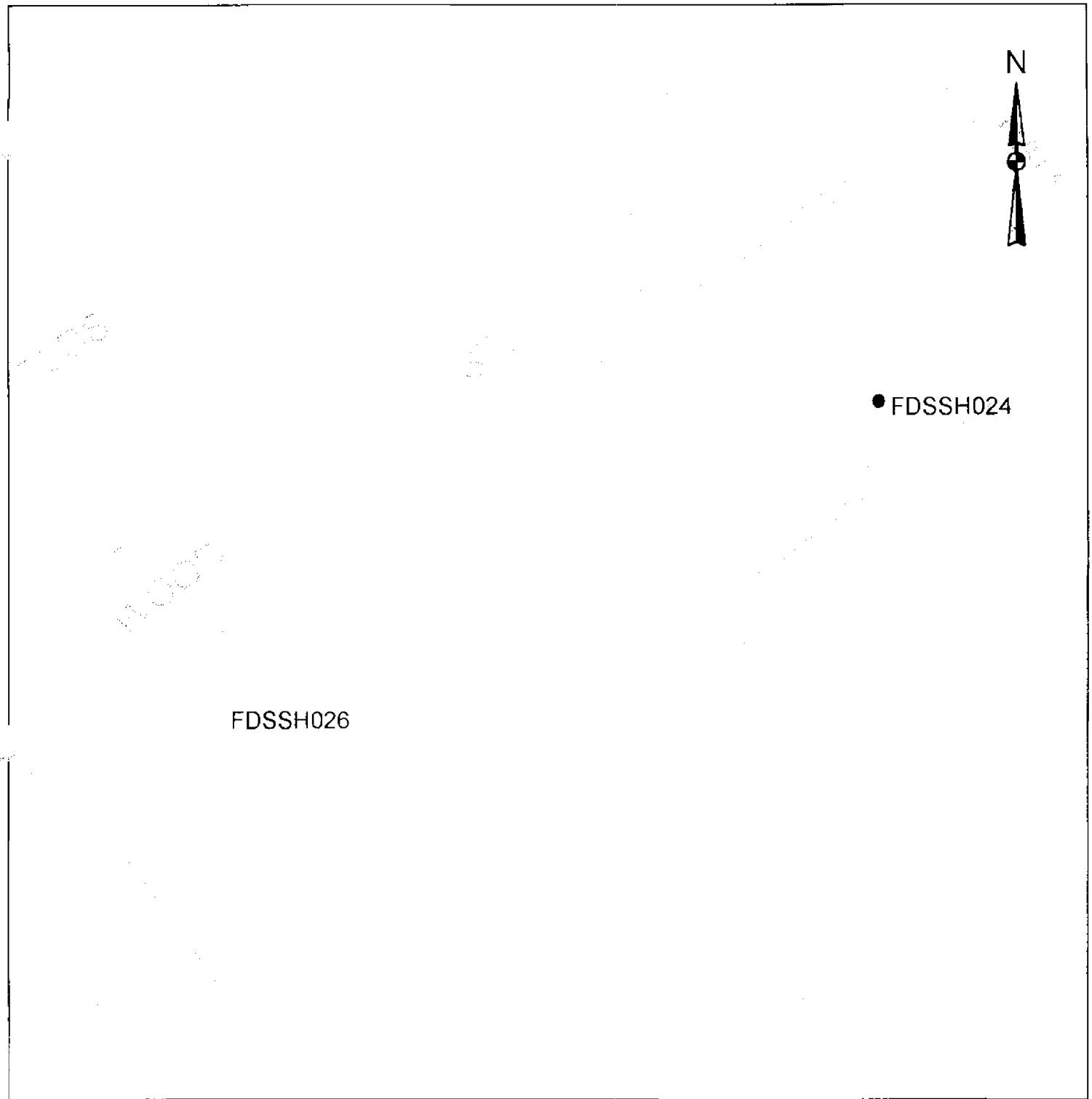
BEQs were identified as site worker soil pathway COCs for SWMU 24. Figure 10.15-7 illustrates point risk for SWMU 24 surface soil pathways under a site worker scenario. Table 10.15.24 summarizes the risk and hazard contribution of each COPC at each sample location. Risk estimates exceeded 1E-06 at only one location (FDSSH026) with BEQs as the primary contributors. Site worker risk estimates ranged from 2E-07 to 8E-06.

Groundwater — Residential Scenario

The residential groundwater pathway COC identified for SWMU 24 is arsenic. Figures 10.15-8 and 10.15-9 illustrate point risk and hazard estimates for SWMU 24 groundwater pathways under a residential scenario. Table 10.15.25 summarizes the risk and hazard contribution of each COPC at each monitoring well location and each sampling round. Arsenic was the primary contributor to both risk and hazard estimates at all four groundwater sample locations. Risk estimates ranged from 1E-04 (024002 second round) to 2E-03 (024001 second round). Hazard indices ranged from 1 to 18.

Groundwater — Site Worker Scenario

The site worker groundwater pathway COC identified for SWMU 24 is arsenic. SWMU 24 groundwater is not currently used as a source of potable or process water nor is it anticipated to be used in the future. Risk and hazard projections under the site worker are less conservative than those calculated under the residential site use scenario. Therefore any remedial decisions regarding groundwater should consider the residential risk assessment.



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

70 0 70 140 Feet

ZONE G - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.15-7
SWMU 24

POINT RISK ESTIMATES FOR
SURFACE SOIL
INDUSTRIAL SCENARIO

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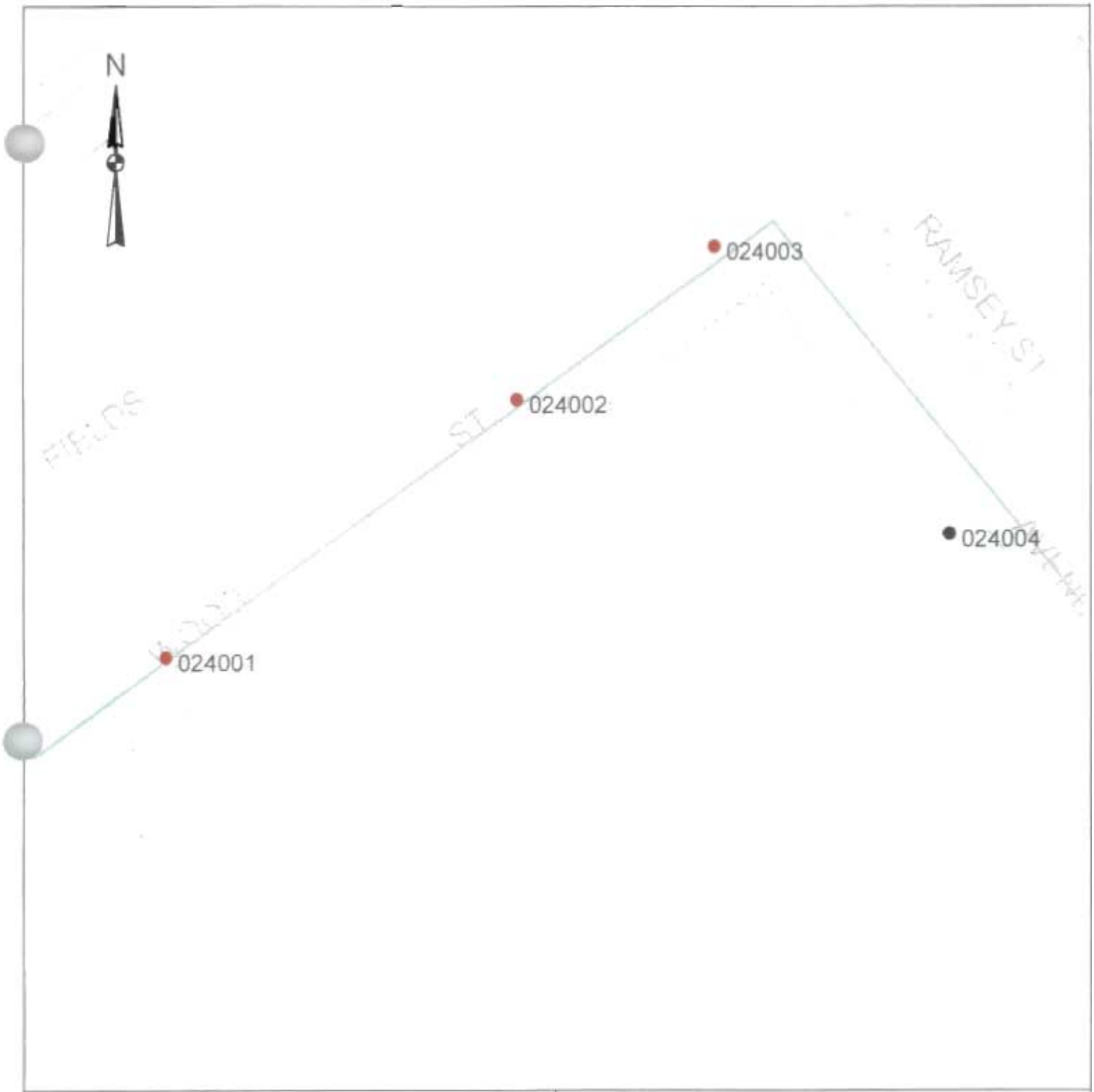
Table 10.15.24
Point Estimates of Risk - Surface Soil Pathways
Site Worker Scenario
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
FDS	SH024	B(a)P Equiv.	51.5	UG/KG	NA	0.17
FDS	SH026	B(a)P Equiv.	2501	UG/KG	NA	8.42



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

80 0 80 160 Feet

ZONE G - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.15-8
SWMU 24

POINT RISK ESTIMATES FOR
GROUNDWATER
RESIDENTIAL SCENARIO

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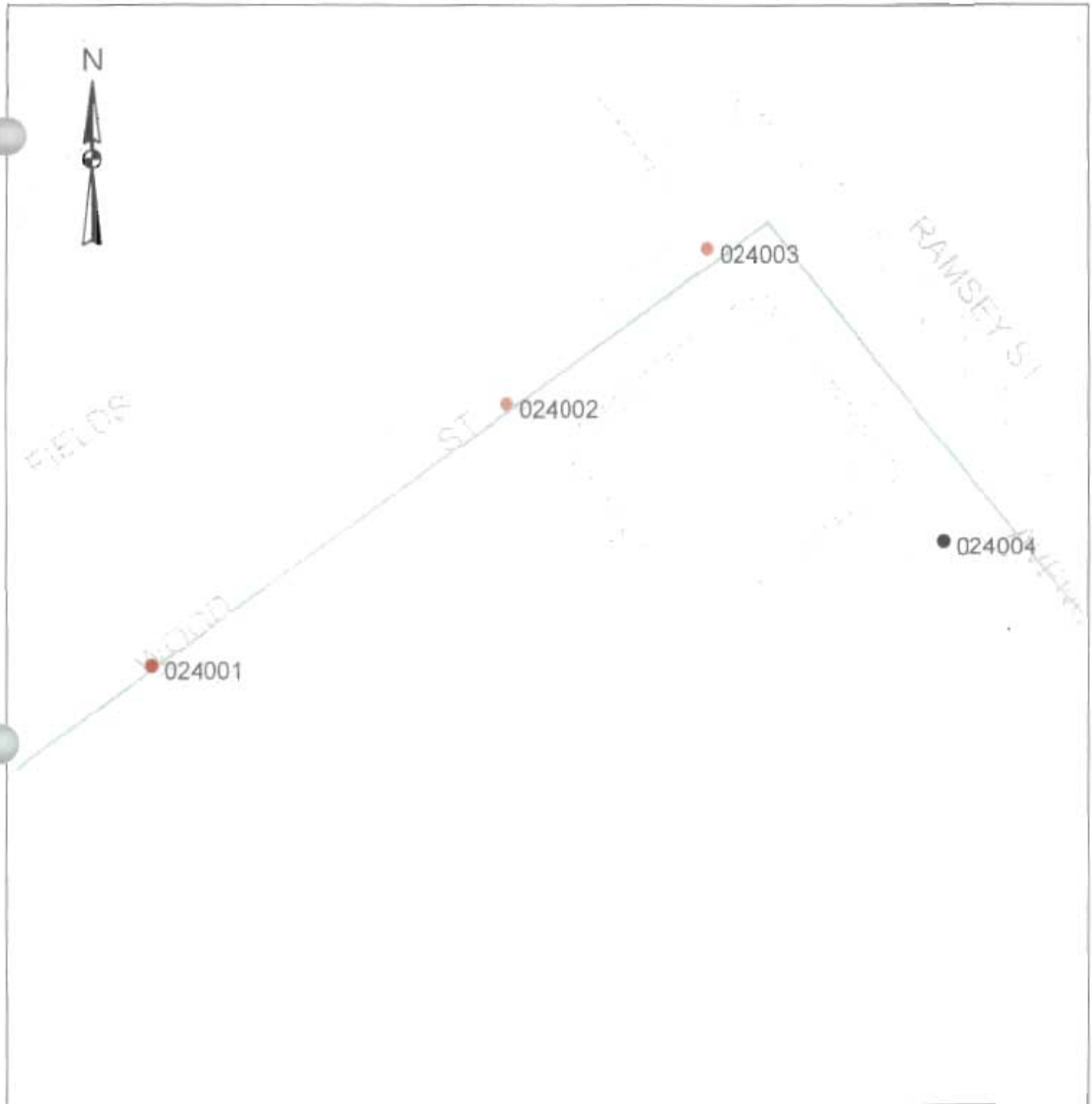

LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

80 0 80 160 Feet

ZONE G - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.15-9
SWMU 24

POINT HAZARD ESTIMATES FOR
GROUNDWATER
RESIDENTIAL SCENARIO

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Table 10.15.25
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Site	Location	Round	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
024	001	01	Arsenic (As)	47.2	UG/L	10.06	1053
024	001	02	Arsenic (As)	86.1	UG/L	18.35	1921
024	002	01	Arsenic (As)	6.5	UG/L	1.39	145
024	002	02	Arsenic (As)	5.6	UG/L	1.19	125
024	003	01	Arsenic (As)	10.5	UG/L	2.24	234
024	003	02	Arsenic (As)	16.4	UG/L	3.49	366
024	004	01	No COPCs	NA	UG/L	NA	NA
024	004	02	Arsenic (As)	8.9	UG/L	1.90	199

10.15.10.8 Remedial Goal Options

Soil

Risk-based residential RGOs for surface soil were based on the lifetime weighted average risk for the site resident as presented in Table 10.15.26. Risk-based site worker RGOs were based on the site worker scenario.

Groundwater

Risk-based residential RGOs for groundwater were based on the lifetime weighted average risk for the site resident as shown in Table 10.15.27. Risk-based site worker RGOs were based on the site worker scenario. Residential hazard-based RGOs were calculated based on the child resident and site worker hazard-based RGOs were calculated based on the site worker scenario.

10.15.11 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for SMWU 24, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in an industrial setting, however risk to human health was evaluated under both the residential and industrial (site worker) scenarios for incidental ingestion and dermal contact exposure pathways. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

BEQs were identified as soil pathway COCs for SMWU 24. Arsenic was identified as a groundwater pathway COC for SMWU 24. Table 10.15.27 presents cumulative and COC-specific exposure risks and hazard quotients.

Table 10.15.26
Remedial Goal Options Surface Soil
SWMU 24
Charelston Naval Complex, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Semivolatile Organics										
Benzo(a)pyrene Equivalents	7.3	NA	2.5	ND	ND	ND	0.060	0.60	6.0	NA

Worker-Based Remedial Goal Options

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Semivolatile Organics										
Benzo(a)pyrene Equivalents	7.3	NA	2.5	ND	ND	ND	0.30	3.0	30	NA

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.15.27
Remedial Goal Options Groundwater
SWMU 24
Charleston Naval Complex, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)$^{-1}$	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options **0.1** mg/l	**1.0** mg/l	**3** mg/l	Risk-Based Remedial Goal Options **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	Background Concentration mg/l	MCL mg/l
Inorganics											
Arsenic	1.5	0.0003	0.0861	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.0178	0.05

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Risk-based remedial goals for the COCs at SMWU 24 for soil and groundwater are presented in Tables 10.15.26 and 10.15.27, respectively. Potential corrective measures are presented in Table 10.15.28.

Table 10.15.28
Zone G
SWMU 24
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
BEQs	8E-06	4E-05	ND	ND
Cumulative	8E-06	4E-05	2.8	ND
Groundwater				
Arsenic	5.0E-04	2.0E-03	2.8	18
Cumulative	5.0E-04	2.0E-03	2.8	18

Notes:
ND = Not Determined

Table 10.15.29
Zone G
SWMU 24
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No Action b) Excavate, offsite disposal, and monitoring c) Containment/Capping
Groundwater	Arsenic	a) No Action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

SECTION 11

11.0 CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

The RFI in Zone G was conducted to determine which sites, if any, designated as AOCs and/or SWMUs during the RFA pose unacceptable risk to human health or the environment (ecological concerns) and will require additional evaluation under the CMS. The conclusions reached regarding each site are based on a technical evaluation of the data following procedures outlined in the NAVBASE Charleston *Comprehensive RFI Work Plan*, regulatory guidance, and as required by the Part B permit. The NAVBASE Charleston project team has established a conservative protocol for using risk and hazard based thresholds to make preliminary recommendations for each site. The recommendations will be for no further action, additional evaluation under the CMS, additional sampling needed to complete the RFI (in which case an addendum to the report will be required). The protocol for determining which course of action may be appropriate is as follows:

- NFA - Human health risks do not exceed the 1E-06 residential ILCR and the hazard index is <1. Potential risk to ecological receptors is low based on the criteria described in Section 11.15.

- CMS - One or more of the thresholds listed above for NFA is exceeded.

- Additional Sampling Required - Data gaps exist for one or more media investigated. The data gaps are significant enough to preclude a NFA or CMS recommendation.

The recommendations are to be considered preliminary until the risk managers with the USEPA, SCDHEC, and the Navy have reviewed the data and a final decision is reached. The reason being that the USEPA and SCDHEC generally find a residential risk range of 1E-04 to 1E-06 acceptable for human health because of the conservative nature of the baseline risk assessment. This means some sites currently recommended for CMS may not require any further action once all the weight of evidence such as frequency of detection/spatial distribution, realistic exposure potential, nature

of contaminants driving risk, data trends for quarterly groundwater monitoring events, etc. are considered. No further action recommendations are not acceptable for sites where a potential risk exists under a residential scenario even though an industrial reuse of the property is expected since institutional controls for the site will be required. Final recommendations and the rationale for the risk management decisions will be documented in the final version of this report.

A summary of the preliminary recommendations for all the sites investigated in Zone G is included in Table 11.1.

Table 11.1
Site Conclusions and Zone G Preliminary Recommendations

Site Designation	Conclusion/Recommendations
AOC 628	Recommended for CMS - Surface Soil
AOC 633	No Further Action
AOC 634	No Further Action
AOC 638	Recommended for CMS - Surface Soil
AOC 642	Recommended for CMS - Surface Soil
SWMU 8, AOC 636	Recommended for CMS - Surface Soil and Shallow Groundwater
AOC 637	Recommended for CMS - Surface Soil and Shallow Groundwater
SWMU 11	Recommended for CMS - Surface Soil
SWMU 120	Recommended for CMS - Surface Soil and Shallow Groundwater
AOC 643	Recommended for CMS - Surface Soil
SWMU 3	Recommended for CMS - Surface Soil and Shallow Groundwater
SWMU 6, 7 and AOC 635	Recommended for CMS - Surface Soil and Shallow Groundwater
AOC 646	Recommended for CMS - Surface Soil
AOC 706	Recommended for CMS - Shallow Groundwater
SWMU 24	Recommended for CMS - Surface Soil and Shallow Groundwater

The following sections summarize the recommendations for each site, level of risk/hazard posed by each of the sites recommended for corrective measures, the media affected, and the chemicals driving risk.

11.1 AOC 628, Sandblasting Area, Southeast of Building 68

A CSI site, AOC 628 is a fenced area southeast of Building 68 that was used from 1962 to 1967 for abrasive blasting of large metal parts, including ship parts. Materials released, stored or disposed of included spent blasting media, paint and metallic residues, organic solvent wastes, and petroleum products.

This site is recommended for a surface soil CMS based on an ILCR of 6.2E-05 and HI of 1.07. Table 11.2 lists the affected media, the risk/hazard, and the chemicals that drove the risk.

Table 11.2
AOC 628
Conclusion Summary

Affected Media	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface Soil	Yes - ILCR = 6.2E-05 Yes - HI = 1.07	Arsenic, BEQs Arsenic, Chromium

11.2 AOC 633, Substation, Building 451C

A CSI site, AOC 633 is located near Building 451C, an electrical substation built in 1943. The building is a block structure with a concrete roof and floor, several steel enclosures on concrete slabs and foundations from earlier buildings. Several high voltage switches, breakers and transformers are located in the two room block structure. Several large PCB releases have been documented from this site.

No COCs were identified at AOC 633, which indicates no threat to current or future human receptors. Therefore, no further action is recommended for this site. Table 11.3 lists the affected medium and the COPCs driving risk at AOC 633.

Table 11.3
AOC 633
Conclusion Summary

Affected Media	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	No ILCR = 7.4E-07 No HI = ND	Aroclor-1260

11.3 AOC 634, Flammable Material Storage, Building 1814

A CSI site, AOC 634 is located at Building 1814, a former flammable materials storage facility. Built in 1977, Building 1814 was used until 1992 to store small (less than one gallon) containers of flammable material. The building is no longer used, and the 1995 RFA cited that the roof of the building and its surrounding chain link fence have been removed. Paint and flammable materials were stored at this facility.

Based on the analytical results and the human health risk assessment for AOC 634, no COPCs or COCs have been identified. Arsenic and beryllium were detected in surface soil samples at concentrations exceeding their RBCs but lower than their background concentrations. As a result, arsenic and beryllium were eliminated as COPCs based on comparison to their background concentrations. Consequently no further action is required at AOC 634.

11.4 AOC 638, Former Torpedo Workshop, Building 132

A CSI site, AOC 638 is the former torpedo workshop at Building 132, which was used from 1944 until 1991. Building 132 is on the northeast corner of the intersection of Brumby Street and Hobson Avenue. From 1991 to 1995, the building was used by the Public Works Department for equipment and parts storage. The building is currently vacant.

AOC 638 is recommended for a surface soil CMS based on an ILCR of 4.0E-06. No COPCs or COCs were identified in the shallow groundwater at AOC 638, while indicates no threat to current or future human receptors. Table 11.4 lists the affected medium, the risk/hazard, and the chemicals that drive the risk.

Table 11.4
AOC 638
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard Future Residential Scenario	Chemicals Driving Risk
Surface Soil	Yes - ILCR = 4.0E-06 No - HI =ND	BEQs

11.5 AOC 642, Former Pistol Range, Present Parking Lot

A CSI site, AOC 642 is the former pistol range located south of Building X-10, and west of Buildings X-12 and 1431. Hobson Avenue is to the north, while Dyess Avenue is south of the site. The site is currently a fenced, asphalt paved, parking area. The area was used as a pistol range during the 1940s. It is unknown if any spent lead bullets were removed from the site.

AOC 642 soil has been recommended for a surface soil CMS based on an ILCR of 1.5E-04 and HI of 2.83.

Table 11.5 lists the affected medium, the risk/hazard, and the chemical(s) that drive the risk.

Table 11.5
AOC 642
Conclusion Summary

Affected Media	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 1.5E-04 Yes - HI = 2.83	Arsenic, Beryllium Arsenic, Nickel and Thallium

11.6 SWMU 8, Oil Sludge Pit; AOC 636, Torpedo Magazine, Building 161 Area

These sites were combined into one investigation due to their close proximity and their potential for similar COPCs. The approved final RFI work plan also grouped AOC 637 into this combined SWMU 8 and AOC 636 investigation. AOC 637 was investigated separately because subsurface conditions are different at this site. SWMU 8 (a RFI site) and AOC 636 (a CSI site) are located in an area bound by Hobson Avenue to the north, Dyess Avenue to the south, Brumby Street to the west, and the Building X-10 compound (AOC 642) to the east. The SWMU 8 area contained three unlined pits which were used to dispose of oil sludge from 1944 to 1977. The pits have since been filled. The area is currently a gravel paved parking area.

AOC 636 is the former torpedo magazine where subsurface disposal of unused torpedoes and munitions alledgedly occurred prior to 1944. The AOC 636 area was primarily marshlands at the time. This area has since been filled with dredged materials. Currently, the AOC 636 area contain Building 161 and an asphalt paved parking lot.

A CMS is recommended for soil and groundwater at the combined SWMU 8 and AOC 636 based on a ILCRs of 6.2E-05 and 9.7E-06 respectively. In addition, HIs of 1.21 and 9.3 contributed

to this recommendation. Table 11.6 lists the affected medium, the risk/hazard, and the chemicals that drive the risk.

Table 11.6
SWMU 8 and AOC 636
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 6.2E-05 Yes - HI = 1.21	Arsenic, and BEQs Arsenic, thallium and chromium
Shallow Groundwater	Yes - ILCR = 9.7E-06 Yes - HI = 9.3	Bis(2-ethylhexyl)phthalate Thallium, antimony and barium

Although AOC 637 and the combined SWMU 8 and AOC 636 sites were investigated independently, the CMS for shallow groundwater should address these sites and the adjacent SWMU 9 (Zone H) as one study. This recommendation is based on the analytes detected and the overall groundwater flow regime which connects these sites and controls distribution of these contaminants. Benzene, antimony, arsenic, barium, beryllium and thallium are the most commonly detected COCs in shallow groundwater. Figures 11-1 through 11-6 illustrate the distribution of these COCs across Zone G.

11.7 AOC 637, Dump Area, Building 161 Area

A CSI site, AOC 637 was grouped for investigation with SWMU 8 and AOC 636 in the approved final RFI work plan. However, because subsurface conditions are different at this site it was investigated separately. The site is a former burning dump located between Dyess Avenue and Bainbridge Avenue directly south of SWMU 8 and AOC 636. The area was used from the late 1940s to the early 1950s. Although no spills or releases were documented at this site, the burning

to this recommendation. Table 11.6 lists the affected medium, the risk/hazard, and the chemicals that drive the risk.

Table 11.6
SWMU 8 and AOC 636
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 6.2E-05 Yes - HI = 1.21	Arsenic, and BEQs Arsenic, thallium and chromium
Shallow Groundwater	Yes - ILCR = 9.7E-06 Yes - HI = 9.3	Bis(2-ethylhexyl)phthalate Thallium, antimony and barium

Although AOC 637 and the combined SWMU 8 and AOC 636 sites were investigated independently, the CMS for shallow groundwater should address these sites and the adjacent SWMU 9 (Zone H) as one study. This recommendation is based on the analytes detected and the overall groundwater flow regime which connects these sites and controls distribution of these contaminants. Benzene, antimony, arsenic, barium, beryllium and thallium are the most commonly detected COCs in shallow groundwater. Figures 11-1 through 11-6 illustrate the distribution of these COCs across Zone G.

11.7 AOC 637, Dump Area, Building 161 Area

A CSI site, AOC 637 was grouped for investigation with SWMU 8 and AOC 636 in the approved final RFI work plan. However, because subsurface conditions are different at this site it was investigated separately. The site is a former burning dump located between Dyess Avenue and Bainbridge Avenue directly south of SWMU 8 and AOC 636. The area was used from the late 1940s to the early 1950s. Although no spills or releases were documented at this site, the burning

LEGEND

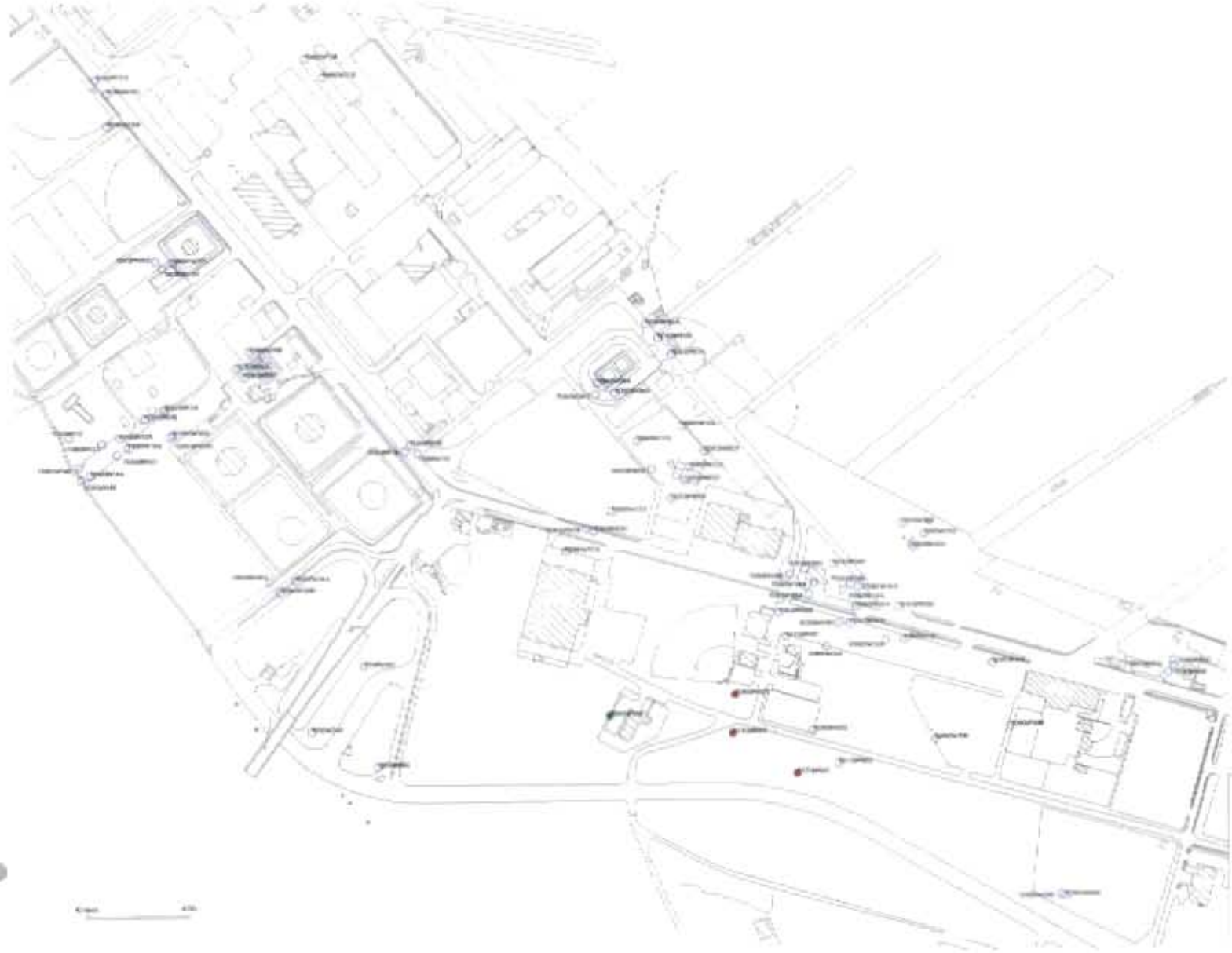
- > MCL
- RBC to MCL
- < RBC
- Non-Detect/No Data

MCL = 5 ug/l

RBC = .036 ug/l

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 11-1
Benzene in Shallow Groundwater



LEGEND

- > MCL
- Background to MCL
- < Background
- Non-Detect/No Data

MCL = 6 ug/l

Background = 4.85 ug/l

ZONE G - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 11-2
Antimony in Shallow Groundwater

LEGEND

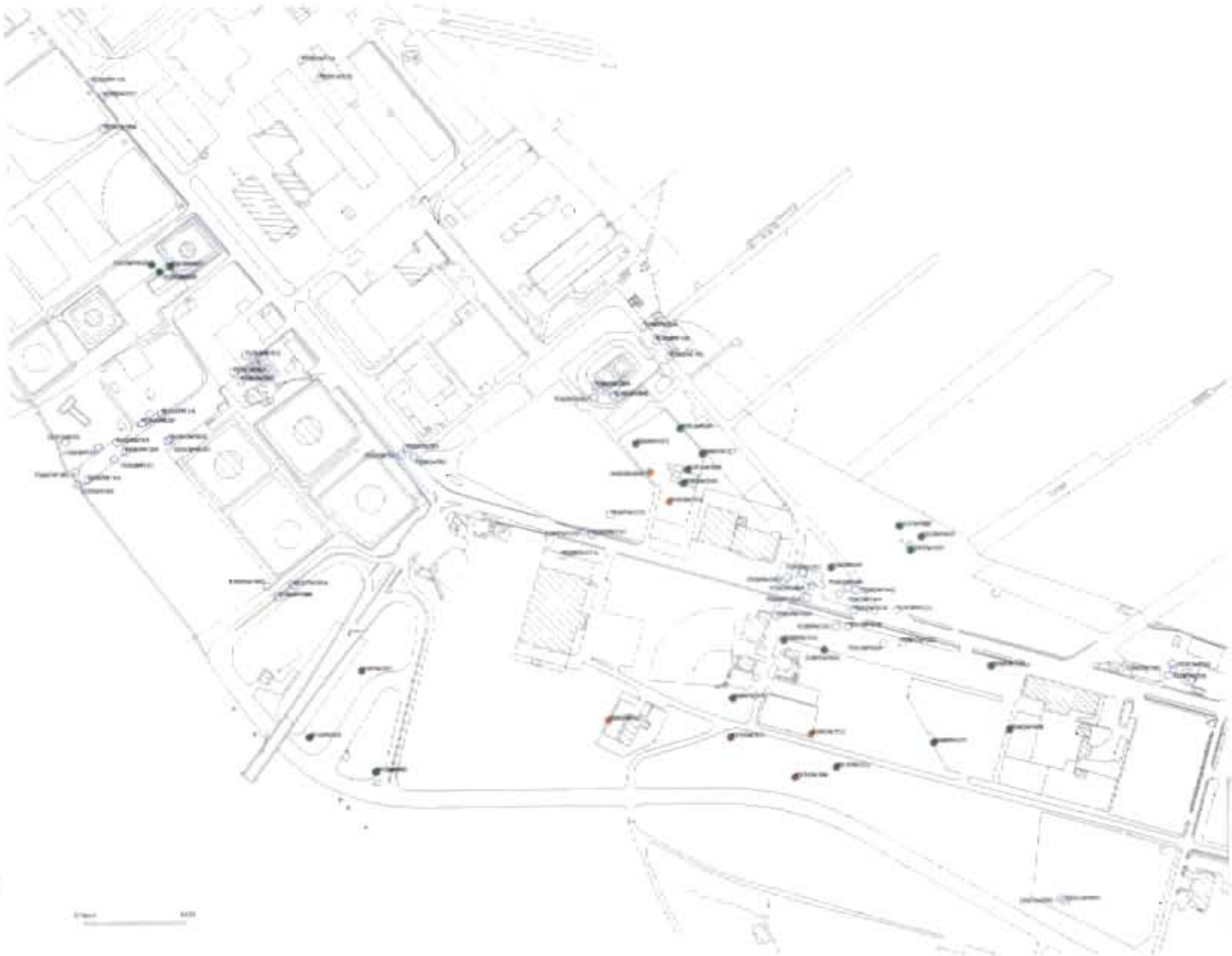
- > MCL
- Background to MCL
- < Background
- Non-Detect/No Data

MCL = 50 ug/l

Background = 17.8 ug/l

ZONE G - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 11-3
Arsenic in Shallow Groundwater



LEGEND

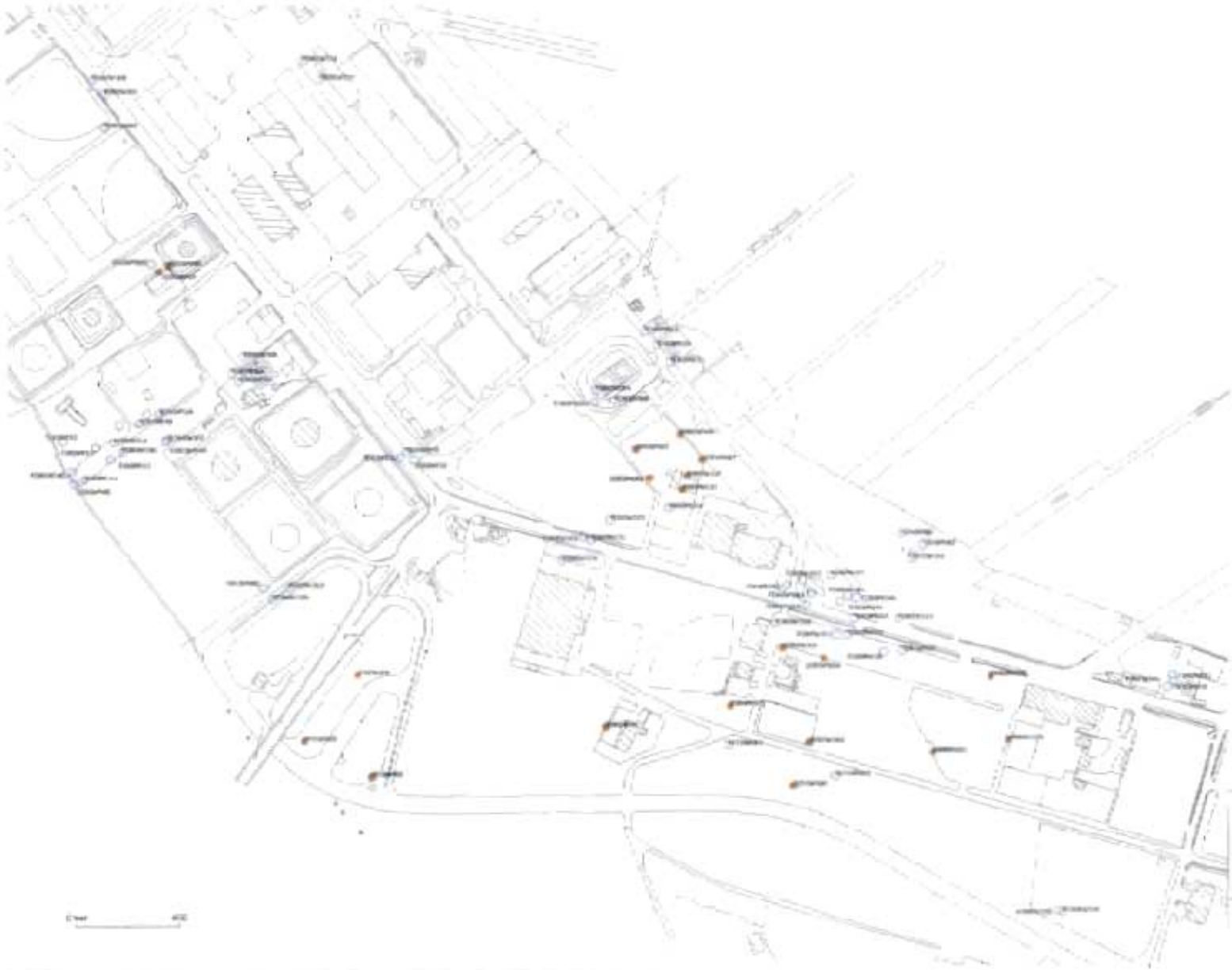
- > MCL
- RBC to MCL
- < RBC
- Non-Detect/No Data

MCL = 2000 ug/l

RBC = 260 ug/l

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 11-4
Barium in Shallow Groundwater



LEGEND

- > MCL
- RBC to MCL
- < RBC
- Non-Detect/No Data

MCL = 4 ug/l

RBC = 0.016 ug/l

ZONE G - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 11-5
Beryllium in Shallow Groundwater

LEGEND

- > MCL
- RBC to MCL
- < RBC
- Non-Detect/No Data

MCL = 2 ug/l

RBC = 0.29 ug/l

ZONE G - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 11-6
Thallium in Shallow Groundwater

and burial of wastes supports the possibility that contamination exists at the site. No visible evidence of the past disposal remains, as the area has since been filled with dredged spoil, and now the area is a gravel covered parking area.

A CMS is recommended for soil and shallow groundwater at AOC 637 based on ILCRs of 7.6E-05 and 4.0E-04 for soil and groundwater respectively. A HI of 17.1 for shallow groundwater contributed to this recommendation. Table 11.7 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.7
AOC 637
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemical Driving Risk
Surface soil	Yes - ILCR = 7.6E-05 Yes - HI = 1.05	Arsenic, hydrazine and BEQs Arsenic and thallium
Shallow Groundwater	Yes - ILCR = 4.0E-04 Yes - HI = 17.1	Hydrazine and benzene Barium, thallium and benzene

11.8 SWMU 11, Caustic Pond

A RFI site, SWMU 11 is located near the interchange formed by the junction of Bainbridge Avenue and Viaduct Road. It is currently an open space, landscaped with grass. From the early 1940s to the early 1970s, the site was a settling pond used for the disposal of calcium hydroxide generated as a byproduct of the production of acetylene gas. Unknown quantities of water saturated with calcium hydroxide were discharged into the pond, which discharged supernatant into Shipyard Creek.

Lead was identified as a residential soil pathway COC for SWMU 11 based on the results of the lead model. Only one surface soil sample reported a concentration above the 400 mg/kg AL for

lead in soil (011SB001; 1,100 mg/kg). The remaining four surface soil samples reported lead concentrations well below the AL.

A CMS is recommended for lead in surface soil based on a single lead concentration of 1,100 mg/kg which exceeds the action level of 400 mg/kg. Additional delineation of the lead in suficial soil may be required during the CMS. Table 11.8 presents the affected medium and lead model results for SWMU 11.

Table 11.8
SWMU 11
Conclusion Summary

Affected Medium	Lead Model Results
Surface soil	Lead in surface soil exceeds 400 mg/kg action level

11.9 SWMU 120, Pier M Laydown

A RFI site, SWMU 120 consists of the laydown area associated with Pier M, included is the former Building AS-40-1, which was adjacent to the area. Palletized lead bricks and shielding were stored at the site, and it is suspected that radiologically contaminated tarps may have also been stored there. Severe paint, grease, and solvent staining were noted in the area in the past. Materials released, stored, or disposed of at the site included lead bricks and shielding, paint/thinner wastes, and greases.

A CMS for soil and shallow groundwater is recommended for SWMU 120 based on an ILCRs of 2.1E-06 and 8.0E-04 respectively. In addition, arsenic detected in the groundwater drove a HI of 7.5. Table 11.9 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.9
SWMU 120
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 2.1E-06 No - HI = ND	BEQs
Shallow groundwater	Yes - ILCR = 8.0E-04 Yes - HI = 7.5	Arsenic Arsenic

11.10 AOC 643, Substation, Building 125

A CSI site, AOC 643 is the electric substation at Building 125 which lies on the north side of Hobson Avenue, near the entrance to Pier N. At one time, PCB transformers, inactive DC generators, switches, and circuit breakers were stored in a wooden shed adjacent to Building 125. A dielectric fluid spill/cleanup was documented, and stains were noted on concrete pavement around this area.

A CMS for soil is recommended for AOC 643 based on an ILCR of 1.5E-04 and an HI of 2.83. Table 11.10 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.10
AOC 643
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 1.5E-04 Yes - HI = 2.83	Arsenic, BEQs and Aroclor-1260 Arsenic, chromium and vanadium

11.11 SWMU 3, Pesticide Mixing Area

A RFI site, SWMU 3 is an approximately 50 by 30 foot area where the former Building 42-A was located. The building was a shed where pesticides were mixed prior to 1971. Equipment for

spraying and mixing pesticides was reportedly rinsed on the ground outside, with the rinsate allowed to infiltrate the soil.

A CMS for soil and shallow groundwater is recommended for SWMU 3 based on ILCRs of 8.7E-05 and 7.1E-05 respectively. Pesticides detected in soil resulted in a residential HI of 4.75. In addition, metals detected in the groundwater drove a HI of 4.6. Table 11.11 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.11
SWMU 3
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 2E-05 Yes - HI = 0.3	Aroclor-1248, alpha-chlordane and gamma-chlordane, gamma-chlordane, alpha-chlordane
Shallow groundwater	Yes - ILCR = 7.1E-05 Yes - HI = 4.6	Beryllium Thallium, Aluminum, Vanadium, Chromium

11.12 SWMU 6, Public Works Storage Yard; SWMU 7, PCB Transformer Storage Yard; and AOC 635, Paint and Oil Storehouse, Building 3902

All RFI sites, these sites were combined into one investigation due to their close proximity and their potential for similar COPCs. Known as the Public Works Storage Yard, SWMU 6 is an unpaved, open, fenced storage yard located north of Hobson Avenue, south of River Road, and southeast of Thirteenth Street. Routinely generated containerized wastes (cleaning solvents and used motor oil from vehicle maintenance, along with wastes from building maintenance and pest control operations) were stored at this site prior to shipment offsite. The fenced area within SWMU 6 encompasses two other RFI sites associated with activities which took place in and around Building 3902.

SWMU 7 consists of Building 3902, the concrete slab adjacent the building, and the surrounding areas which were used for storage of transformers and associated electrical equipment between 1970 and 1976. Transformers that were taken out of use were temporarily stored there prior to being shipped off base. Previous oil spills around the pad were evident during the RFA.

AOC 635 consists of the paint and oil storehouse at Building 3902. The small steel storehouse was erected in 1942 on a 25 foot by 25 foot pad, and was used until 1976. Leaking transformers, old electrical equipment, paint cans and drums, used motor oil, paint solvents and plating wastes were stored there. The western parking lot was also a drum storage area. Building 3902 and its associated area lies within the fenced compound of SWMU 6.

A CMS for soil and shallow groundwater is recommended for SWMUs 6, 7 and AOC 635 based on ILCRs of 4.6E-04 and 6.1E-03 respectively. COCs in the surface soil contributed to a cumulative HI of 1.8 for surface soil. In addition, metals detected in the shallow groundwater drove a HI of 57.3. Table 11.12 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.12
SWMUs 6, 7 and AOC 635
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 4.6E-04 Yes - HI = 1.8	Dioxin, BEQs and Aroclor-1260 Arsenic, Aroclor-1254 and 4,4'-DDT
Shallow groundwater	Yes - ILCR = 6.1E-03 Yes - HI = 57.3	Arsenic, Beryllium Arsenic

11.13 AOC 646, Operational Storage, Building 3906Q

A CSI site, AOC 646 is located at Building 3906Q, the operational storage for the Chicora Tank Farm. Building 3906Q is a single story block structure with a flat concrete roof and a concrete

floor. It was built in 1943 to house a boiler that heated residual fuel oil stored at the tank farm. The boiler was removed in 1971, and the building converted to a storage facility. Until recently, the building was used to store absorbent materials, and pumps and compressors used to operate the fuel terminal. A flammable storage locker in the southeast corner of the structure stored small quantities of paints, lubricants, kerosene, and gasoline.

A CMS for surface soil is recommended for AOC 646 based on an ILCRs of 1.9E-06. Table 11.13 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.13
AOC 646
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 1.9E-06 Yes - HI = ND	BEQs

11.14 AOC 706, Area Behind Building 246

A RFI site, AOC 706 is located behind Building 246, the former Hazardous Waste Storage and Transit Facility. Building 246 and its surrounding paved area were constructed in 1986. Prior to this, the land parcel appears to have been an open lot surrounded by trees, accessed from Bainbridge Avenue.

No COCs were identified in AOC 706 surface soil samples, which indicates no threat to current or future human receptors. Therefore, no further action is recommended for site soil. A CMS for shallow groundwater is recommended for AOC 706 based on a HI of 7.7. Table 11.14 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.14
AOC 706
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	No - ILCR = ND No - HI = ND	
Shallow groundwater	No - ILCR = ND Yes - HI = 7.7	Thallium and Barium

11.15 SWMU 24, Waste Oil Reclamation Facility

SWMU 24, the waste oil reclamation facility for the CNC, consists of tanks 39-A and 39-D. This area is located south of Hobson Avenue and east of Wood Street. Included in this area is SWMU 3, the pesticide mixing area. SWMU 3 is discussed in Section 10.11 of the Zone F RFI. SWMU 24 was originally investigated under the petroleum program as part of the Fuel Distribution System (FDS) but was returned to the RCRA program to assess inorganics detected in the area groundwater. Tanks 39-A and 39-D operated as waste oil settling tanks. Waste oil containing water and presumably other impurities was delivered to these tanks via the pipeline system. The tanks were used both to separate and store the water and oil phases. The waste water was subsequently discharged to the sanitary sewer system. Materials stored and potentially released include waste oil and other petroleum products.

A CMS is recommended for surface soil and shallow groundwater for SWMU 24 based on ILCRs of 4E-05 and 2E-03 respectively. Arsenic in groundwater also resulted in a HI of 18 (resident child). Table 11.15 list the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.15
SWMU 24
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 4E-05 Yes - HI = ND	BEQs
Shallow groundwater	Yes - ILCR = 2E-03 Yes - HI = 18	Arsenic

11.16 Ecological Risk Summary

As described in Section 8.0, Zone G was segregated into three "subzones" for purposes of the ERA. Table 11.16 identifies sites associated with each subzone which were illustrated on Figure 8.2 found in Section 8.0. Risk to ecological receptors was evaluated for ECPCs in sediment at subzone G-1 and for soil only at subzone G-2. The assessment of subzone G-3 will be conducted as part of the Chicora Tank Farm investigation. Risk associated with exposure to ECPCs in surface soil was evaluated for terrestrial wildlife based on a model that predicts the amount of contaminant exposure via the diet and incidental ingestion of soil. The risk evaluation is based on a comparison of predicted doses for representative wildlife species with doses representing thresholds for both lethal and sublethal effects (RTVs). Risk for soil invertebrates and plants was evaluated based on qualitative comparison to literature effects levels for taxonomic groups similar to those potentially inhabiting Zone G. Risk from sediment to aquatic organisms were evaluated by calculating HQs from benchmark values that are either promulgated or proposed by federal and state regulatory agencies.

Table 11.16
Zone G
AOC/SWMUs Associated With Ecological Subzones

AOC/SWMU	Description	Potentially Impacted Ecological Areas Outside of Zone G
Subzone G-1		
AOCs 633, 634, and 706	Substation Bldg. 451C, Flammable Material Storage Bldg. 1814, and Area Behind Bldg. 246.	Shipyard Creek
Subzone G-2		
SWMU 11	Caustic Pond	Shipyard Creek
AOC 637	Dump Area, Bldg. 161 Area	Shipyard Creek
AOC 706	Area Behind Bldg. 246	Shipyard Creek
Subzone G-3		
None	Chicora Tank Farm	Chicora Marsh

Notes:
Chicora Tank Farm and marsh is being investigated as part of the petroleum UST investigations at NAVBASE

11.16.1 Aquatic Wildlife

Potential risk to the aquatic communities exists throughout subzone G-1 based on the detected sediment concentrations. HQ values are greater than one for both inorganic and organic parameters. Actual risk to receptors within the subzone may be lower than that implied by using the SSV in the screening assessment. Specific impacts at G-1 to receptors for both water and sediment would be difficult to determine.

11.16.2 Terrestrial Wildlife

No risk potential for lethal effects to terrestrial wildlife exist based on soil ECPCs within subzones G-1 and G-2. All HQ and HI values calculated for each of the representative wildlife species within each subzone were less than one.

Potential sub-lethal effects to both small carnivorous mammals and passerine birds from exposure to arsenic and mercury is soil at subzone G-2. Although literature information appears to be accurate and supportive of the model, measurement of tissue concentrations or in situ bioaccumulation studies would reduce the uncertainty inherent in the model predictions.

11.16.3 Vegetation

A potential risk to woody seedlings and young herbaceous species exist at subzone G-2. Copper, lead, and zinc concentrations are above levels reported in literature. Effects from organic concentrations could not be assessed. The actual effects of site constituents to vegetation in G-1 can not be determined because of limited studies for accumulation of contaminants by aquatic plants growing in sediment.

SECTION 12

12.0 REFERENCES

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SECTION 13

13.0 SIGNATORY REQUIREMENT

Condition I.E. of the HSWA portion of RCRA Part B (permit number: SCO 170 022 560) (SCDHEC, May 4, 1990) states: *All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with 40 CFR §270.11.* The certification reads as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Henry M. Hyland II, PE
Deputy, Caretaker Site Officer for

P. M. Rose
Office In Charge of
Caretaker Site Office, Charleston

3 March 1998
Date

SECTION A

Appendix A
Zone G
Monitoring Well Construction Diagrams

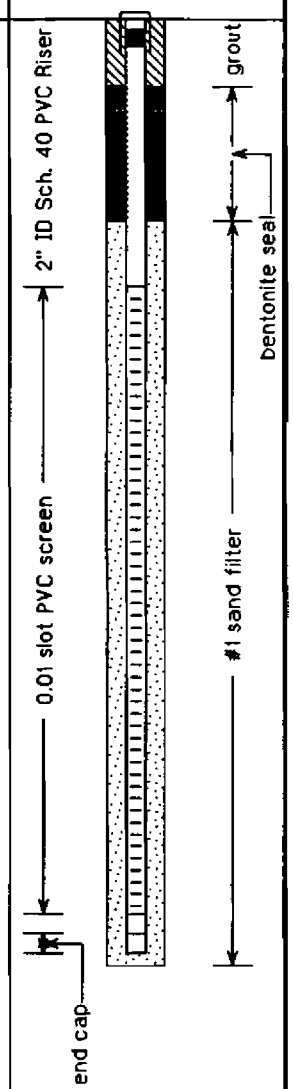
EnSafe/Allen & Hoshall

Monitoring Well NBCG003001

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318995.03 E, 373468.80 N*
Location: *Charleston, SC*	Surface Elevation: *13.1 feet msl*
Started at *12:45 on 10-30-96*	TOC Elevation: *12.91 feet msl*
Completed at *15:00 on 10-30-96*	Depth to Groundwater: *8.39 feet TOC* Measured: *12/18/96*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.52 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *14.0 feet bgs*
Geologist: *S. Parker*	Well Screen: *4.0 to 13.4 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass Surface Cuttings: Dark brown gravelly silty clay and sandy (coarse to fine) clay.	
5			1	33	0		SC CL	Interbedded Sand/Clay: red-orange; fine to medium; soft; moist.	8.1 7.3
10			2	58	0		SC CL SM	Clay: orange to gray; w/ some fine to medium sand; soft; moist. Sand: gray and tan; medium; silty; dense; moist.	4.1 3.3 2.9
15			3	100	0			Shelby Tube (13-15'): Bottom: Interbedded Sand/Clay: gray to brown; fine to very fine; silty; laminated; stiff; moist.	
20									

WELL DIAGRAM



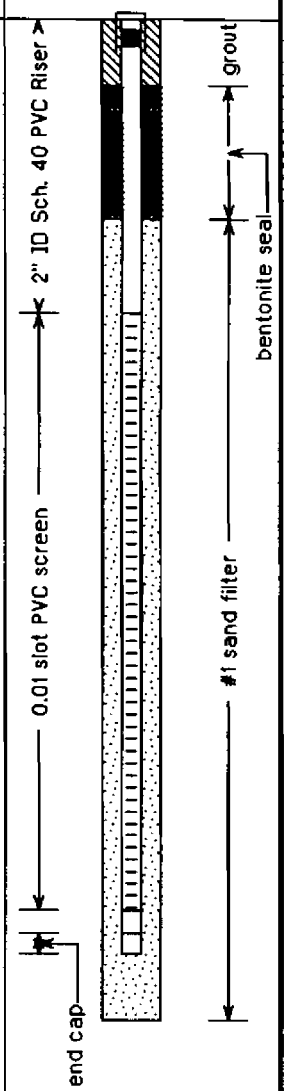
EnSafe/Allen & Hoshall

Monitoring Well NBCG003002

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318924.81 E, 373475.26 N*
Location: *Charleston, SC*	Surface Elevation: *13.0 feet msl*
Started at *14:00 on 10-31-96*	TOC Elevation: *12.86 feet msl*
Completed at *16:00 on 10-31-96*	Depth to Groundwater: *8.33 feet TOC* Measured: *12/16/96*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.54 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *14.0 feet bgs*
Geologist: *S. Parker*	Well Screen: *4.0 to 13.4 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface: Grass	
5							SC CL	Clay: dark red-brown to grey; some fine to medium sandy; stiff; moist.	8
			1	75	0				6.5
10							SP	Sand: red-brown to gray; fine to medium; stiff; moist.	4
							SP SW	Sand: grey; fine to medium w/ trace coarse; dense; wet.	2.9
			2	90	0				2.2
							ML SM	Silt: grey; some fine to medium sand; dense; wet.	2
15			3	100	0		CL	Clay: grey; stiff; moist.	1.4
									2
20									

WELL DIAGRAM



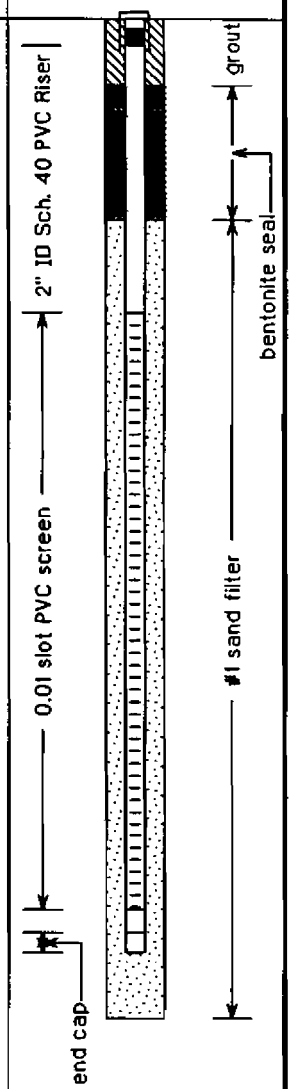
EnSafe/Allen & Hoshall

Monitoring Well NBCG003003

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318953.48 E, 373446.43 N*
Location: *Charleston, SC*	Surface Elevation: *12.9 feet msl*
Started at *10:00 on 10-31-96*	TOC Elevation: *12.71 feet msl*
Completed at *14:00 on 10-31-96*	Depth to Groundwater: *8.27 feet TOC* Measured: *12/18/96*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.44 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #899)*	Total Well Depth: *14.0 feet bgs*
Geologist: *S. Parker*	Well Screen: *4.0 to 13.4 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Gravel and sand	
5			1	50	0		SM, SC, CL	Sand: dark red-brown; fine to medium; silty; hard; moist.	7.9, 7.6
								Clay: reddish brown with gray mottling; some fine to medium sand; stiff; moist.	6.9
10			2	75	0		SC	Sand: grey and orange mottled; very fine to medium w/ trace coarse; clayey; wet.	3.7, 2.5
							ML	Silt: grey to reddish brown; dense; saturated.	.4
15			3	100	0		CL	Clay: grey; stiff; saturated.	1.5, 2.1
20									

WELL DIAGRAM



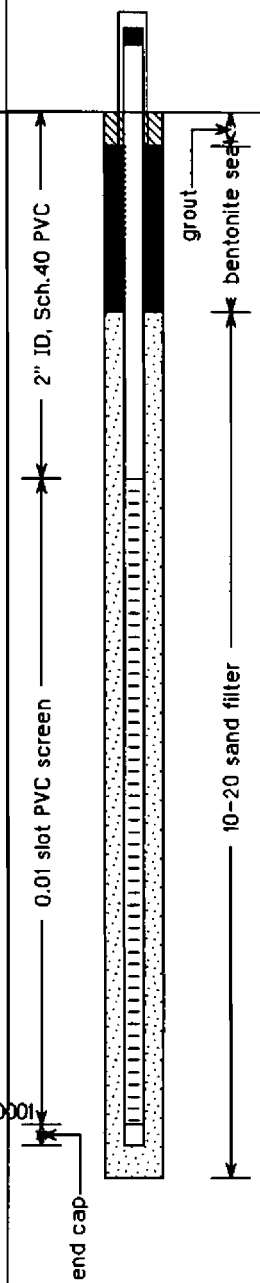
EnSafe/Allen & Hoshall

Monitoring Well NBCG006001

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2320944.49 E, 372827.24 N*
Location: *Charleston, SC*	Surface Elevation: *5.6 feet msl*
Started at *1115 on 9-23-93*	TOC Elevation: *8.46 feet msl*
Completed at *on 9-23-93*	Depth to Groundwater: *6.39 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *2.07 feet msl*
Drilling Company: *ETE*	Total Well Depth: *15.5 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *5.5 to 15.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
									5.6
							ML	Silt: brown to black; clayey; wet.	2.6
5			1	100	0				.6
							ML	Silt: brown to black with some gravel.	-2.4
							SP	Sand: brown; coarse; well sorted w/ shell fragments; wet.	-3.4
10			2	100	0				-4.4
							SP	Sand: brown; coarse; well sorted w/ shell fragments; wet.	-7.4
15			3	100	0				-9.400001
20									

WELL DIAGRAM



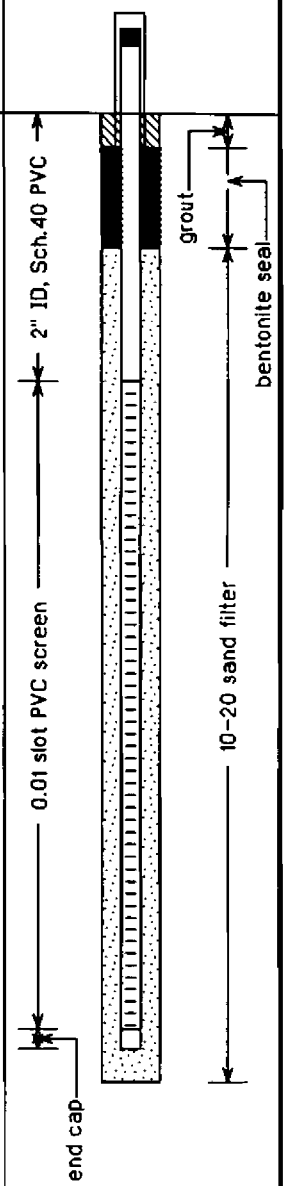
EnSafe/Allen & Hoshall

Monitoring Well NBCG006002

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2320773.12 E, 372767.97 N*
Location: *Charleston, SC*	Surface Elevation: *4.8 feet msl*
Started at *0935 on 9-21-93*	TOC Elevation: *7.79 feet msl*
Completed at *1100 on 9-21-93*	Depth to Groundwater: *5.78 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *2.20 feet msl*
Drilling Company: *ETE*	Total Well Depth: *14.0 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *4.0 to 14.0 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Cuttings: black-dark-brown; sand and silt with gravel; wet.	
5									
								No recovery	
							SP	Sand: tan; medium to coarse; well sorted w/ shell fragments; wet.	4.2 / 4.7
10			1	75	0				
								No recovery	
			2	75	0		SP	Sand: fine to medium; well sorted; wet.	9.2 / 9.7
15									
20									

WELL DIAGRAM



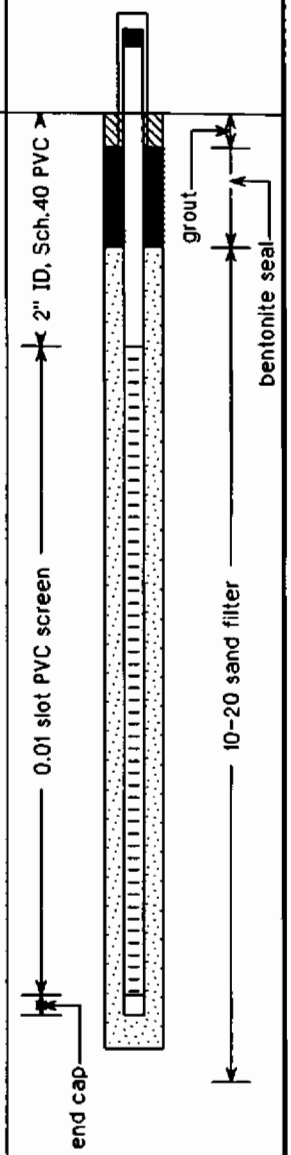
EnSafe/Allen & Hoshall

Monitoring Well NBCG006003

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2320828.39 E, 372657.68 N*
Location: *Charleston, SC*	Surface Elevation: *5.3 feet msl*
Started at *1050 on 9-21-93*	TOC Elevation: *7.97 feet msl*
Completed at *on 9-21-93*	Depth to Groundwater: *5.77 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *2.20 feet msl*
Drilling Company: *ETE*	Total Well Depth: *13.5 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *3.5 to 13.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Cuttings: light brown; medium grained well sorted; wet.	
							CL	Sand: black-brown; fine; clayey.	2.3
5			1	30	0				.3
							SC CL	Sand: brown-black; silty; clayey.	2.7
							SP	Sand: brown; medium to coarse; well sorted w/ shell frags.	3.5
10			2	100	0				4.7
							SC	Sand: brown; fine to medium; silty; clayey.	7.7
			3	100	0		ML CL	Clay: sandy w/ shell frags.	8.7
15									9.7
20									

WELL DIAGRAM



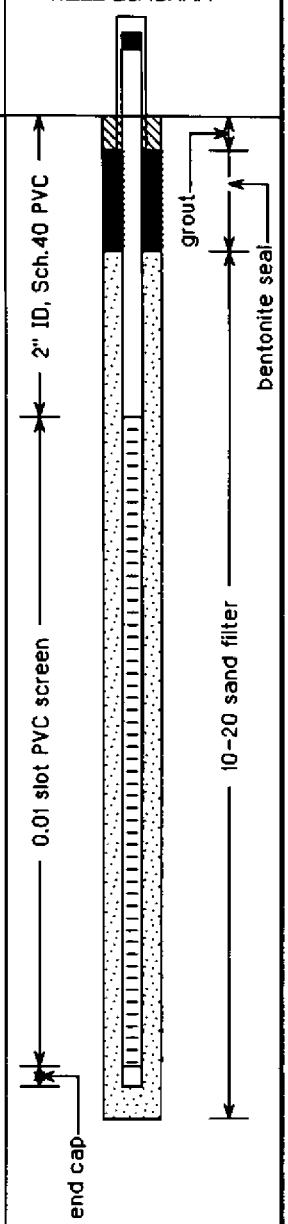
EnSafe/Allen & Hoshall

Monitoring Well NBCG006004

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2320902.72 E, 372542.13 N*
Location: *Charleston, SC*	Surface Elevation: *5.3 feet msl*
Started at *0820 on 9-22-93*	TOC Elevation: *8.16 feet msl*
Completed at *on 9-22-93*	Depth to Groundwater: *5.99 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *2.17 feet msl*
Drilling Company: *ETE*	Total Well Depth: *14.5 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *4.5 to 14.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Cuttings: brown; fine to medium grained well sorted.	
							SP	Sand: light brown; fine to coarse; wood debris.	2.3 / 2.1
								No recovery	
5			1	30	0				
							SP	Sand: light brown-black; fine to coarse; some gravel.	2.7
							ML	Clay: black; silty; w/ coarse sand; wet.	4.2 / 4.7
10			2	90	0				
							SW SM	Sand: light brown; coarse; w/ some silt and gravel; wet.	7.7
							ML	Clay: black; silty.	8.7
15			3	90	0				9.7
20									

WELL DIAGRAM



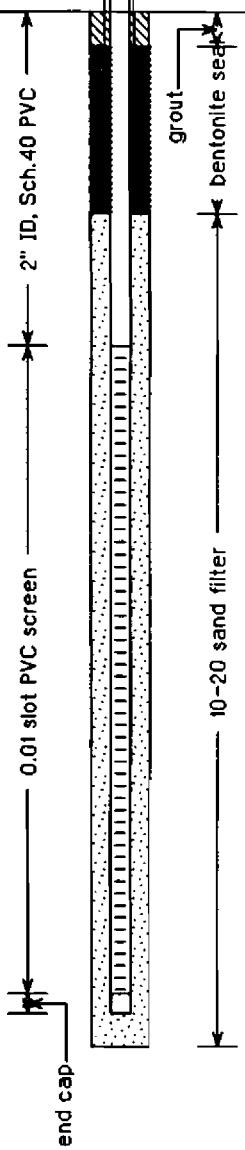
EnSafe/Allen & Hoshall

Monitoring Well NBCG006005

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2320955.69 E, 372614.28 N*
Location: *Charleston, SC*	Surface Elevation: *6.2 feet msl*
Started at *1100 on 9-22-93*	TOC Elevation: *9.08 feet msl*
Completed at *on 9-22-93*	Depth to Groundwater: *7.09 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *1.99 feet msl*
Drilling Company: *ETE*	Total Well Depth: *15.0 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *5.0 to 15.0 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Cuttings: wood w/ heavy creosote oder.	
							SC	Sand: light brown; clayey.	3.2
							CL	Clay: Black; silty.	2.7
								No recovery.	2.2
5			1	50	12				
							SM	Sand: light brown; fine; silty.	1.8
							ML	Silt: black w/ wood.	2.3
							SP	Sand: light brown; coarse; well sorted; wet.	2.7
10			2	100	1				3.8
							CL	Clay: black; silty.	6.8
							SP	Sand: light brown; coarse; well sorted.	7.3
15			3	100	10				8.8
20									

WELL DIAGRAM



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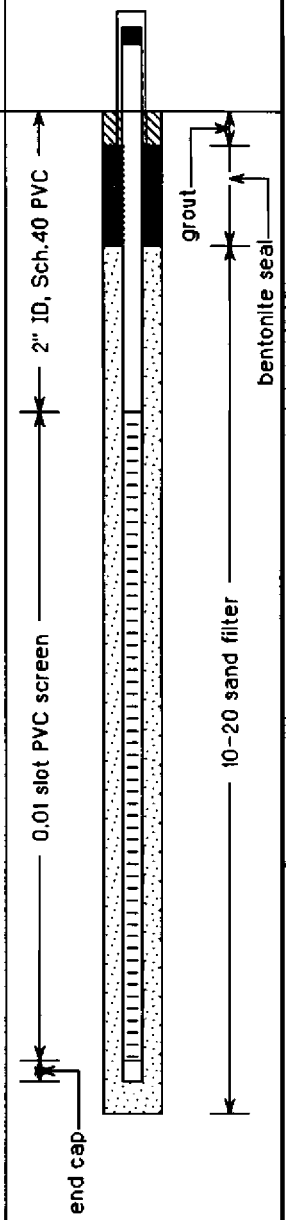
Monitoring Well NBCG006006

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2320972.73 E, 372667.58 N*
Location: *Charleston, SC*	Surface Elevation: *6.4 feet msl*
Started at *1500 on 9-22-93*	TOC Elevation: *9.40 feet msl*
Completed at *on 9-22-93*	Depth to Groundwater: *7.44 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *1.96 feet msl*
Drilling Company: *ETE*	Total Well Depth: *14.5 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *4.5 to 14.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
									3.4
							SM	Sand: brown; fine; silty.	2.9
							CL ML	Clay: black; silty; wet.	
5			1	70	2				1.4
									1.6
							SP	Sand: dark brown; fine.	1.3
							ML	Silt: black w/ brown mottling.	2.6
							SP	Sand: light brown; coarse; well sorted; wet.	
10			2	100	0				3.6
									6.6
							ML	Silt: grey.	6.3
							SP	Sand: light brown; coarse; well sorted; shell fragments; wet.	
15			3	100	0				8.6
20									

WELL DIAGRAM



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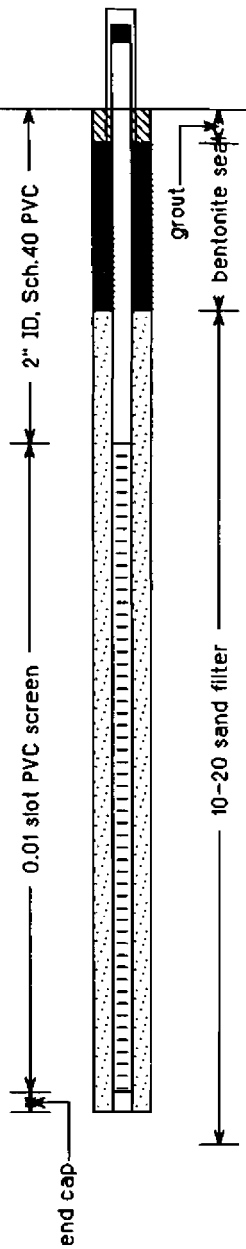
Monitoring Well NBCG006007

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2321029.40 E, 372728.37 N*
Location: *Charleston, SC*	Surface Elevation: *5.9 feet msl*
Started at *0820 on 9-23-93*	TOC Elevation: *8.80 feet msl*
Completed at *on 9-23-93*	Depth to Groundwater: *6.98 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *1.82 feet msl*
Drilling Company: *ETE*	Total Well Depth: *15.0 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *5.0 to 15.0 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SM	Sand: light brown; fine to medium; silty.	2.9 / 2.7
							CL	Clay: grey-black; silty.	
5			1	100	30		SP	Sand: light brown; coarse.	1.1 / .9
							CL	Clay: brown; sandy w/ gravel and silt; wet.	-2.1
							SP	Sand: light brown; coarse; well sorted w/ shell fragments.	-3.1
10			2	100	20				-4.1
							SP	Sand: light brown; coarse; well sorted; wet.	-7.1
							CL	Clay: sandy; silty; wet.	-8.6 / -9.1
15			3	100	10				
20									

WELL DIAGRAM



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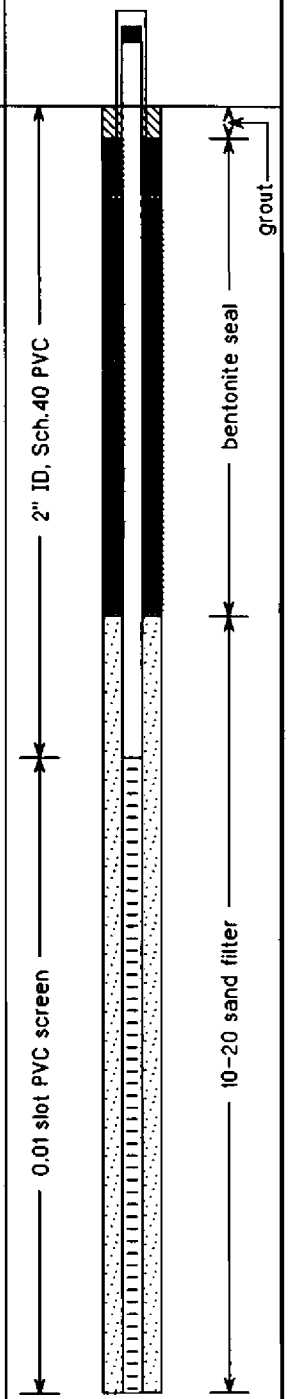
Monitoring Well NBCG008001

Project: *ZONE G – Naval Base Charleston*	Coordinates: *232193.23 E, 371602.25 N*
Location: *Charleston, SC*	Surface Elevation: *4.5 feet msl*
Started at *1500 on 9-24-93*	TOC Elevation: *7.37 feet msl*
Completed at *1610 on 9-24-93*	Depth to Groundwater: *3.92 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *3.45 feet msl*
Drilling Company: *ETE*	Total Well Depth: *20.2 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *10.2 to 20.2 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SP	Sand: brown to black (stained); fine; some pebbles; wet; strong petroleum odor.	1.5 / -.5
5			1	50	20				
							SP	Sand: as above w/ less staining; wet.	-3.5 / -4.5
10			2	50	>10				
							SP SC	Sand: as above; increased clay content.	-8.5
							CL	Clay: black; silty; strong petroleum odor; wet.	-9.5 / -10
15			3	75	10				
							CL	Clay: black w/ some brown; silty; saturated.	-13.5
20			4	100	<10				-15.5

WELL DIAGRAM



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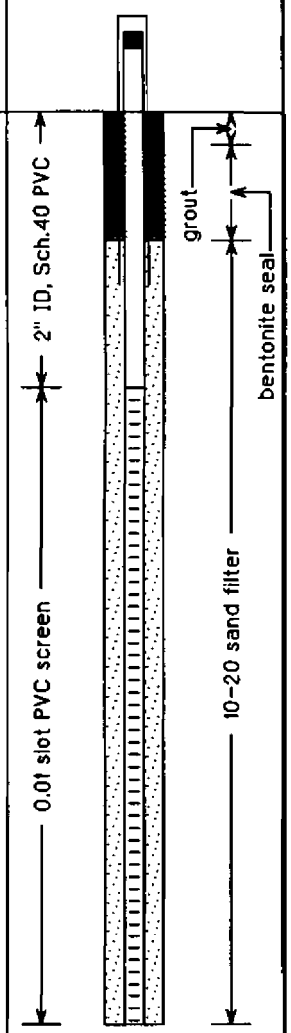
Monitoring Well NBCG008002

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2321441.71 E, 371636.04 N*
Location: *Charleston, SC*	Surface Elevation: *5.8 feet msl*
Started at *0915 on 9-25-93*	TOC Elevation: *8.62 feet msl*
Completed at *on 9-25-93*	Depth to Groundwater: *4.80 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *3.82 feet msl*
Drilling Company: *ETE*	Total Well Depth: *14.3 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *4.3 to 14.3 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SP	Sand: brown; fine; w/ wood and plastic; black staining at bottom of spoon; saturated.	2.8 / 2.3
5			1	25	10				
								Unable to obtain 8-10' sample due to bolts and rubber in split spoon.	
10			2	0			ML	Silt: gravelly in upper 0.5'; grades into silt w/ grass stems; saturated; oily sheen on water.	4.2 / 5.7
			3	75	20+				
							ML	Silt: gravelly grading to cleaner silt at bottom of spoon; saturated; oily sheen on water.	7.2 / 9
15			4	83	10				
20									

WELL DIAGRAM



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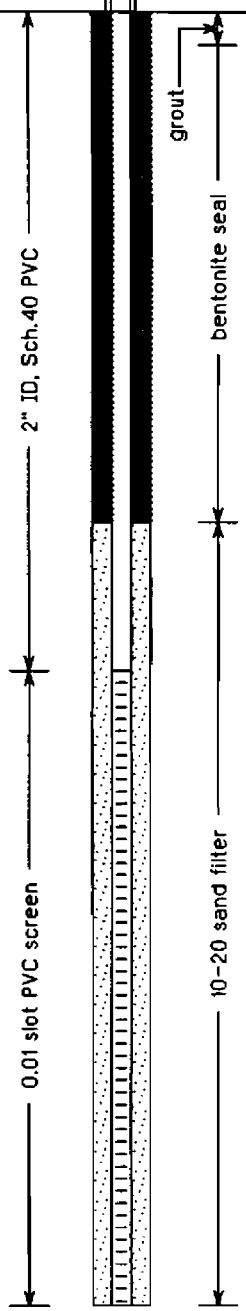
Monitoring Well NBCG008003

Project: *ZONE G – Naval Base Charleston*	Coordinates: *232142.06 E, 371766.33 N*
Location: *Charleston, SC*	Surface Elevation: *5.4 feet msl*
Started at *on 9-25-93*	TOC Elevation: *8.33 feet msl*
Completed at *on 9-25-93*	Depth to Groundwater: *3.42 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *4.91 feet msl*
Drilling Company: *ETE*	Total Well Depth: *20.3 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *10.3 to 20.3 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
									2.4
							OL	Clay: black; silty; brick and wood debris limits effectiveness of split spoon drive.	1.7
5			1	33	3				
									2.6
							SC SM	Sand: dark brown to black; fine to medium; w/ shell fragments; bottom 3" of spoon grades into black silty clay, wet.	4.1
10			2	75	3				
									7.6
							ML	Silt: black; clayey; strong petroleum odor; saturated.	9.1
15			3	75	30				
									12.6
							ML	Silt: as above.	13.3
20			4	33	>60				

WELL DIAGRAM



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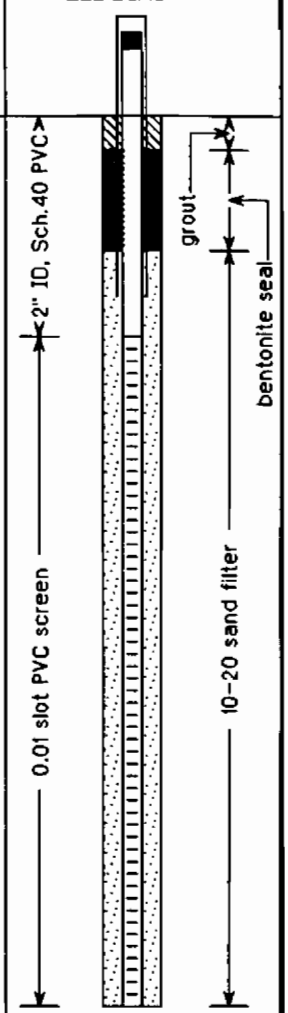
Monitoring Well NBCG008004

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2321492.99 E, 371964.29 N*
Location: *Charleston, SC*	Surface Elevation: *5.8 feet msl*
Started at *on 9-27-93*	TOC Elevation: *8.63 feet msl*
Completed at *on 9-27-93*	Depth to Groundwater: *7.69 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *0.94 feet msl*
Drilling Company: *ETE*	Total Well Depth: *13.3 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *3.3 to 13.3 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
									2.8
							SP	Sand: brown; medium; w/ wood.	2.3
							CL	Clay: black; sitly; saturated; w/ wood chips.	1.3
5			1	75	10				
									2.2
							ML	Silt: brown to black; clayey; w/ grass and other organic material.	3.2
							SP	Sand: brown; fine to medium; saturated.	
10			2	100	10				4.2
									7.2
							CL SC	Clay: black; silty; w/ some brown, fine to medium sand at top of spoon; saturated.	
15			3	100	7				9.2
20									

WELL DIAGRAM



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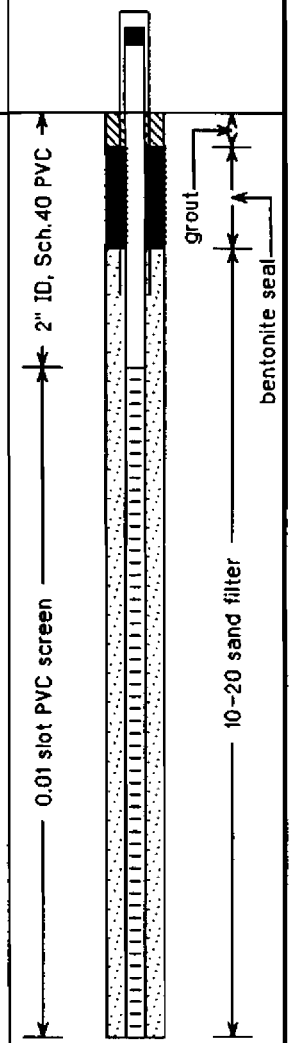
Monitoring Well NBCG008005

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2322200.05 E, 371652.34 N*
Location: *Charleston, SC*	Surface Elevation: *5.8 feet msl*
Started at *on 9-29-93*	TOC Elevation: *8.52 feet msl*
Completed at *on 9-29-93*	Depth to Groundwater: *3.92 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *4.60 feet msl*
Drilling Company: *ETE*	Total Well Depth: *13.8 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *3.8 to 13.8 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface sample had strong diesel odor.	
							SM	Sand: black; silty; w/ wood fragments; some light brown, fine, clayey sand in bottom of spoon; saturated.	2.8 / 2.3
5			1	25	30				
							CL	Clay: brown; sandy; saturated.	2.2 / 3.2
10			2	50	20				
							ML	Silt: light brown; some fine sand.	7.2 / 7.7
							CL	Clay: black; silty; saturated. *Apparent hydrocarbon contamination.*	8.7
15			3	75	20				
20									

WELL DIAGRAM



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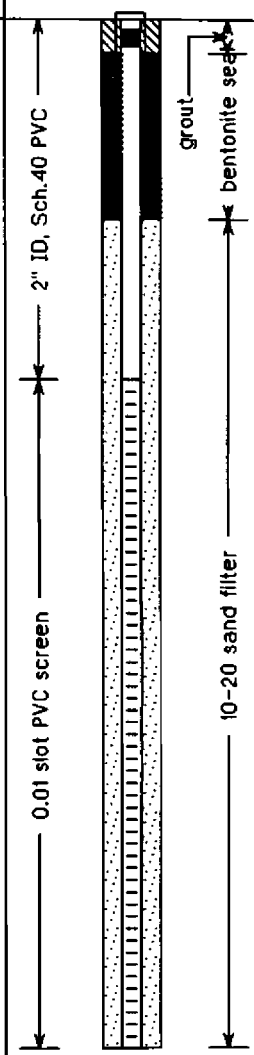
Monitoring Well NBCG008006

Project: *ZONE G - Naval Base Charleston*	Coordinates: *232213.04 E, 371899.81 N*
Location: *Charleston, SC*	Surface Elevation: *6.5 feet msl*
Started at *on 9-30-93*	TOC Elevation: *6.87 feet msl*
Completed at *on 9-30-93*	Depth to Groundwater: *3.35 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon*	Groundwater Elevation: *3.52 feet msl*
Drilling Company: *ETE*	Total Well Depth: *15.4 feet bgs*
Geologist: *Britton Dotson*	Well Screen: *5.4 to 15.4 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
									3.5
							SP	*Sample collected with hand auger:* Sand: light; medium; well sorted; saturated.	
5			1	100	5				1.5
							ML CL	Silt: brown; stiff; increasing clay and sand content w/ depth; saturated.	1.5
									2.5
10			2	50	10				
							CL	Clay: brown to black; silty; firm to stiff; saturated.	6.5
15			3	100	0				8.5
20									

WELL DIAGRAM



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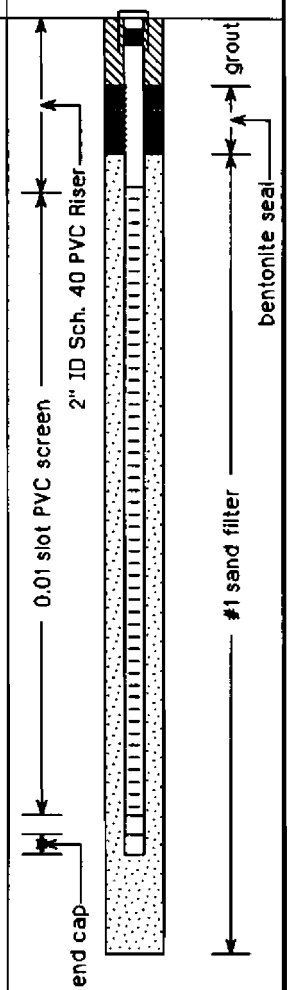
Monitoring Well NBCG011001

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2319716.33 E, 371889.24 N*
Location: *Charleston, SC*	Surface Elevation: *10.4 feet msl*
Started at *14:00 on 09-09-96*	TOC Elevation: *10.14 feet msl*
Completed at *15:30 on 09-09-96*	Depth to Groundwater: *6.68 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *3.46 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.5 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.5 to 11.9 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface condations: Grass	
5							CL SC	Interbedded sand and clay: brown and gray mottled; fine to medium; stiff; moist.	6.4
			1	75	0				4.9
							CL SC	Interbedded sand and clay: as above.	4.4
			2	75	0				2.9
								Shelby tube (8-10' bgs): bottom: Sand: gray; medium; some silt; dense; saturated.	
10			3	100			SM	Sand: gray; medium; silty; loose; saturated.	.4
								Sand: red-brown; medium; silty; loose; saturated.	1.1
			4	75	0				
15									
20									

WELL DIAGRAM



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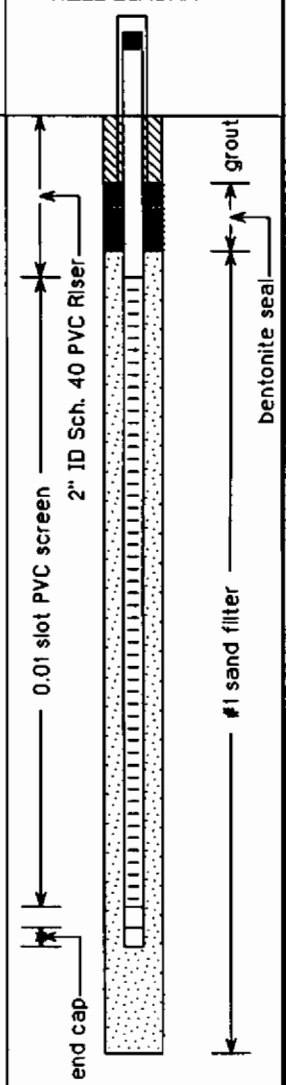
Monitoring Well NBCG011002

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2319768.83 E, 371493.91 N*
Location: *Charleston, SC*	Surface Elevation: *8.7 feet msl*
Started at *09:30 on 09-12-96*	TOC Elevation: *11.45 feet msl*
Completed at *11:00 on 09-12-96*	Depth to Groundwater: *6.35 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *5.10 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.4 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.4 to 11.8 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
								Sand: brown; medium; silty; dense; saturated.	4.7
5			1	100	30		SM	At 7-9': color change to gray-green.	
			2	100	230				.7
10							ML	Silt: gray-green; some fine to coarse sand; stiff; saturated.	1.3
			3	50	50				2.3
15									
20									

WELL DIAGRAM



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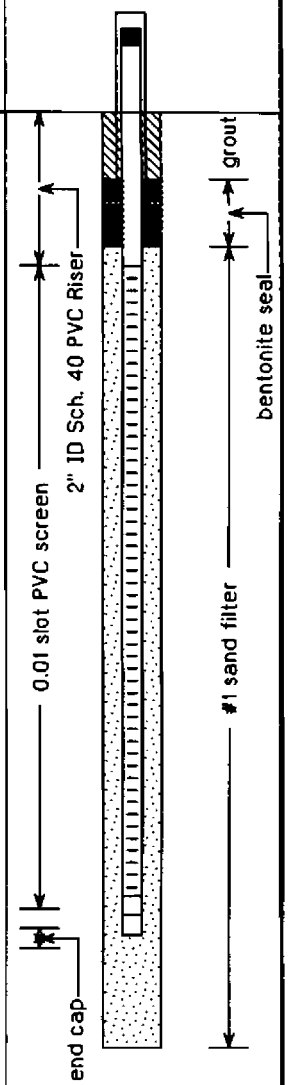
Monitoring Well NBCG011003

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2319513.60 E, 371630.68 N*
Location: *Charleston, SC*	Surface Elevation: *9.5 feet msl*
Started at *12:30 on 09-09-96*	TOC Elevation: *11.83 feet msl*
Completed at *13:50 on 09-09-96*	Depth to Groundwater: *7.16 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.67 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.3 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.3 to 11.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
							CL	Clay: brown and gray mottled; some fine to medium sand; firm.	5.5
5							SM SP	Sand: dark gray; fine to medium; some silt; medium dense; very moist.	5
			1	85	3			Shelby tube (6-8'): Bottom: Sand: light brown; fine to medium; silty; dense; saturated.	3.8
			2	95				Interbedded Clay/Sand: brown and gray mottled; fine to coarse; stiff; saturated.	1.5
10			3	100	0		CL SC		
			4	100	0				2.5
15									
20									

WELL DIAGRAM



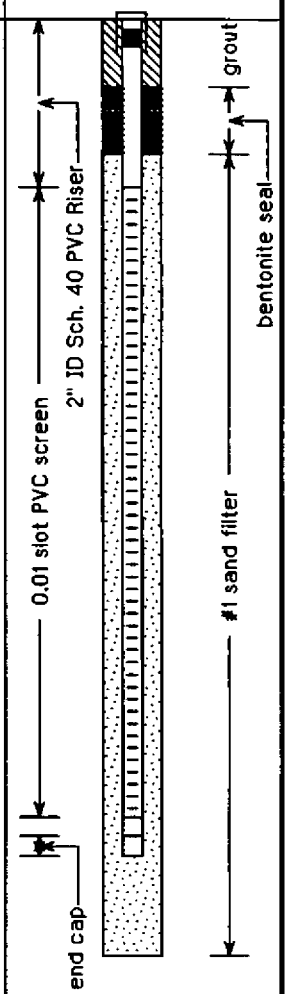
EnSafe/Allen & Hoshall

Monitoring Well NBCG120001

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2321785.08 E, 372446.13 N*
Location: *Charleston, SC*	Surface Elevation: *6.2 feet msl*
Started at *08:15 on 08-30-96*	TOC Elevation: *6.05 feet msl*
Completed at *09:30 on 08-30-96*	Depth to Groundwater: *2.26 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *3.79 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.5 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.5 to 11.9 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: ROC, gravel.	
							ML SM	Silt: black and gray; w/ white calcareous coarse sand; soft; saturated.	2.2 / 1.7
5			1	5	2			Shelby Tube (6-8' bgs): marsh clay.	
			2	85			OL SP	Clay: black; very silty with trace fine sand; high organic content; saturated.	1.8 / 2.2 / 2.6
								Sand: grey; coarse silica; some silt; loose; saturated.	
10			3	40	910		SP	Sand: as above.	3.8
			4	100	180				5.8
15									
20									

WELL DIAGRAM



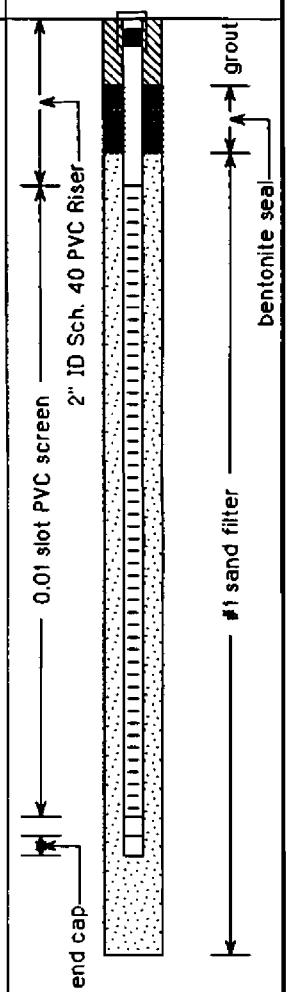
EnSafe/Allen & Hoshall

Monitoring Well NBCG120002

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2321867.22 E, 372404.41 N*
Location: *Charleston, SC*	Surface Elevation: *7.2 feet msl*
Started at *09:30 on 08-30-96*	TOC Elevation: *7.01 feet msl*
Completed at *10:45 on 08-30-96*	Depth to Groundwater: *2.81 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.20 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.5 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.5 to 11.9 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
							SM	Sand: brown-gray; fine; silty; loose; saturated.	3.2
5									2.2
			1	50	190		OL	Clay: black to gray; very silty; trace mica; high organic content; soft; saturated.	1.2
			2	100	990			Shelby Tube (8-10' bgs): top and bottom as above.	-.8
10			3	100			SP SM	Sand: coarse silica; with gray silt; loose; saturated.	-2.8
							OL ML	Clay: black to gray; very silty; trace mica; high organic content; soft; saturated.	-3.8
			4	75	100				-4.3
15									
20									

WELL DIAGRAM



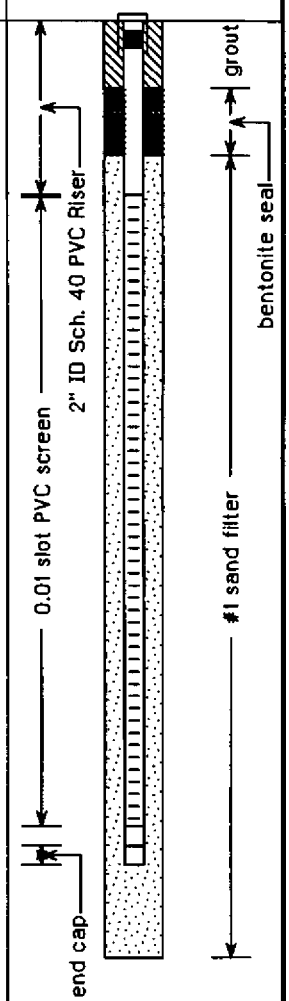
EnSafe/Allen & Hoshall

Monitoring Well NBCG120003

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2321826.82 E, 37235.97 N*
Location: *Charleston, SC*	Surface Elevation: *6.4 feet msl*
Started at *16:00 on 09-03-96*	TOC Elevation: *6.34 feet msl*
Completed at *17:30 on 09-03-96*	Depth to Groundwater: *2.02 feet TOC* Measured: *04/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.32 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.6 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.6 to 12.0 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface: asphalt.	
5							ML SM	Sand: green-grey; fine to medium; silty; dense; moist.	1.4 / .4
			1	50	40		ML SM	Sand: as above.	.6 / .9
							OL	Clay: black; very silty; high organic content; soft; wet.	
			2	100	310				2.6
10							OL	Clay: black with tan; very silty; high organic content; soft; wet.	3.6 / 4.3
							SM	Sand: grey; coarse; some silt; medium dense; saturated.	4.8
			3	75	200				
15									
20									

WELL DIAGRAM



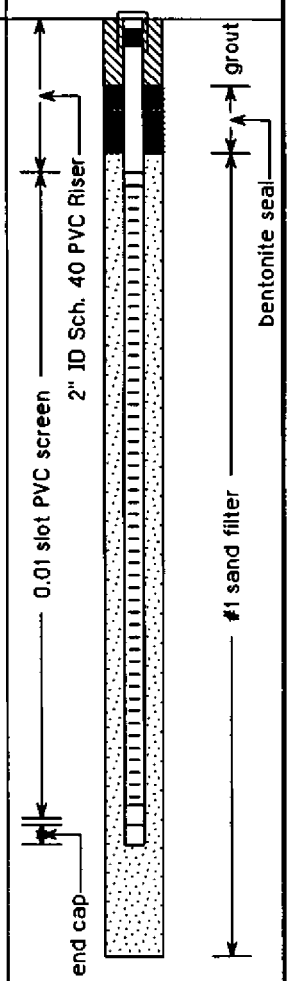
EnSafe/Allen & Hoshall

Monitoring Well NBCG636001

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2321339.02 E, 372002.41 N*
Location: *Charleston, SC*	Surface Elevation: *5.5 feet msl*
Started at *14:00 on 09-11-96*	TOC Elevation: *5.41 feet msl*
Completed at *16:20 on 09-11-96*	Depth to Groundwater: *3.60 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *1.81 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.3 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.3 to 11.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Asphalt.	
5							OL	Clay: black to gray: silty; high organic content; soft; saturated. Note: Some wood in the top of the spoon.	.5 / -.5
			1	50	300		OL	Clay: black to gray silty; high organic content; soft; saturated.	-1.5
			2	100	340			Shelby Tube (9-11' bgs): bottom: marsh clay as above.	-3.5
10			3	100					
15									
20									

WELL DIAGRAM



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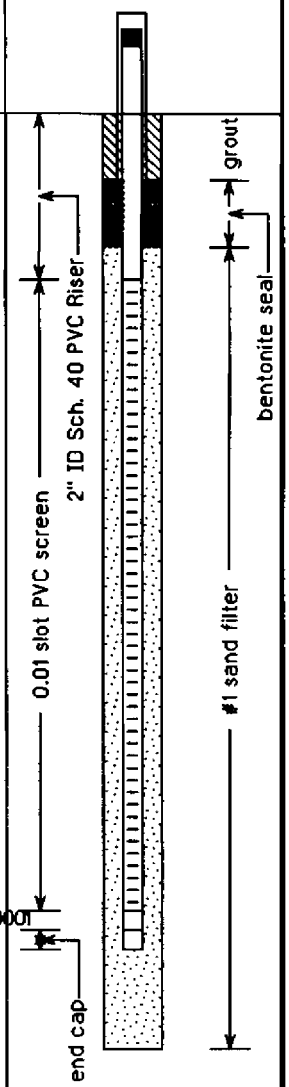
Monitoring Well NBCG637001

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2321380.86 E, 371466.85 N*
Location: *Charleston, SC*	Surface Elevation: *3.1 feet msl*
Started at *10:30 on 09-11-96*	TOC Elevation: *8.15 feet msl*
Completed at *12:00 on 09-11-96*	Depth to Groundwater: *5.15 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *3.00 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.5 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.5 to 11.9 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Gravel.	
							FILL	Wood: very coarse sand; some silt; saturated. FILL Note: This sample had a sweet petroleum odor.	.9 / 1.4
5			1	5	3000			Sheby tube was crushed.	
			2	0			FILL	Wood: very coarse sand; some silt; saturated. FILL Note: This sample had a sweet petroleum odor.	4.9 / 5.4
10			3	10	440		OL	Clay: silty; soft; saturated.	6.9
			4	100	170				8.90000T
15									
20									

WELL DIAGRAM



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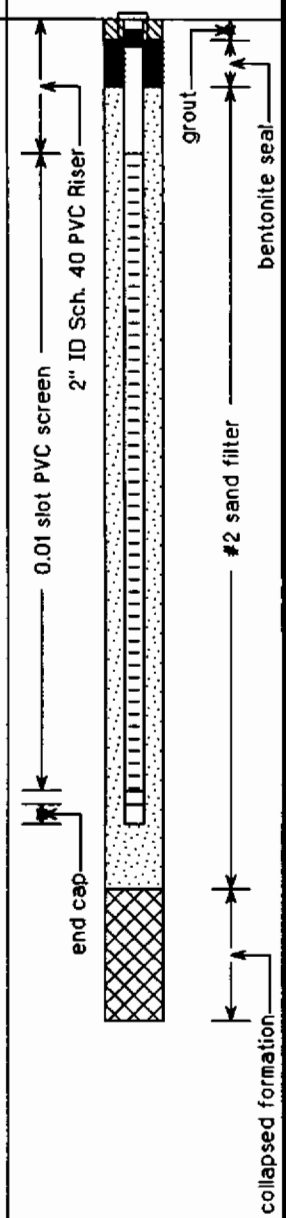
Monitoring Well NBCG637002

Project: *ZONE G- Naval Base Charleston*	Coordinates: *2321539.67 E, 371507.72 N*
Location: *Charleston, SC*	Surface Elevation: *5.6 feet msl*
Started at *1530 on 4-17-97*	TOC Elevation: *5.43 feet msl*
Completed at *1645 on 4-17-97*	Depth to Groundwater: *1.45 feet TOC* Measured: *4/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *3.98 feet msl*
Drilling Company: *Miller Drilling (SC cert. # 1236)*	Total Well Depth: *12.0 feet bgs*
Geologist: *B. Blythe*	Well Screen: *2.0 to 11.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: gravel and ROC.	
							FILL	Fill: gray ROC w/ debris (plastic, metal), and heavy petro odor.	2.6 2.3
5			1	15	0			Borehole logged from cuttings due to debris and limited sampling success. Cuttings from 5-12': black fibrous material; debris; plastic; heavy petro odor.	
10									
							FILL	FILL: tan and gray ROC; w/ shell hash and silty fine sand; wet.	7.4 8
							OL	Clay: gray-black; organic; silty; firm; w/ sand laminae throughout.	8.5
15			2	55	0				
20									

WELL DIAGRAM



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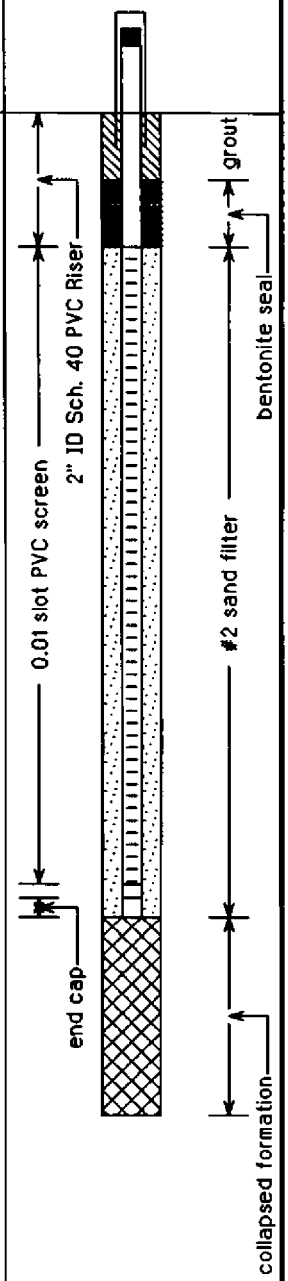
Monitoring Well NBCG637003

Project: *ZONE G- Naval Base Charleston*	Coordinates: *2321134.17 E, 371624.25 N*
Location: *Charleston, SC*	Surface Elevation: *4.2 feet msl*
Started at *1230 on 4-17-97*	TOC Elevation: *7.10 feet msl*
Completed at *1430 on 4-17-97*	Depth to Groundwater: *2.62 feet TOC* Measured: *4/29/97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.48 feet msl*
Drilling Company: *Miller Drilling (SC cert. # 1236)*	Total Well Depth: *13.0 feet bgs*
Geologist: *SHW/BB*	Well Screen: *2.0 to 11.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: grass and gravel.	
							FILL	Fill: brown clayey sand w/ gravel and carbonate ROC.	1.2 / -.6
							SP	Sand: black w/ tan to gray; coarse; clean; moist.	-.5
5			1	70	0				
							FILL	Sand: very coarse; angular; saturated; metal debris and gravel throughout.	-3.8 / -4.1
10			2	15	500				
							FILL	Debris w/ medium to coarse saturated sand intermixed.	-8.8
15			3	15	0		OL OH	Clay: black; silty; organic; soft; wet. Heavy petroleum staining and sheening on cutting head when retracted from borehole.	-10.5 / -10.8
20									

WELL DIAGRAM



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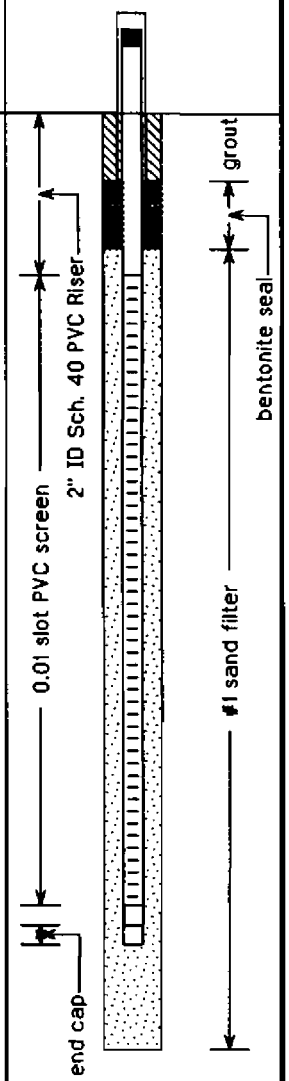
Monitoring Well NBCG638001

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2321520.61 E, 372285.01 N*
Location: *Charleston, SC*	Surface Elevation: *7.4 feet msl*
Started at *09:00 on 09-11-96*	TOC Elevation: *9.87 feet msl*
Completed at *10:30 on 09-11-96*	Depth to Groundwater: *7.78 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *2.09 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.4 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.4 to 11.8 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
5							OL	Clay: black; silty; high organic content; soft; saturated.	3.4
			1	100	0			Shelby tube (6-8'): Bottom: Clay: gray-brown; silty; soft; saturated.	1.4
			2	100			SM	Sand: brown; coarse; silty; loose; saturated.	.6
									-1.6
10			3	50	220		ML	Silt: yellow-brown; some medium to coarse sand; soft; saturated.	-2.6
									-3.6
			4	50	50				
15									
20									

WELL DIAGRAM



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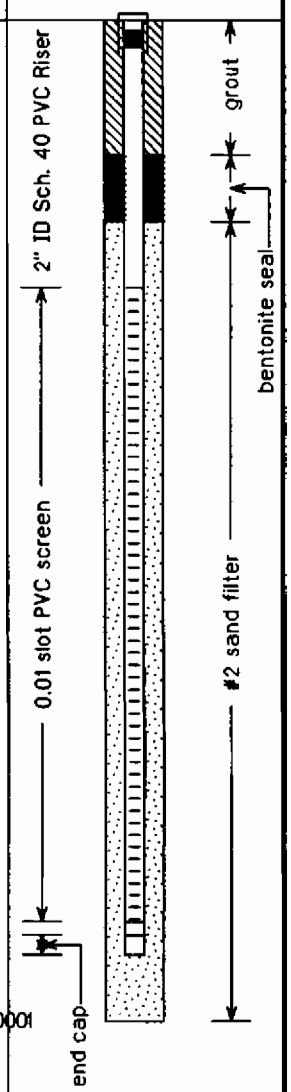
Monitoring Well NBCG706001

Project: *ZONE G- Naval Base Charleston*	Coordinates: *2320680.94 E, 371691.40 N*
Location: *Charleston, SC*	Surface Elevation: *6.1 feet msl*
Started at *1115 on 4-17-97*	TOC Elevation: *5.90 feet msl*
Completed at *1210 on 4-17-97*	Depth to Groundwater: *1.54 feet TOC* Measured: *4-29-97*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *4.36 feet msl*
Drilling Company: *Miller Drilling (SC cert. # 1236)*	Total Well Depth: *14.0 feet bgs*
Geologist: *SHW*	Well Screen: *4.0 to 13.5 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: asphalt	
							FILL	Fill: ROC, asphalt, and damp, fat silty clay.	3.1 2.9
5			1	10	0				
							FILL	Fill: as above; likely slough.	1.9 2.4
							SC	Sand: gray-green; fine; clayey.	2.9
10			2	50	0				
							SM	Sand: gray-green; w/ shell hash and phosphate nodules; silty; loose; wet.	6.9 7.9
							OH	Clay: gray-green; silty; fat; damp.	
15			3	100	2				8.900001
20									

WELL DIAGRAM



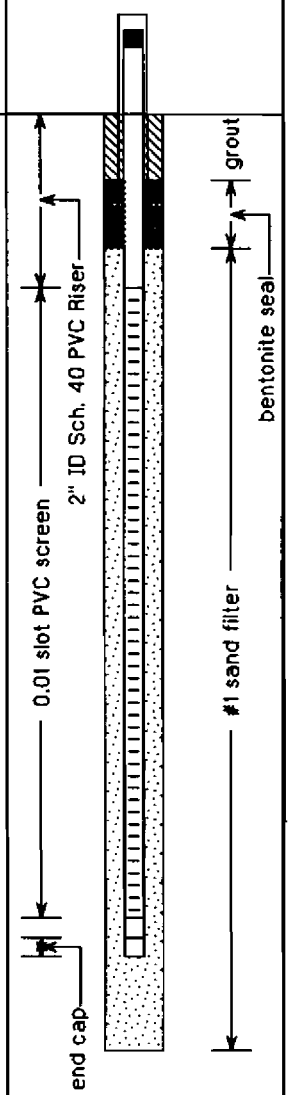
EnSafe/Allen & Hoshall

Monitoring Well NBCGGDG001

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2322412.87 E, 370984.56 N*
Location: *Charleston, SC*	Surface Elevation: *6.0 feet msl*
Started at *08:00 on 08-28-96*	TOC Elevation: *8.49 feet msl*
Completed at *10:00 on 08-28-96*	Depth to Groundwater: *4.56 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *3.93 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.6 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.6 to 12.0 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: ROC and grass.	
							FILL	Silt and sand: black; coarse to fine; some wood and cloth; loose to dense; saturated. Fill	3 / 2.5
5			1	25	250				
								Shelby tube (8-10'): Top: Sand: black; fine to coarse; silty; some wood; cloth; concrete; loose to dense, saturated. Fill	
10			2	25	150		SM	Sand: gray and light brown; fine to coarse; silty; loose; saturated.	4
			3	100	150				6
							OL	Clay: gray to black; very silty; high organic content;soft; saturated.	7
15			4	100	110				9
20									

WELL DIAGRAM



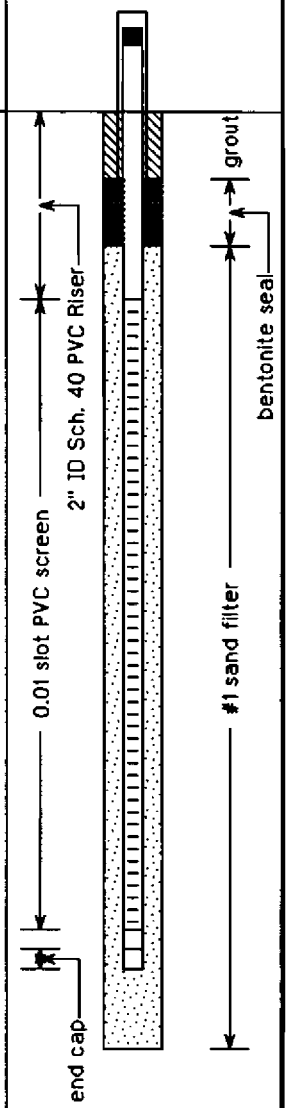
EnSafe/Allen & Hoshall

Monitoring Well NBCGGDG002

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318989.64 E, 372797.45 N*
Location: *Charleston, SC*	Surface Elevation: *8.5 feet msl*
Started at *10:15 on 08-28-96*	TOC Elevation: *10.96 feet msl*
Completed at *11:45 on 08-28-96*	Depth to Groundwater: *4.77 feet TOC* Measured: *12/18/96*
Drilling Method: *4.25" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *6.19 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Well Depth: *12.8 feet bgs*
Geologist: *D. Doyle*	Well Screen: *2.8 to 12.2 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
							CL	Clay: brown; silty; trace organic content; soft; moist.	5.5
							OL	Clay: black; silty; high organic content; soft; moist.	5 / 4.9
5			1	20	0				
								Shelby tube (6-8'): Top: Clay: black and brown; silty; high organic content.	
			2	30					
							ML	Silt: brown; sandy (fine to coarse); soft; saturated.	0
10			3	100	540		CL	Clay: gray; silty; trace fine to coarse sand; soft; saturated.	1.5 / 2
							ML SM	Silt: brown; sandy (fine to coarse sand); loose; saturated.	3.5
			4	75	0		CL	Clay: gray; sandy (fine to coarse); silty; soft; saturated.	5 / 5.5
15									
20									

WELL DIAGRAM



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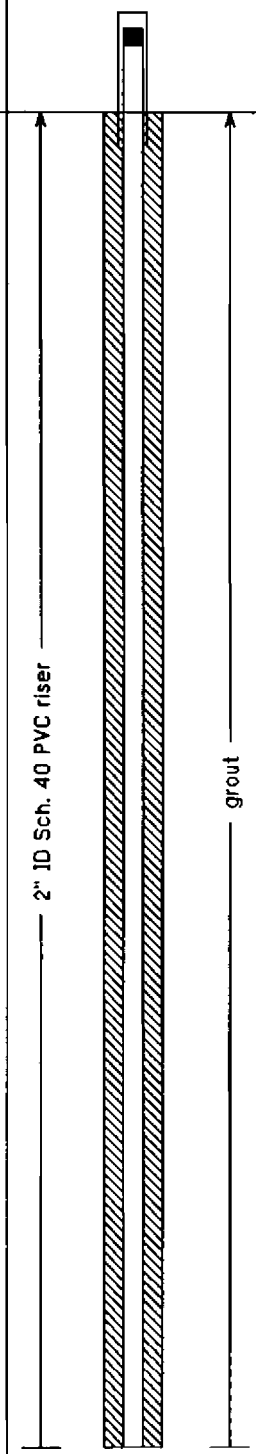
Monitoring Well NBCGGDG01D

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2322397.54 E, 370990.43 N*
Location: *Charleston, SC*	Surface Elevation: *6.0 feet msl*
Started at *1430 on 9-14-96*	TOC Elevation: *8.71 feet msl*
Completed at *1410 on 9-15-96*	Depth to Groundwater: *3.46 feet TOC* Measured: *12-18-96*
Drilling Method: *Rotasonic (6.5" OD casing, 3.8" ID coring bit)*	Groundwater Elevation: *5.25 feet msl*
Drilling Company: *Boart-Longyear (SC# 1232)*	Total Well Depth: *56.5 feet bgs*
Geologist: *P. Bayley*	Well Screen: *46.7 to 55.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
						GM	Surface conditions: Soil/Gravel	
						ML	Gravel: lt grey, white ROC; damp.	5.3
						CL CH	Silt: dark brown; some sand to sandy-very fine, some clay to clayey; wet, plastic, soft; w/disseminated bivalve shells.	4.6
						SP GP	Clay: dark brown black; some silt to silty, some sand-very fine; moist, plastic, stiff; @2.1 ft.: shell fragment. @2.6 ft.: wood fragment.	2.6
5			1	100	0.0		Sand: black; fine to coarse, w/gravel: granule to 2 cm; matrix supported. @4.4-5.0 ft .: brown; w/trace gravel; FID 4.5 ppm. @5.0 ft.: red brick fragment.	1
						OL OH	Clay: dark grey black w/slight brown cast; silty; wet, soft, plastic; w/occasional sand laminae; faint H_2S odor. @6.0-6.9 ft.: many sand laminae/pods decreasing w/depth.	
10						SP SM	Sand: brown; very fine to fine, trace to some silt; wet, soft	3.8
						OL OH	Clay: dark grey black w/slight brown cast; silty; wet, soft, plastic; w/occasional sand laminae; faint H2S odor. @11.9-12.3 ft.: Sand: brown; very fine to fine. @12.7-13.7 ft.: sandy: dark grey; very fine to fine. @13.7-14.1, 14.2 ft.: Sand: dark grey; very fine to fine, silty, clayey.	5.5
						SP SM		5.9
						OL OH		6.3
						SP SM		7.7
						OL OH		8.1
15			2	94	0.0			8.7
						OL OH		9
20								

WELL DIAGRAM



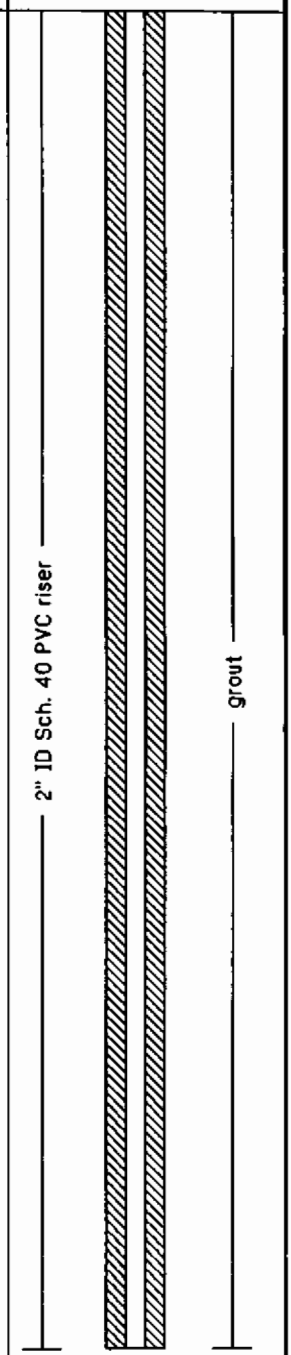
EnSafe/Allen & Hoshall

Monitoring Well NBCGGDG01D

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2322397.54 E, 370990.43 N*
Location: *Charleston, SC*	Surface Elevation: *6.0 feet msl*
Started at *1430 on 9-14-96*	TOC Elevation: *8.71 feet msl*
Completed at *1410 on 9-15-96*	Depth to Groundwater: *3.46 feet TOC* Measured: *12-18-96*
Drilling Method: *Rotasonic (6.5" OD casing, 3.8" ID coring bit)*	Groundwater Elevation: *5.25 feet msl*
Drilling Company: *Boart-Longyear (SC# 1232)*	Total Well Depth: *56.5 feet bgs*
Geologist: *P. Bayley*	Well Screen: *46.7 to 55.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								@21.9 ft.: Grading to dark brown: w/occasional grass.	
								@22.5-23.6 ft.: Color grades rapidly to dark olive green grey.	
25			3	100	1.2			@25.0-35.0 ft.: Color change to dark grey; becomes very silty; wet, very soft; w/some disseminated very fine to medium shell fragments.	
							OL/OH		
								@28.5 ft.: wood fragment. @30.2-30.4, 30.8, 32.2, 32.8, and 34.4 ft.: sandy pods/laminae; very fine to medium; typically w/some shell fragments; silty, clayey.	
30									
									28.1
35			4	82	0.0			No Recovery: Interior of drill rod had portions of marsh clay.	
40									

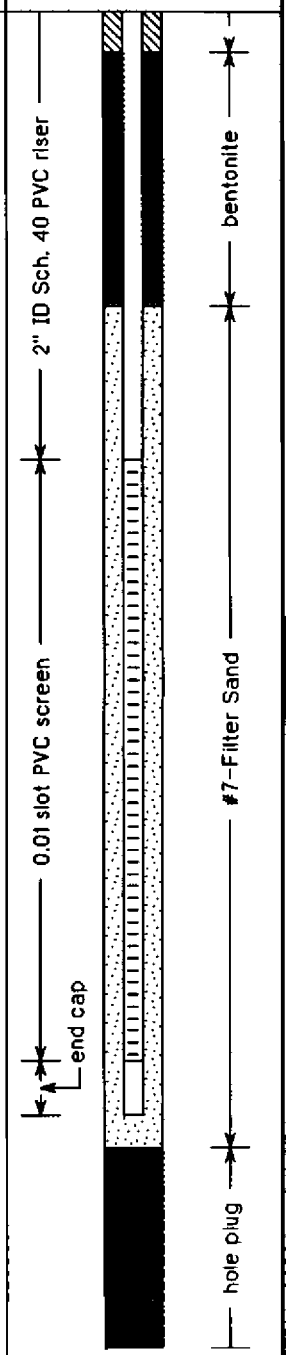
WELL DIAGRAM



EnSafe/Allen & Hoshall	Monitoring Well NBCGGDG01D
Project: *ZONE G – Naval Base Charleston*	Coordinates: *2322397.54 E, 370990.43 N*
Location: *Charleston, SC*	Surface Elevation: *6.0 feet msl*
Started at *1430 on 9-14-96*	TOC Elevation: *8.71 feet msl*
Completed at *1410 on 9-15-96*	Depth to Groundwater: *3.46 feet TOC* Measured: *12-18-96*
Drilling Method: *Rotasonic (6.5" OD casing, 3.8" ID coring bit)*	Groundwater Elevation: *5.25 feet msl*
Drilling Company: *Boart-Longyear (SC# 1232)*	Total Well Depth: *56.5 feet bgs*
Geologist: *P. Bayley*	Well Screen: *46.7 to 55.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			5	0	0.0				39
							OL OH	Clay: dark green grey; silty; soft to firm, wet, plastic, sticky; w/occasional very thin sandy partings (<2mm). @46.0-47.0 ft.: very thin sand laminae every 1-2 cm.	
50									
							SW		47.7
							SP	Sand: grey; fine to coarse, w/some shell fragments; wet, soft-loose. @54.1-54.6 ft.: w/some clayey laminae, no large shell fragments.	48.1
							SW		48.6
55			6	92	0.0				49
							ML CL	Silt: olive green: some sand to sandy-very fine to fine, trace to some PO_4 sand, trace bits of very small shell fragments; moist to wet, firm, plastic; pebbly remnant at top of core---Ashley Fm.	
60									

WELL DIAGRAM



EnSafe/Allen & Hoshall	Monitoring Well NBCGGDG01D
Project: *ZONE G - Naval Base Charleston*	Coordinates: *2322397.54 E, 370990.43 N*
Location: *Charleston, SC*	Surface Elevation: *6.0 feet msl*
Started at *1430 on 9-14-96*	TOC Elevation: *8.71 feet msl*
Completed at *1410 on 9-15-96*	Depth to Groundwater: *3.46 feet TOC* Measured: *12-18-96*
Drilling Method: *Rotasonic (6.5" OD casing, 3.8" ID coring bit)*	Groundwater Elevation: *5.25 feet msl*
Drilling Company: *Boart-Longyear (SC# 1232)*	Total Well Depth: *56.5 feet bgs*
Geologist: *P. Bayley*	Well Screen: *46.7 to 55.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
65			7	98	0.0		ML CL	@65.0-67.5 ft.: Shelby tube: top and bottom of tube as above.		hole plug
			8	100	0.0				61.5	
70										
75										
80										

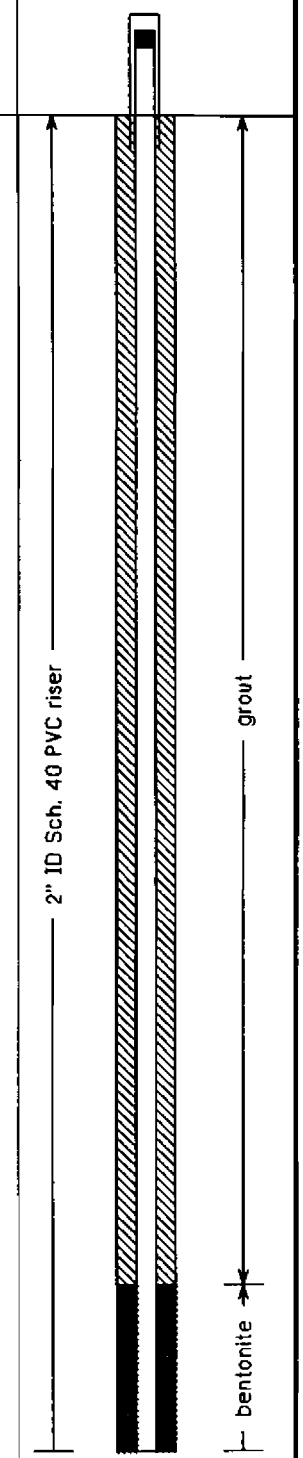
EnSafe/Allen & Hoshall

Monitoring Well NBCGGDG02D

Project: *ZONE G - Naval Base Charleston*	Coordinates: *2318979.15 E, 372789.26 N*
Location: *Charleston, SC*	Surface Elevation: *8.4 feet msl*
Started at *1000 on 8-30-96*	TOC Elevation: *10.37 feet msl*
Completed at *1230 on 8-30-96*	Depth to Groundwater: *4.70 feet TOC* Measured: *12-18-96*
Drilling Method: *Rotasonic (6.5" OD casing, 3.8" ID coring bit)*	Groundwater Elevation: *5.67 feet msl*
Drilling Company: *Boart-Longyear (SC# 1232)*	Total Well Depth: *26.5 feet bgs*
Geologist: *P. Bayley*	Well Screen: *21.7 to 25.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							CL ML	Surface conditions: Soil/Grass Clay: brown; some silt to silty; rootlets.	7.4
							CL CH	Clay: yellow orange brown; some silt to silty; dry; rootlets. Clay: brown to red brown, w/faint very thin lighter color silty-sandy laminae; some silty; dry, stiff, plastic. @1.7-3.2 ft.: very firm to stiff. @2.5-3.2 ft.: w/black laminae/pods increasing with depth. @3.2-3.6 ft.: color has become black w/brown.	4.8 4.2
5			1	84	0.0		OL OH	Clay: dark grey black; silty; wet, soft, sticky, plastic.	3.4 3.1
							OL CL	Clay: brown w/occasional black; some silt to silty; wet, soft, sticky, plastic; rootlets throughout and somewhat peaty. @5.9-6.3 ft.: rootlet mass. @7.8-8.1 ft.: Clay: brown grey; silty, some sand-very fine; wet, plastic.	-6
							CL		-8
10							CL CH	Clay: blue green w/occasional dark grey black laminae (<1cm) at irregular intervals in upper 1.5 ft (9.0-10.5) interval; some silt, some sand; wet, plastic, stiff; occasional thin sandy laminae with indistinct contacts. @11.0-14.3 ft.: coloration grades to grey green and has someFeOx sandy pits.	-5.9
15			2	86	0.0		CL CH	Clay: blue grey; some silt; moist, stiff; w/thinly interbedded sandy laminae and pits colored w/FeOx stain. @19.7-19.8 ft.: trace shell fragments and PO_4 granules.	-6.6
20									

WELL DIAGRAM



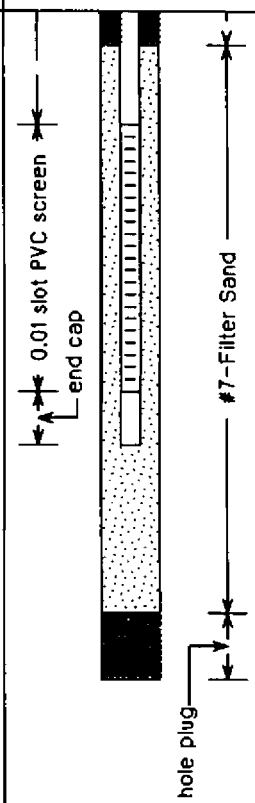
EnSafe/Allen & Hoshall

Monitoring Well NBCGGDG02D

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318979.15 E, 372789.26 N*
Location: *Charleston, SC*	Surface Elevation: *8.4 feet msl*
Started at *1000 on 8-30-96*	TOC Elevation: *10.37 feet msl*
Completed at *1230 on 8-30-96*	Depth to Groundwater: *4.70 feet TOC* Measured: *12-18-96*
Drilling Method: *Rotasonic (6.5" OD casing, 3.8" ID coring bit)*	Groundwater Elevation: *5.67 feet msl*
Drilling Company: *Boart-Longyear (SC# 1232)*	Total Well Depth: *26.5 feet bgs*
Geologist: *P. Bayley*	Well Screen: *21.7 to 25.7 feet bgs*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							CL CH ML	Clay: as above and Sand: brown; very fine to fine, silty, interbedded.	12.1
								Silt: brown; sandy-very fine, trace clay; wet, soft, slightly sticky.	13
							SC SM	Sand: brown w/thin dark brown laminae increasing w/depth; very fine to fine, silty, trace to some clay; firm, wet; w/some PO_4 sand-very fine. @24.2-24.4 ft.: becomes lt brown; silty, clayey; w/some shell fragments. @24.4-24.6 ft.: color grades to olive brown; w/PO_4 sand.	16.2
25			3	92	0.0				16.6
							SM ML	Sand: olive green; very fine to fine, trace medium, , clayey, very silty; wet, firm, low plasticity; strong effervescence in HCl--- Ashley Fm.	
30			4	100	0.0				21.6
35									
40									

WELL DIAGRAM



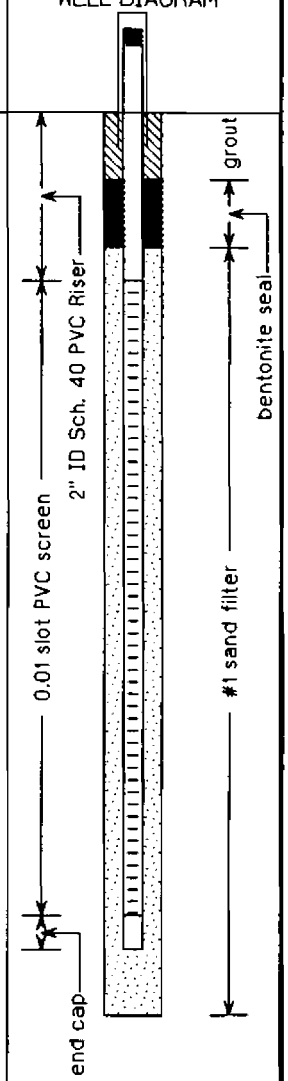
ENSAFE

Monitoring Well NBCG024001

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318620.1 E, 373377.1 N*
Location: *Charleston, SC*	Surface Elevation: *7.5 feet msl*
Started at *1645 on 3-18-98*	TOC Elevation: *7.42 feet msl*
Completed at *1830 on 3-18-98*	Depth to Groundwater: *1.90 feet TOC* Measured: *3/24/98*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *5.52 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Depth: *12.5 feet*
Geologist: *T. Kafka*	Well Screen: *2.5 to 12.0 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	OVA (ppm)	% RECOVERY	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
5							CL	Clay: brown; silty; w/ very fine/fine sand; soft to firm; wet.	2.5 / 2
			1	0	25		SC	Sand: blue-green; very fine/fine; trace to some silt; w/ soft, med. plastic clay; wet.	.5
							SM	Sand: olive-brown; very fine/fine; silty; saturated.	-3 / -3.5
			2	0	50		SC CL	Sand: blue-green w/ FeOx stains and pits; very fine/med.; silty; clay in matrix and as thin laminae <1 cm thick; saturated.	-1.5 / -3.1
10			3	0	80		CL CH	Clay: gray; silty; heavily oxidized (orange) portions throughout; soft to firm; moist.	-3.5
			4	0	100				-5.5
15									
20									

WELL DIAGRAM



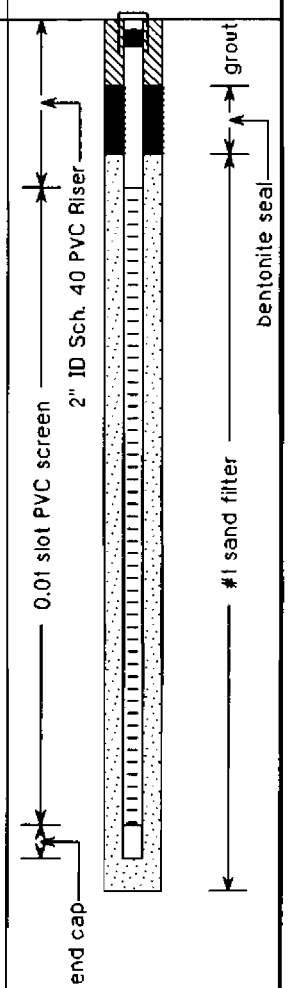
ENSAFE

Monitoring Well NBCG024002

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2318893.2 E, 373574.3 N*
Location: *Charleston, SC*	Surface Elevation: *9.2 feet msl*
Started at *1510 on 3-18-98*	TOC Elevation: *11.19 feet msl*
Completed at *1635 on 3-18-98*	Depth to Groundwater: *3.10 feet TOC* Measured: *3/24/98*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *8.09 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Depth: *12.5 feet*
Geologist: *T. Kafka*	Well Screen: *2.5 to 12.0 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	OVA (ppm)	% RECOVERY	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: grass.	
5							SM SC	Sand: orange to gray w/ brown mottling; fine/med.; silty; trace to some clay in matrix and occ. thin laminae and stringers; wet.	5.2 / 4.6
			1	0	30		SM	Sand: green-gray; very fine/fine w/ trace med.; silty; some clay in small, distinct lenses/stringers; saturated.	3.2 / 2.2
			2	0	50		CL CH	Clay: med. gray w/ brown to orange laminae; sticky; med. plasticity; soft to firm; very fine/fine sand in rapidly interbedded brown laminae; saturated.	1.2 / .3
10			3	0	75		SM CL SM SM	Interbedded sand/clay: Sand: brown; very fine/fine, w/ trace med. at 10.9'; silty; Clay: med. gray; silty; med. plasticity; soft; rapidly interbedded w/ very fine sand lenses at 10.5-10.9'; wet.	.8 / 1.3 / 1.7 / 1.9
			4	0	95		CH		2.7 / 2.8
							CH CL	Clay: med. gray; silty; med. to high plasticity; firm; moist.	3.3
			5	0	95			Clay: as above.	4.7
15								Clay: brown-gray to med. gray; silty; low plasiticity; soft; ~20% very fine/fine sand; wet.	
20									

WELL DIAGRAM



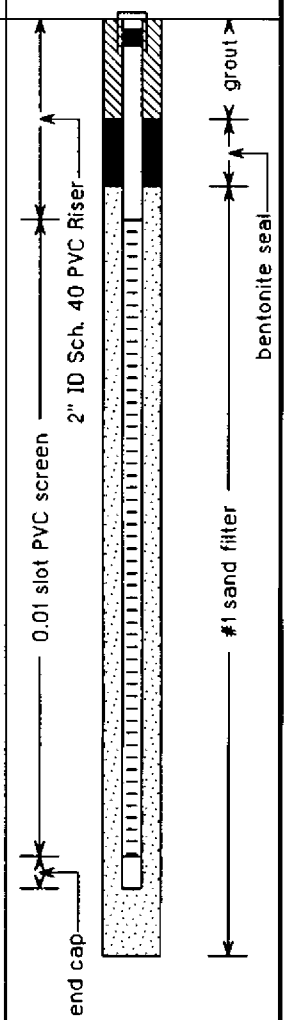
ENSAFE

Monitoring Well NBCG024003

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2319046.9 E, 373690.9 N*
Location: *Charleston, SC*	Surface Elevation: *10.0 feet msl*
Started at *1115 on 3-18-98*	TOC Elevation: *12.27 feet msl*
Completed at *1230 on 3-18-98*	Depth to Groundwater: *5.30 feet TOC* Measured: *3/24/98*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *6.97 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Depth: *13.0 feet*
Geologist: *T. Kafka*	Well Screen: *3.0 to 12.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	OVA (ppm)	% RECOVERY	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: asphalt.	
5							CL SC	Clay: lt. gray w/ orange-brown mottling; FeOx pits; med. plasticity; soft; ~30% very fine/fine sand in matrix; trace-some silt; moist.	6 / 5.4
			1	0	30		CL CH	Clay: green-blue to green-gray w/ FeOx mottling/pits; silty; med. plasticity; soft; ~20% very fine/fine sand in matrix; moist.	4 / 3.5
			2	0	25		CL CH	Clay: as above w/o FeOx mottling.	2 / 1.6
							SC	Sand: green-gray; very fine/fine; clayey; trace-some silt; moist.	1
10			3	0	50		SC	Sand: green-gray to green-blue; very fine/fine; soft, med. plasticity clay in matrix; occ. FeOx stains; very fine/fine, silty sand lens at 10.6-10.8'; rapidly interbedded clay and sand lenses between 10.8-11.3 ft; wet.	0 / 1.3
			4	0	65		SM SC		2 / 2.4
							CL CH	Sand: as above w/ fewer clay laminae; very fine/fine; silty; wet.	2.7
15			5	0	35			Clay: med. gray w/ extensive orange-brown FeOx nodules and pits; high plasticity; stiff; some fine/medium sand.	
20									

WELL DIAGRAM



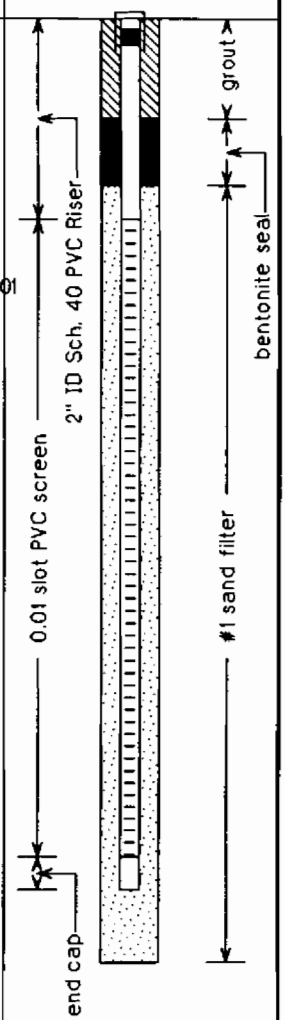
ENSAFE

Monitoring Well NBCG024004

Project: *ZONE G – Naval Base Charleston*	Coordinates: *2319229.8 E, 373471.3 N*
Location: *Charleston, SC*	Surface Elevation: *12.9 feet msl*
Started at *0930 on 3-18-98*	TOC Elevation: *11.11 feet msl*
Completed at *1040 on 3-18-98*	Depth to Groundwater: *5.40 feet TOC* Measured: *3/24/98*
Drilling Method: *4.5" ID (7.5" OD) HSA with split spoon sampler*	Groundwater Elevation: *5.71 feet msl*
Drilling Company: *Alliance Environmental (SC cert. #889)*	Total Depth: *13.0 feet*
Geologist: *T. Kafka*	Well Screen: *3.0 to 12.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	OVA (ppm)	% RECOVERY	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: Grass	
							SP	Sand: brown w/ black silty pits; very fine/fine; dry; crumbly.	8.900001
							CL		8.6
5								Clay: lt. gray w/ orange-brown and yellow mottling; trace-some very fine/fine sand; some silt; soft; moist.	7.9
			1	0	50		CL		6.9
							SC		6.4
							SC	Clay: as above w/ increased percentage of fine/med. sand.	5.6
			2	0	65		SC	Sand: green-blue w/ black silt pods (slight Petro odor); fine/med.; clayey; trace silt in matrix; moist.	4.9
									4.1
10			3	0	40		SC	Sand: as above w/ Petro odor; occasional FeOx stains as horizontal laminae; moist.	2.9
							SM		2.5
							CL	Sand: as above.	1.9
							SM		1.6
			4	0	65		SM	Sand: tan to green-gray; fine/med.; some silt; soft, sticky, low plasticity clay in matrix but mostly at distinct laminae; wet.	.9
							CL		
								Sand: brown to med. brown; very fine/fine; silty; wet.	.3
			5	0	60				
15								Sand: brown to green-gray; very fine/fine; silty; w/ interbedded silty, low plasticity, gray clay lenses/stringers; heavy FeOx stains at 12.9-13.1'.	
20									

WELL DIAGRAM



SECTION B

Appendix B
Zone G
Geotechnical Summary

Geotechnical Subsurface Investigation

Naval Base Charleston, SC
Zone G Investigation
E/A&H P.O. #88

Laboratory Tests Conducted BY:

SOIL CONSULTANTS, INC.
ENGINEERS & GEOLOGISTS
SINCE 1951

SCI
Construction Materials
Non Destructive
Geotechnical
Environmental

SCI Laboratory No. 97-320

Materials Testing Report	SOIL CONSULTANTS, INC.	Tabulated Data Sheet
Project And State: Naval Base Charleston, SC - Zone G Investigation Charleston, SC		Date: 2-20-97

I. Results of Falling Head Permeability Test for Granular Soils, Porosity, and Specific Gravity

Sample Number	Depth (feet)	Moisture Content (%)	Bulk Wet Density (g/cc)	Specific Gravity	Porosity (%)	Permeability
003-SW-00202	2'-4'	9.6	1.94	2.62	33.1	7.70E-04
003-SW-00206	6'-8'	18.7	1.90	2.62	41.0	3.20E-04
003-SW-00210	10'-12'	26.2	1.78	2.71	51.5	1.34E-03
011-SW-00202	2'-4'	10.0	1.53	2.67	48.3	6.70E-03

II. Results of Moisture Contents and Wet Unit Weights for Shelby Tube Samples

Sample Number	Depth (feet)	Moisture Content (%)	Wt. Unit Weight (lb/cu. ft)
'003-SW-00202	2'-4'	9.3	119.80
'003-SW-00206	6'-8'	13.4	116.60
003-SW-00208	8'-10'	20.1	137.70
003-SW-00210	10'-12'	28.7	117.80
011-SW-00106	6'-8'	17.8	129.70
011-SW-00202	2'-4'	8.4	116.10
120-SW-00204	4'-6'	28.4	114.20

Materials Testing Report	SOIL CONSULTANTS, INC.	HYDRAULIC CONDUCTIVITY TEST ASTM - D 5084
Project And Location:	Naval Base Charleston, Zone G Investigation Charleston, SC E/A&H P.O.#88	
SCI Project:	97-320 Date:	2-20-97

SAMPLE IDENTIFICATION	003SW00208 8'-10'	011SW00106 6'-8'	120SW00204 4'-6'	

INITIAL CONDITIONS

Sample Length, cm	5.08	5.0165	5.0165	
Sample Diameter, cm	5.08	5.08	5.08	
Moisture Content, %	19.14	19.6	40.75	
Unit Wet Weight, pcf	128.6	128.2	91.787	
Unit Dry Weight, pcf	107.9577	107.2	65.2	
Specific Gravity	2.76	2.66	2.6	
Porosity %	37.4	35.5	59.7	
Saturation, %	88.6	94.7	71.3	

FINAL CONDITIONS

Sample Length, cm	5.08	5.0165	4.572	
Sample Diameter, cm	5.08	5.08	5.0165	
Moisture Content, %	20.08	20.4	43.01	
Unit Wet Weight, pcf	130.62	129.6	101.8	
Unit Dry Weight, pcf	108.8	107.699	71.2	
Saturation, %	94.9	99.9	87.6	

TEST CONDITIONS

Permeant	Potable Water	Potable Water	Potable Water	
Cell Pressure, psi	40	40	40	
Back Pressure, psi	37-35	37-35	37-35	
B-value	0.100	0.100	0.96	
Average Gradient	27.6	27.95	27.95	
Hydraulic Conductivity, cm/sec @ 20 deg. C	2.218×10^{-6}	6.359×10^{-7}	1.079×10^{-6}	

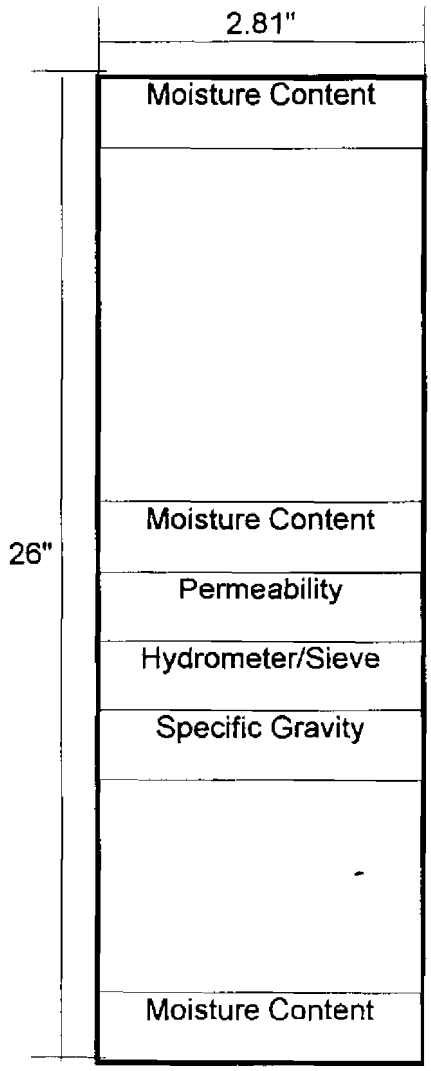
SOIL CONSULTANTS, INC.

John Kenneth Johnson

Materials Testing Report	SOIL CONSULTANTS INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location:	Naval Base Charleston, SC - Zone G Investigation		
Sample Location: 003-SW	Sample No. 00202	Depth: 2'-4'	Type of Sample: Pushed
SCI Project No 97-320		Date: 2-20-97	

Color	Tan	Texture	Sand
Relative Moisture	Damp	Pocket Penetrometer (TSF)	N/A
Consistency	Semi-solid	Visual Classification (USCS)	SM-SP
Porosity or Structure	Uniform	Moisture Content (composite)	9.3%
		Wet Unit Weight (lb/cu. ft)	119.8



REMARKS:

Tan fine sand

pp= N/A tsf

Materials Testing Report	SOIL CONSULTANTS, INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location: Naval Base Charleston, SC - Zone G Investigation

Sample Location:	003-SW	Sample No. 00206	Depth: 6'-8'	Type of Sample: Pushed

SCI Project No. 97-320 Date: 2-20-97 (revised 3-6-97)

Color	Tan	Texture	Sand
Relative Moisture	Damp	Pocket Penetrometer (TSF)	N/A
Consistency	Semi-solid	Visual Classification (USCS)	SM-SP
Porosity or Structure	Uniform	Moisture Content (composite)	13.4%
		Wet Unit Weight (lb/cu.ft)	116.6

2.81"

23 3/4"

Moisture Content

Moisture Content

Permeability

Hydrometer/Sieve

Specific Gravity

Moisture Content

REMARKS:

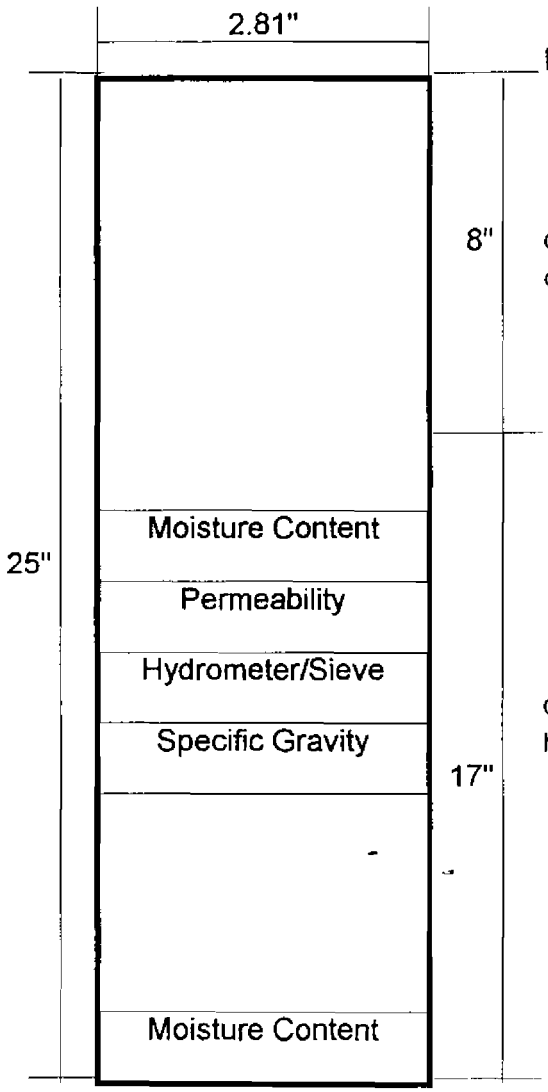
Tan fine sand

pp= N/A tsf

Materials Testing Report	SOIL CONSULTANTS INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location:	Naval Base Charleston, SC - Zone G Investigation		
Sample Location: 003-SW	Sample No. 00208	Depth: 8'-10'	Type of Sample: Pushed
SCI Project No 97-320		Date: 2-20-97	

Color	Tan, green, and orange	Texture	Sand and clay
Relative Moisture	Moist	Pocket Penetrometer (TSF)	N/A
Consistency	Solid	Visual Classification (USCS)	SM-SP and SC
Porosity or Structure	Banded	Moisture Content (composite)	20.1% (bottom 17")
		Wet Unit Weight (lb/cu. ft)	137.7 (bottom 17")



REMARKS:

Orange fine sand with slight clay content.

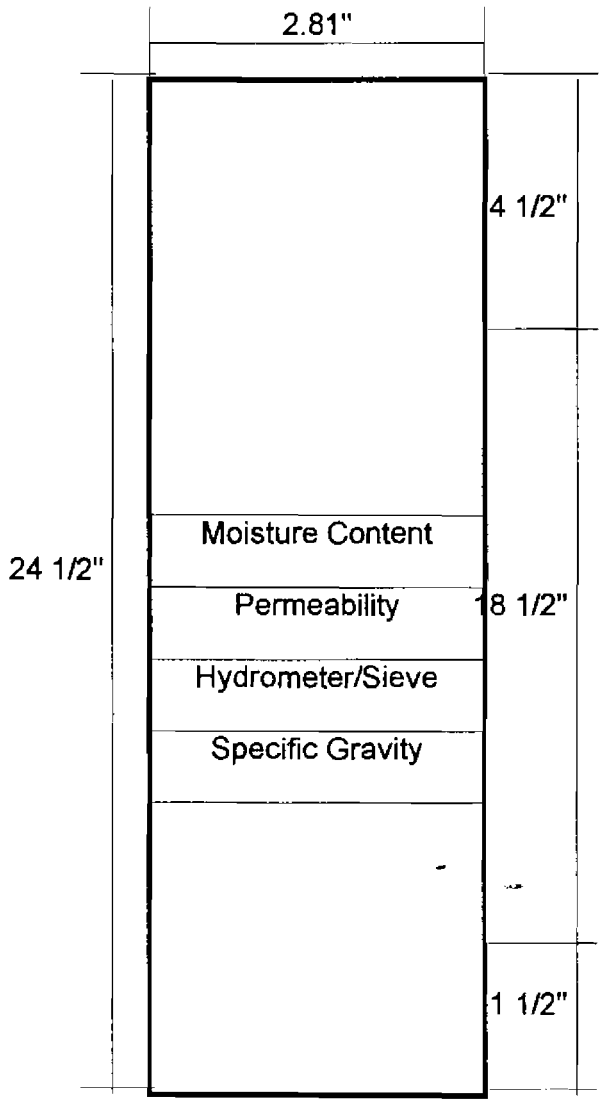
Green, tan, and orange sand with high clay content

pp= N/A tsf

Materials Testing Report	SOIL CONSULTANTS INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location:	Naval Base Charleston, SC - Zone G Investigation		
Sample Location: 003-SW	Sample No. 00210	Depth: 10'-12'	Type of Sample: Pushed
SCI Project No 97-320		Date: 2-20-97	

Color	Orange, tan, and gray	Texture	Sand and clay
Relative Moisture	Excessive	Pocket Penetrometer (TSF)	N/A
Consistency	Semi-solid	Visual Classification (USCS)	SM-SP and CL
Porosity or Structure	Banded	Moisture Content (composite)	28.7% (middle 18 1/2")
		Wet Unit Weight (lb/cu. ft)	117.8 (middle 18 1/2")



REMARKS:

Orange and tan sand with high clay content.

Tan and greenish tan fine sand.

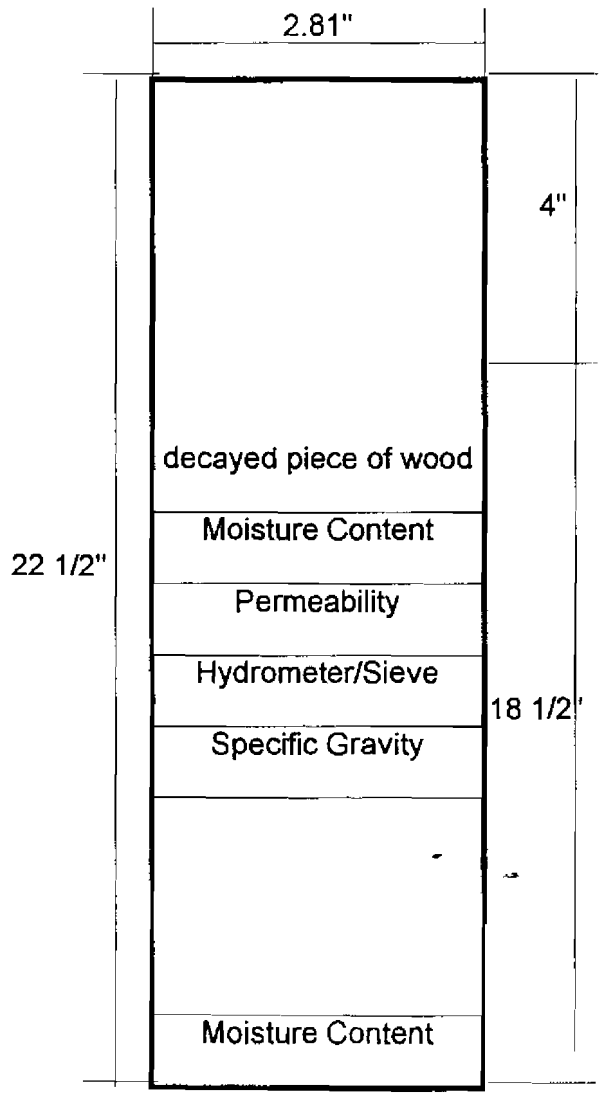
Gray inorganic clay with sand lenses.

pp= N/A tsf

Materials Testing Report	SOIL CONSULTANTS INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location:	Naval Base Charleston, SC - Zone G Investigation		
Sample Location: 011-SW	Sample No. 00106	Depth: 6'-8'	Type of Sample: Pushed
SCI Project No 97-320		Date: 2-20-97	

Color	Tan, brown, greenish, orange tan	Texture	Sand and clay
Relative Moisture	Moist	Pocket Penetrometer (TSF)	N/A
Consistency	Solid	Visual Classification (USCS)	SM-SP and CL-SC
Porosity or Structure	Banded	Moisture Content (composite)	17.8% (bottom 18 1/2")
		Wet Unit Weight (lb/cu. ft)	129.7 (bottom 18 1/2")



REMARKS:

Tan and brown fine sand with slight inorganic clay content

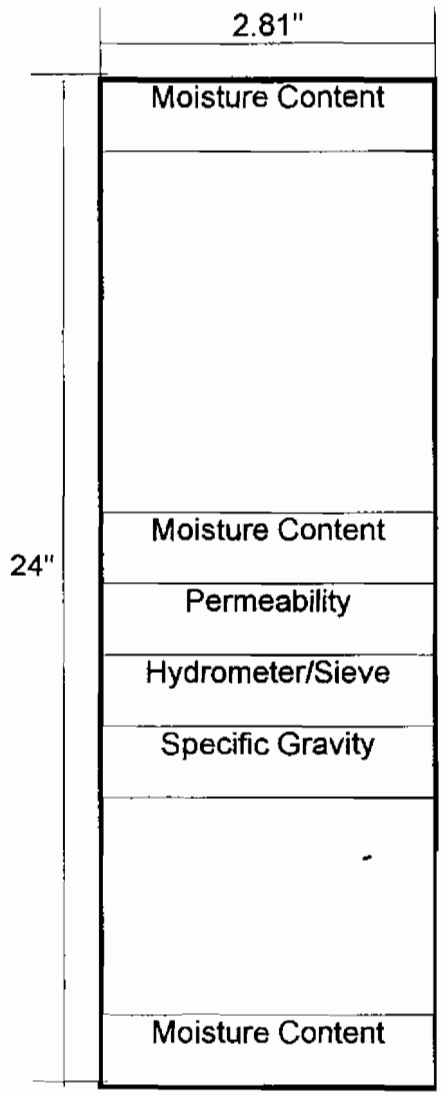
Greenish and orange tan inorganic clay with high sand content.

pp= N/A tsf

Materials Testing Report	SOIL CONSULTANTS INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location:	Naval Base Charleston, SC - Zone G Investigation		
Sample Location: 011-SW	Sample No. 00202	Depth: 2'-4'	Type of Sample: Pushed
SCI Project No 97-320		Date: 2-20-97	

Color	Tan	Texture	Sand
Relative Moisture	Damp	Pocket Penetrometer (TSF)	N/A
Consistency	Semi-solid	Visual Classification (USCS)	SM-SP
Porosity or Structure	Uniform	Moisture Content (composite)	8.4%
		Wet Unit Weight (lb/cu. ft)	116.1



REMARKS:

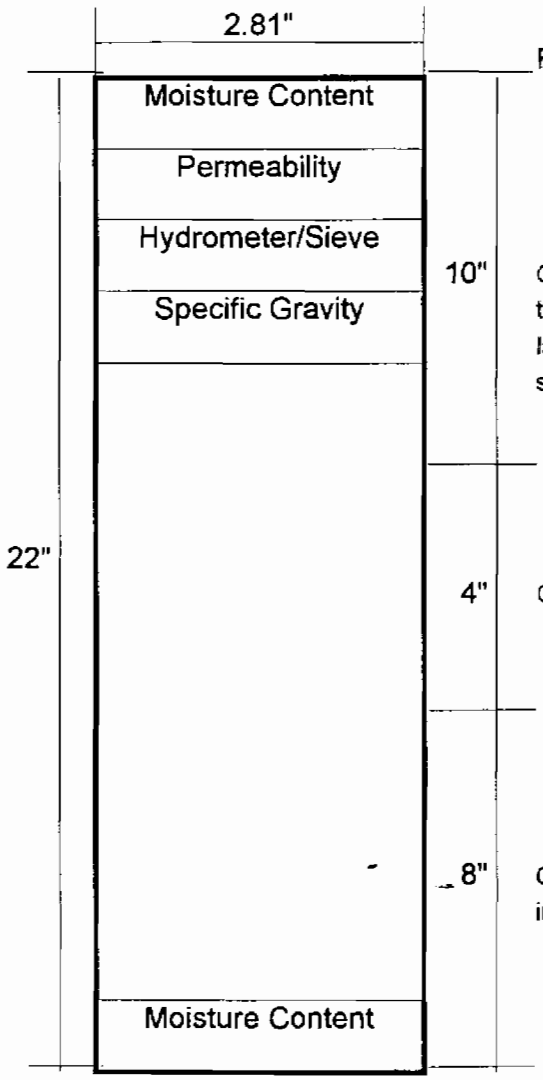
Tan fine sand

pp= N/A tsf

Materials Testing Report	SOIL CONSULTANTS INC.	UNDISTURBED SAMPLE CHARACTERISTICS

Project And Location:	Naval Base Charleston, SC - Zone G Investigation		
Sample Location: 120-SW	Sample No. 00204	Depth: 4'-6'	Type of Sample: Pushed
SCI Project No 97-320		Date: 2-20-97	

Color	Gray and brown	Texture	Sand and clay
Relative Moisture	Moist	Pocket Penetrometer (TSF)	N/A
Consistency	Semi-solid	Visual Classification (USCS)	SM-SP and CH
Porosity or Structure	Banded	Moisture Content (composite)	28.4% (top 10")
		Wet Unit Weight (lb/cu. ft)	114.20 (top 10")



REMARKS:

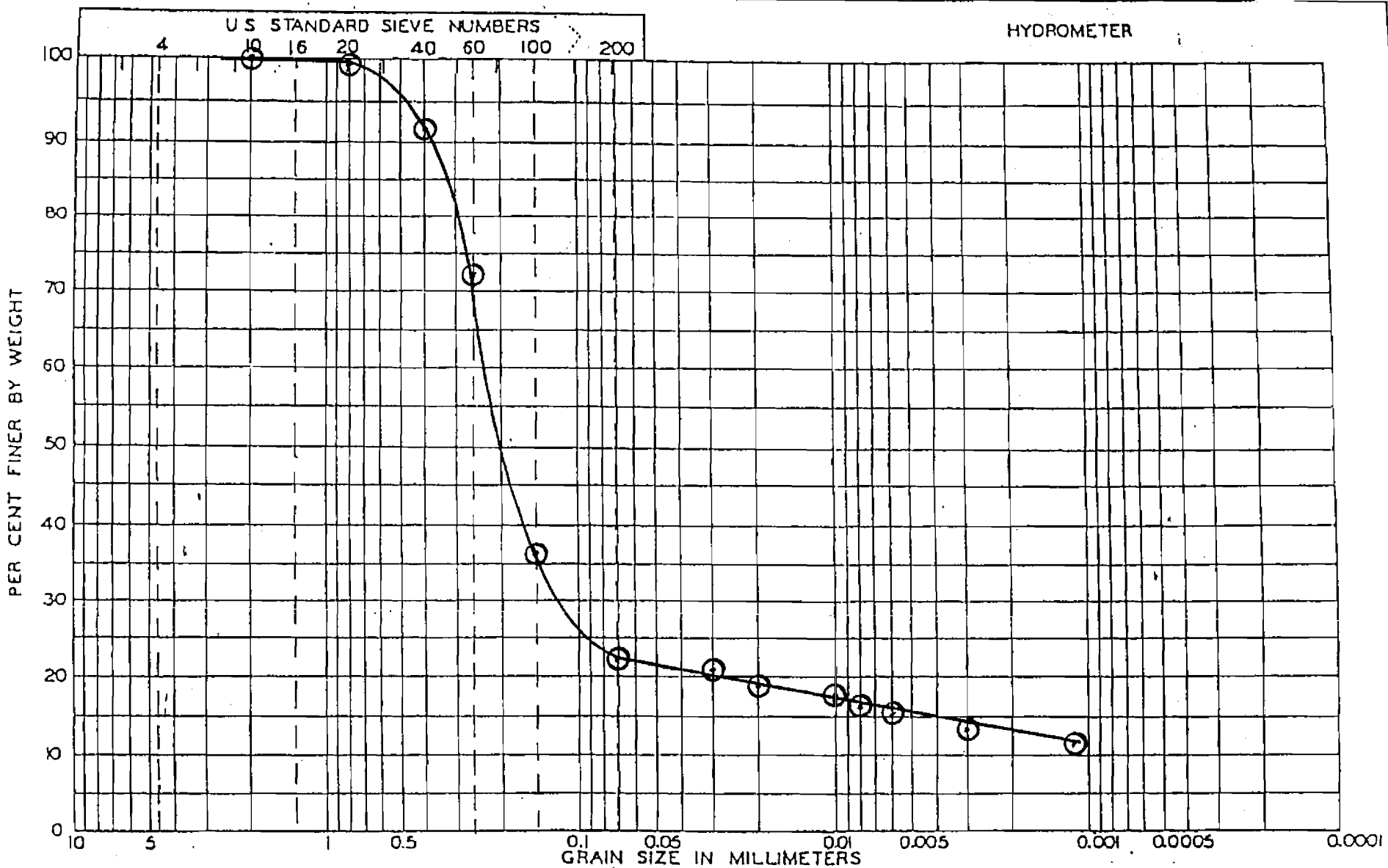
10" Gray and brown fine sand with slight to medium inorganic clay with a large piece of decayed wood and several pieces of large aggregate

4" Gray inorganic clay

8" Grayish tan fine sand with slight inorganic clay content.

pp= N/A tsf

SCI NUMBER: 97-32



UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/003SW0202

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

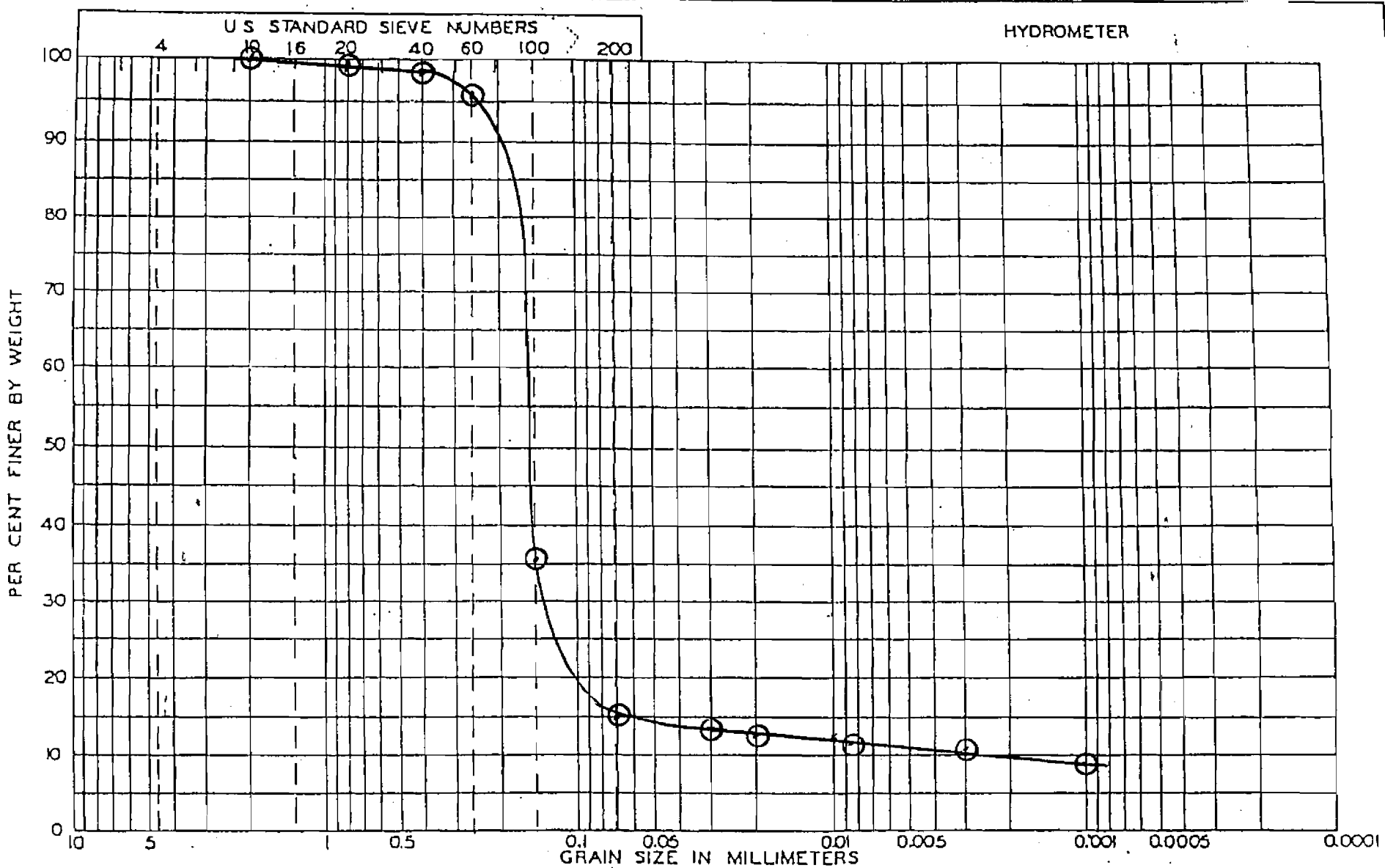
BORING NUMBER _____ SAMPLE NUMBER _____

DEPTH 2' - 4' ELEVATION _____ REMARKS _____

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-32



UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/003SW00206

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

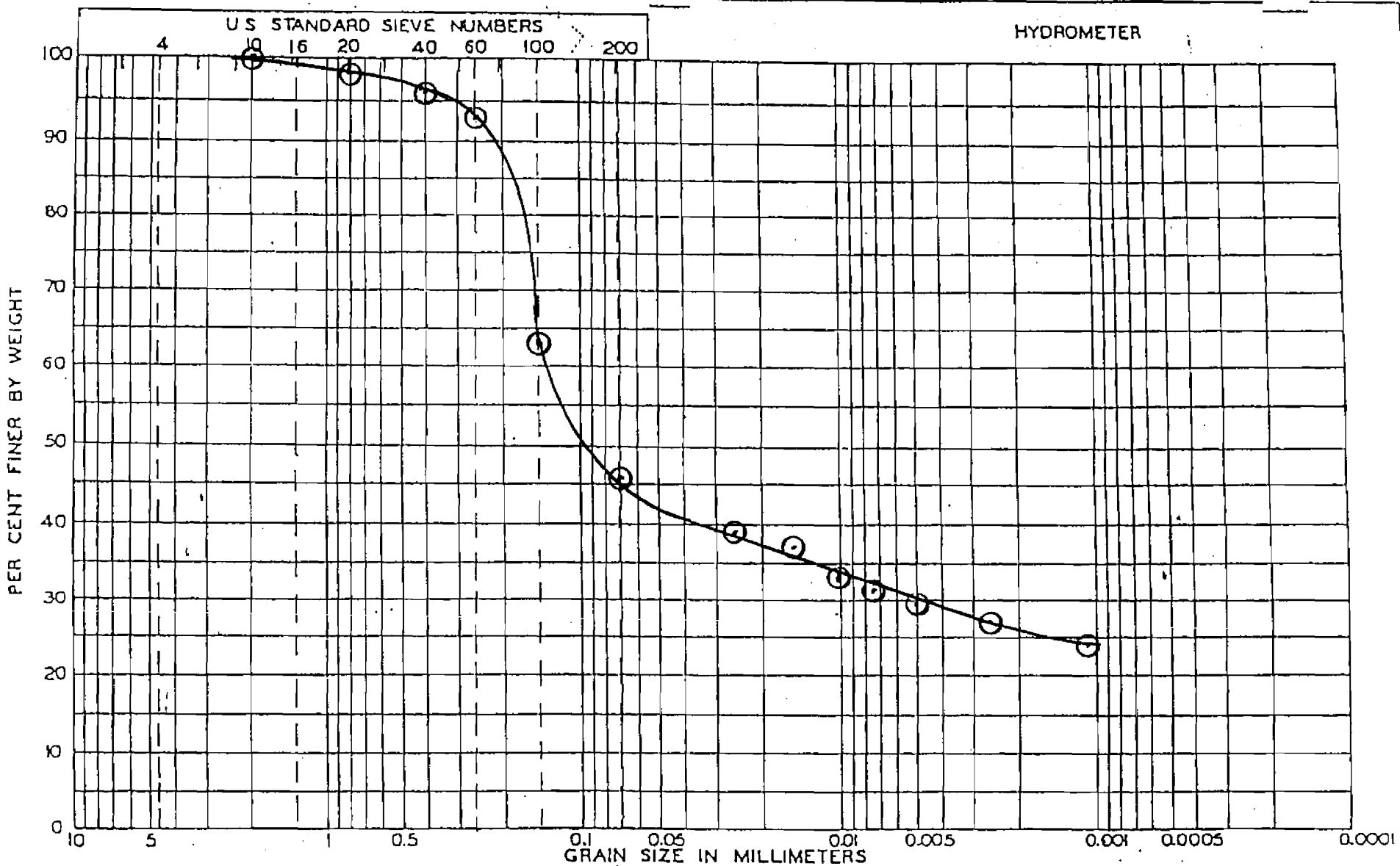
BORING NUMBER _____ SAMPLE NUMBER _____

DEPTH 6' - 8' ELEVATION _____ REMARKS _____

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-320



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/003SW00208

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

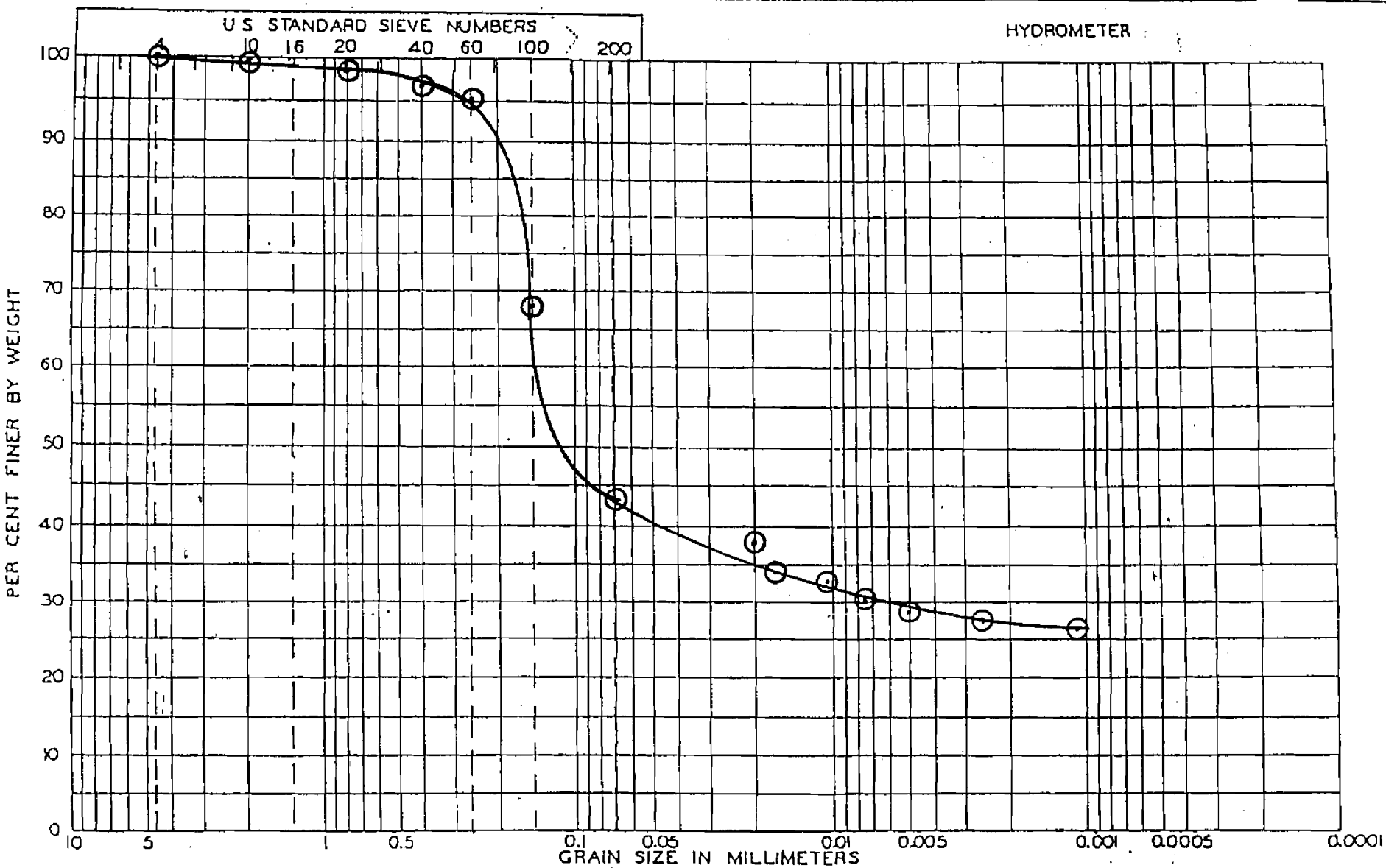
BORING NUMBER _____ SAMPLE NUMBER _____

DEPTH 8' - 10' ELEVATION _____ REMARKS _____

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-32



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

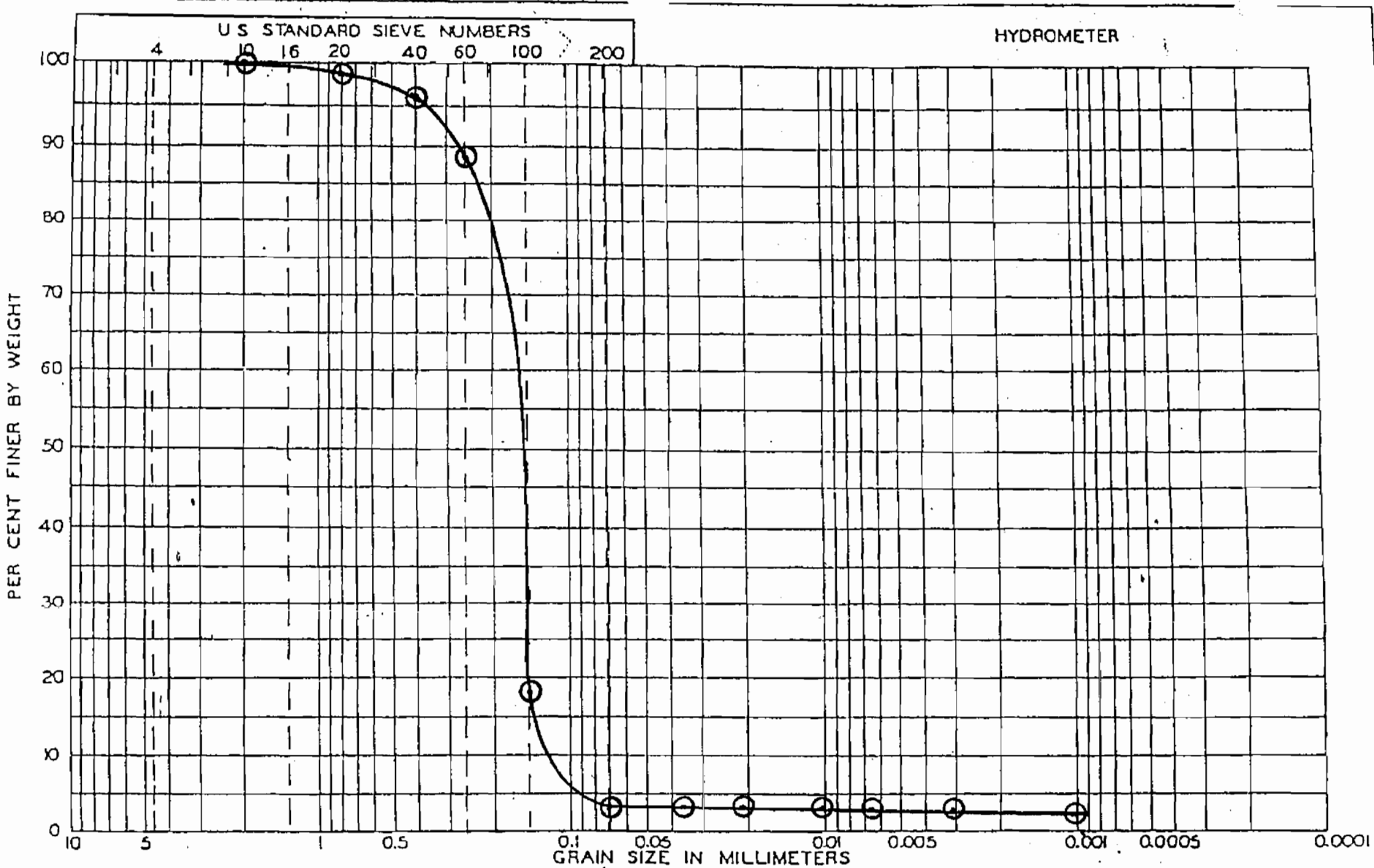
BORING NUMBER _____ SAMPLE NUMBER NBCG/011SW00106

DEPTH 6' - 8' ELEVATION _____ REMARKS _____

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-32



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

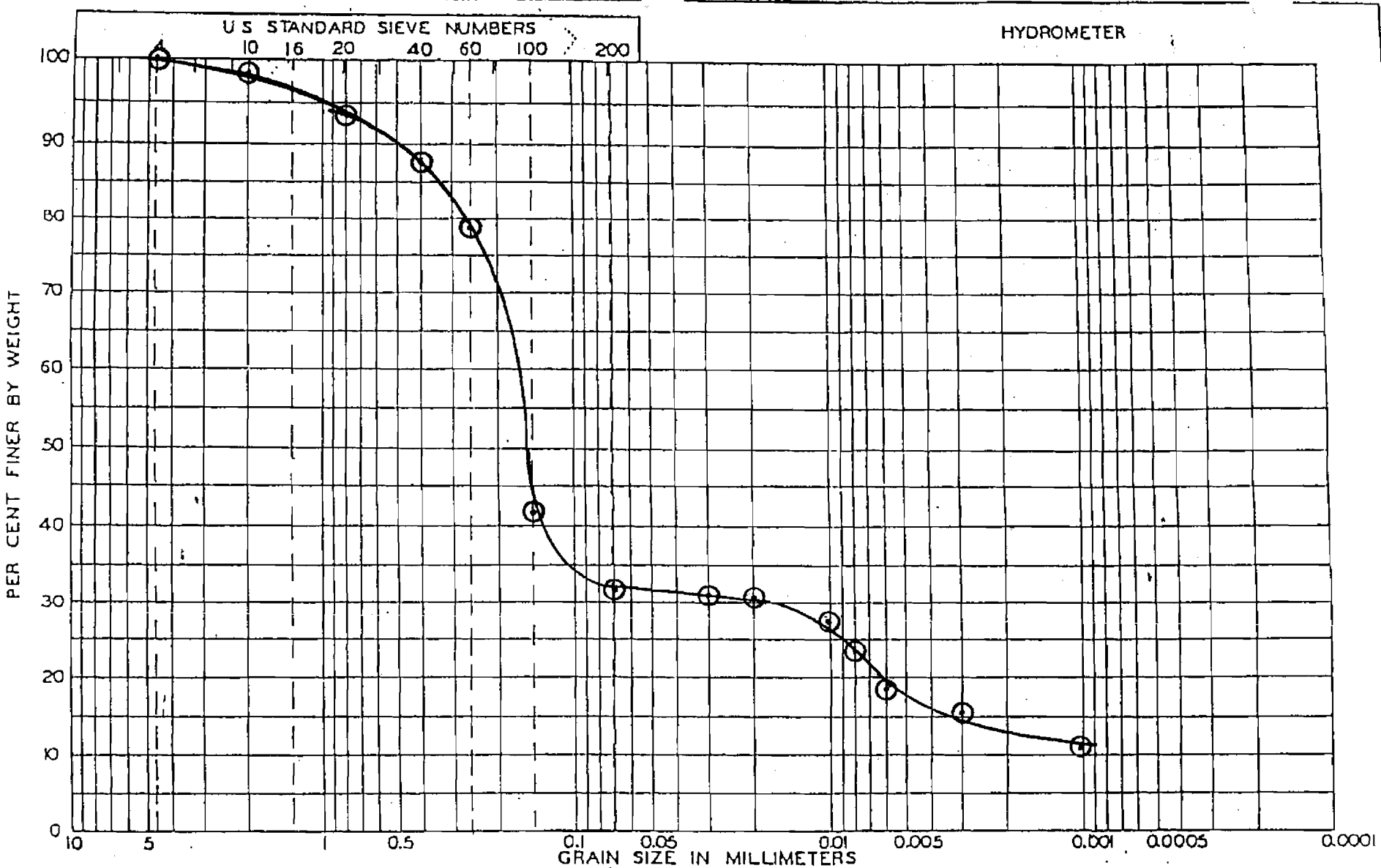
BORING NUMBER _____ SAMPLE NUMBER NBCG/011SW0202

DEPTH 2'-4' ELEVATION _____ REMARKS _____

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-320



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/120SW00204

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

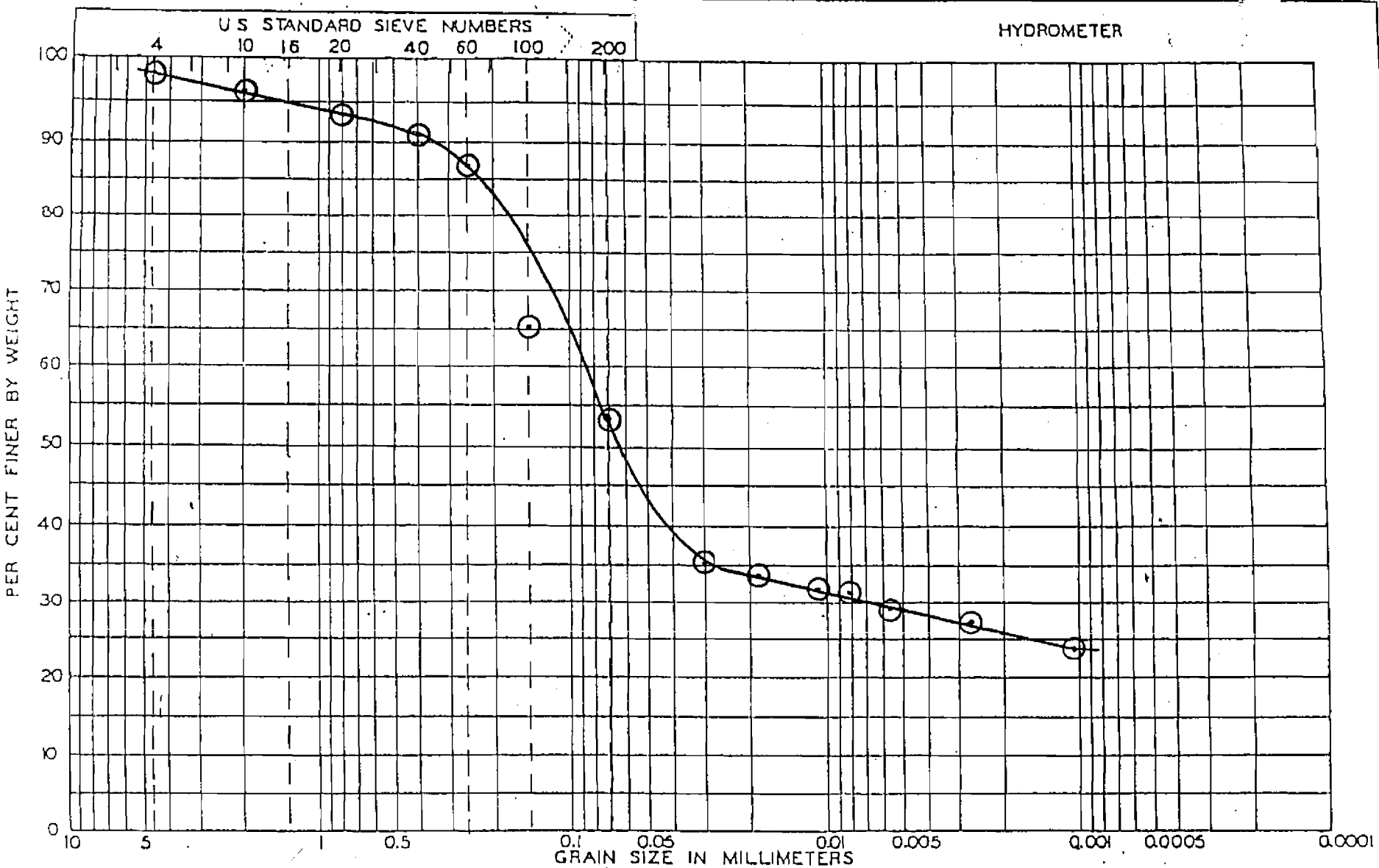
BORING NUMBER _____ SAMPLE NUMBER _____

DEPTH 4'-6' ELEVATION _____ REMARKS _____

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-320



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/628SB002 P1

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

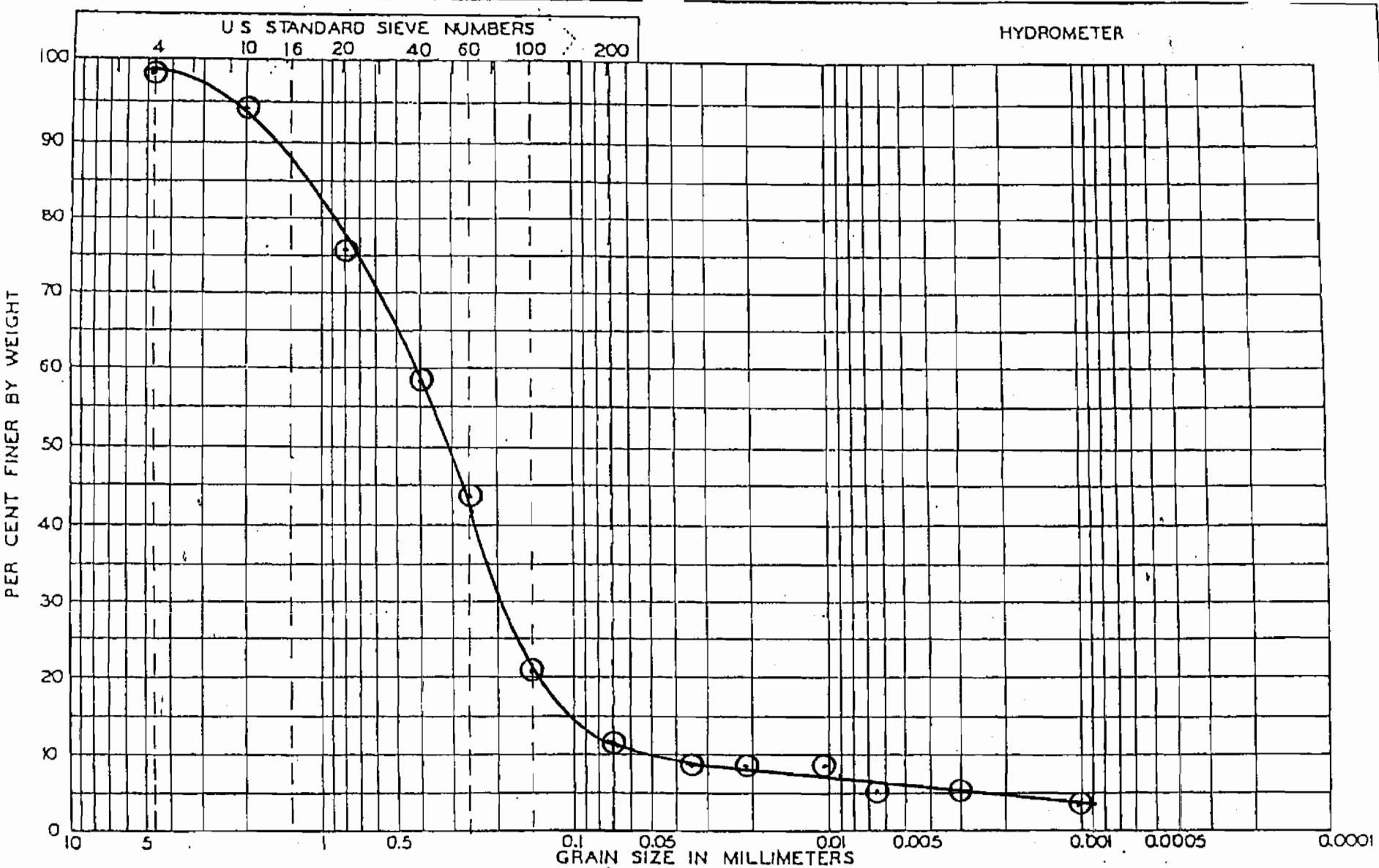
BAG SAMPLE _____ SAMPLE NUMBER _____

DEPTH _____ ELEVATION _____ REMARKS MOISTURE CONTENT (ASTM D2216): 41.3%
SPECIFIC GRAVITY (ASTM D854): 2.63

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-320



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/633SB009 P1

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

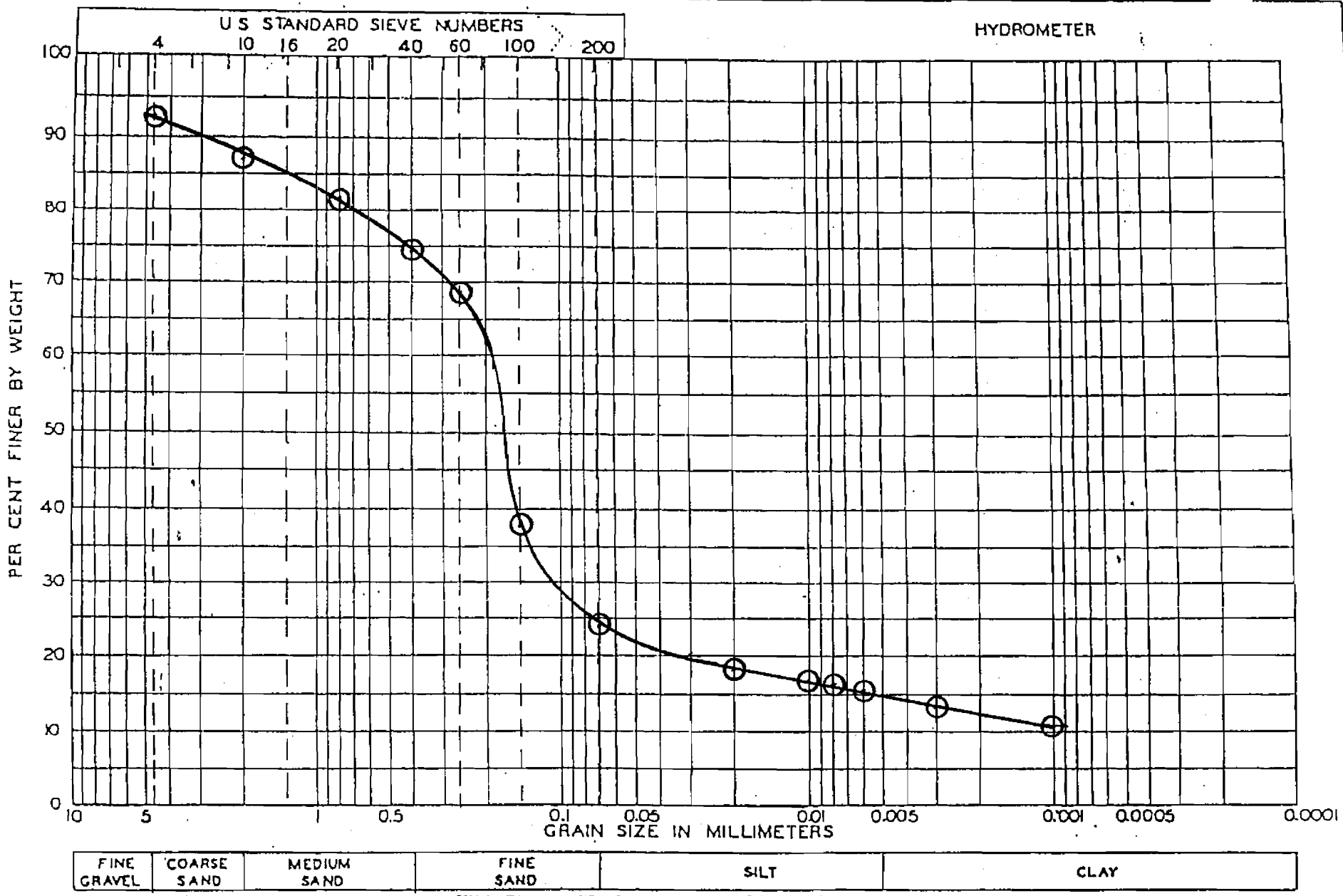
BAG SAMPLE _____ SAMPLE NUMBER _____

DEPTH _____ ELEVATION _____ REMARKS MOISTURE CONTENT (ASTM D2216): 15.1%
SPECIFIC GRAVITY (ASTM D854): 2.69

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-32



UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/637SB007 P1

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

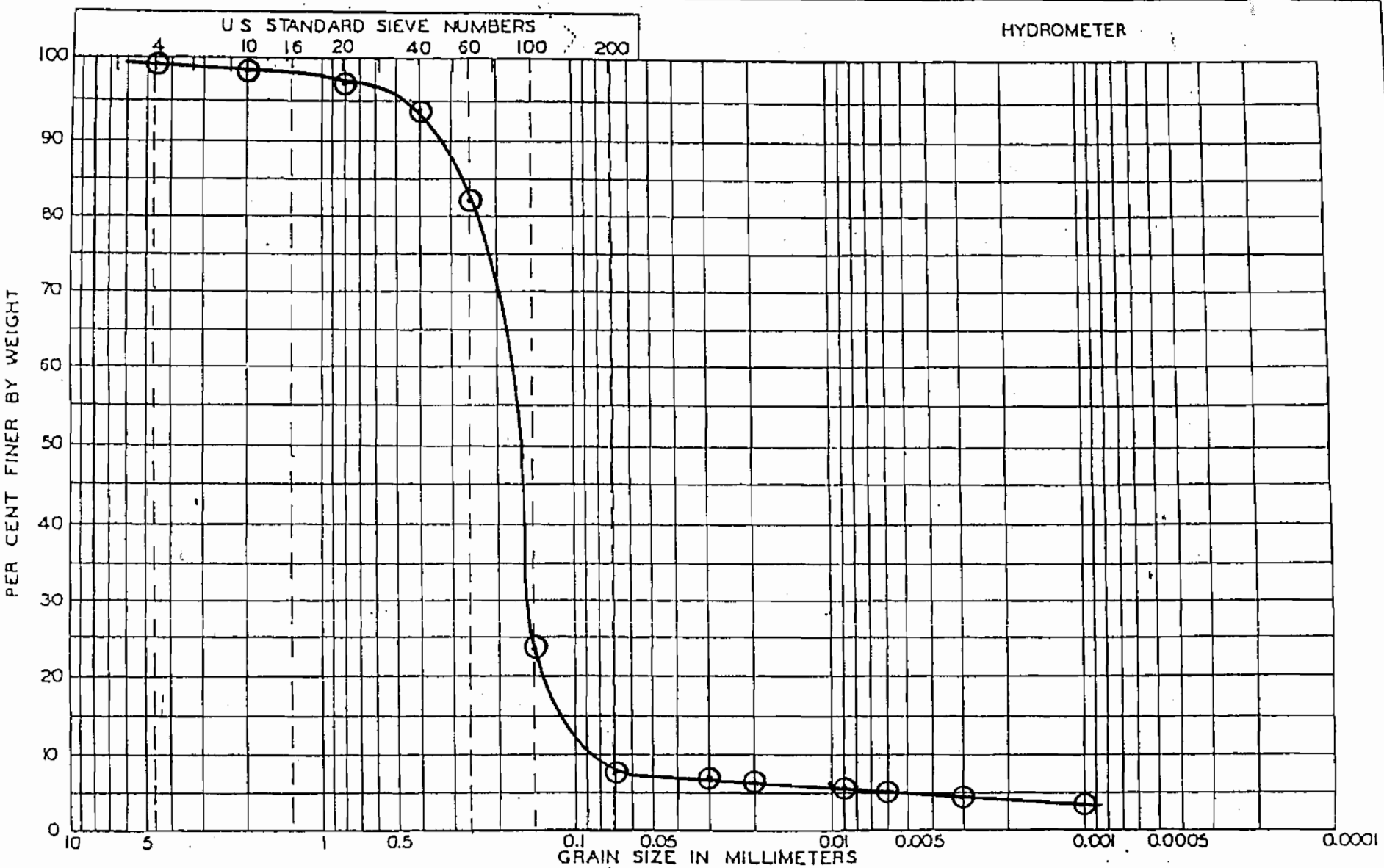
BAG SAMPLE _____ SAMPLE NUMBER _____

DEPTH _____ ELEVATION _____ REMARKS MOISTURE CONTENT (ASTM D2216): 25.7%
SPECIFIC GRAVITY (ASTM D854): 2.63

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-320



UNIFIED SOIL CLASSIFICATION SYSTEM

NBCG/642SB004 P1

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

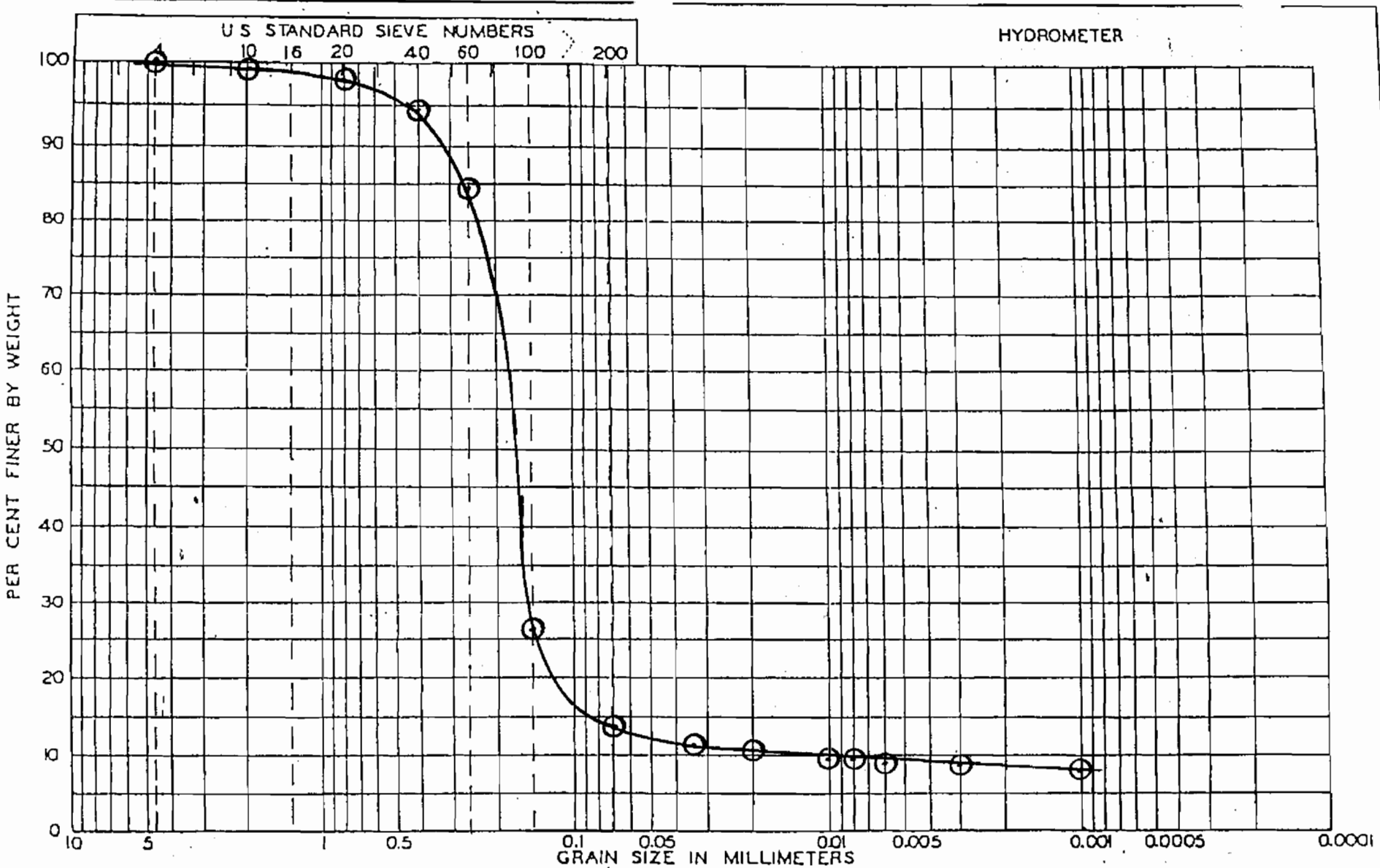
BAG SAMPLE _____ SAMPLE NUMBER _____

DEPTH _____ ELEVATION _____ REMARKS MOISTURE CONTENT (ASTM D2216): 17.7%
SPECIFIC GRAVITY (ASTM D854): 2.74

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

SCI NUMBER: 97-32



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT NAVAL BASE, CHARLESTON, S.C., ZONE G INVESTIGATION
E/A&H, P.O. #88

BAG SAMPLE NBCG/643SB007 P1 SAMPLE NUMBER

DEPTH ELEVATION REMARKS MOISTURE CONTENT (ASTM D2216): 15.4%
SPECIFIC GRAVITY (ASTM D854): 2.69

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

Materials Testing Report	SOIL CONSULTANTS, INC.	Tabulated Data Sheet
Project And State:	Naval Base Charleston, RCRA Facility Investigation - Zones D, F, and G, Charleston, SC	Date: 10-14-96

I. Results of Moisture Contents and Dry Unit Weights for Shelby Tube Samples

Sample Number	Depth (feet)	Moisture Content (%)	Bulk Dry Density (g/cc)
Zone D			
GDD-01D	30 - 32.5	38.2	1.33
Zone F			
109-001	6 - 8	22.9	1.70
**GDF-001	5 - 7	N/A	N/A
619-001	8 - 10	19.4	1.72
619-002	6 - 8	40	1.10
620-002	7 - 9	21.6	1.80
Zone G			
GDG-01D	65 - 67.5	44.8	1.25
120-002	8 - 10.5	42.4	1.33
636-001	9 - 11	56.4	1.04
638-001	8 - 10	83.4	0.85
120-001	6 - 8	79.8	0.82
011-001	8 - 10	20.6	1.77
011-003	8 - 10	22.8	1.69

** Sample obtained was determined to be unsuitable for testing by Mr. Peter Bayley of E/A &H.

II. Results of Falling Head Permeability Test

	Sample Number	Depth (feet)	Moisture Content (%)	Bulk Dry Density (g/cc)	Specific Gravity	Porosity	Permeability
Zone F	619-001	8' - 10'	18.6	1.62	2.67	0.392	3.10E-05
Zone G	120-002	8' - 10'	32.0	1.18	2.73	0.566	8.30E-04
	011-001	8' - 10'	20.4	1.54	2.69	0.430	4.60E-05

Materials Testing Report	SOIL CONSULTANTS, INC	HYDRAULIC CONDUCTIVITY TEST ASTM - D 5084
Project And Location:	Naval Base Charleston, RCRA Facility Investigation, Charleston, SC Zones D, F, and G	
SCI Project:	96-1660	Date: 10-14-96

SAMPLE IDENTIFICATION	Zone G GDG-01D 65' - 67.5'	Zone G 011-003 8' - 10'	Zone G 120-001 6' - 8'	Zone G 636-001 9' - 11'	Zone G 638-001 8' - 10'

INITIAL CONDITIONS

Sample Length, cm	4.6355	5.08	4.2291	5.08	5.08
Sample Diameter, cm	5.08	5.08	5.08	5.08	5.08
Moisture Content, %	45.9	19.2	145.7	91.5	148.9
Unit Wet Weight, pcf	106.3	130.3	82.2	82.1	81.9
Unit Dry Weight, pcf	72.8	109.3	33.4	42.8	32.9
Specific Gravity	2.69	2.69	2.69	2.63	2.71
Porosity (computed)	0.566267	0.348925	0.800665	0.738272	0.805125
Saturation, %	94.7	96.5	97.5	85.2	97.5

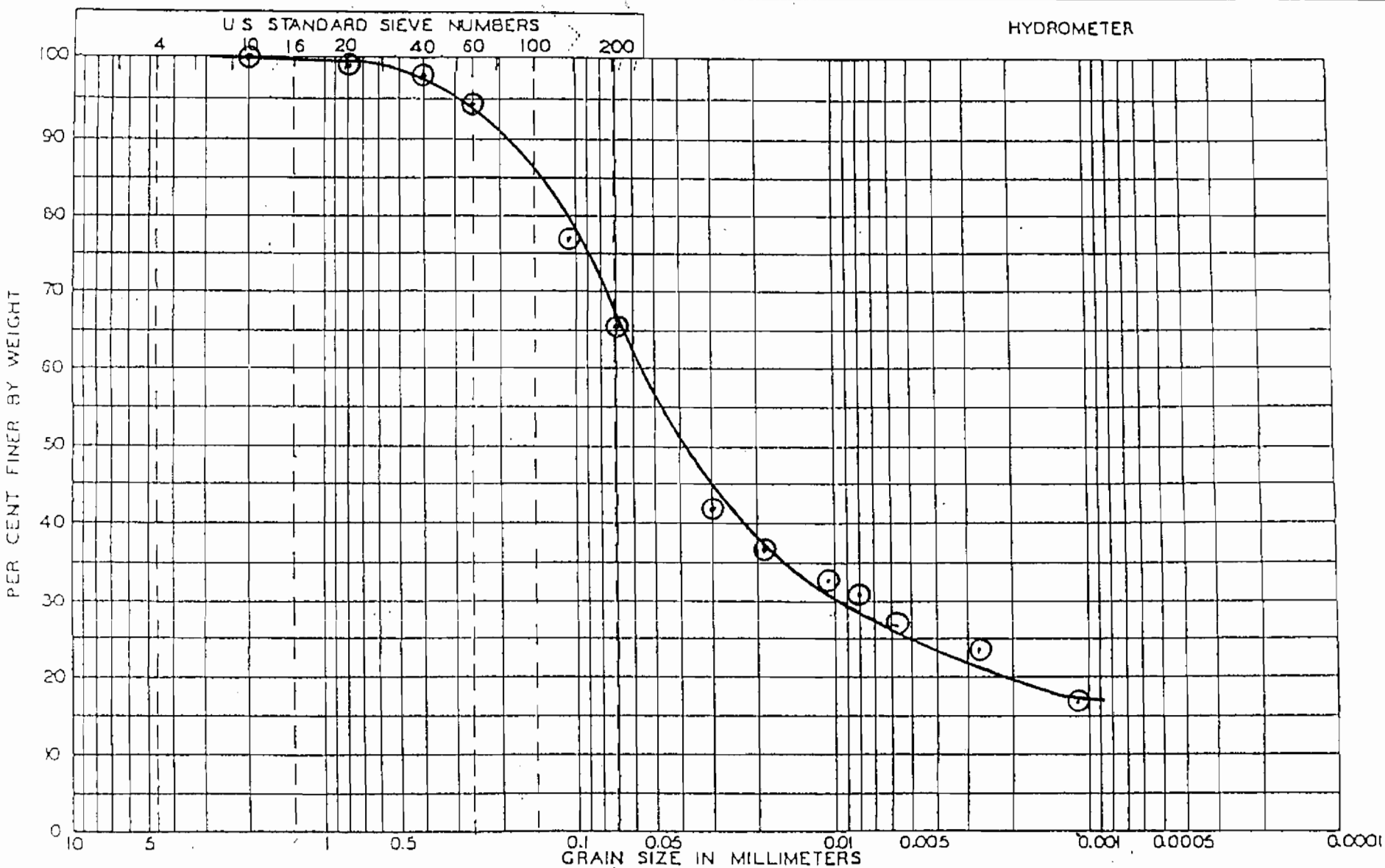
FINAL CONDITIONS

Sample Length, cm	4.572	5.08	4.16052	4.826	5.0165
Sample Diameter, cm	5.08	5.08	5.0165	4.8895	4.8895
Moisture Content, %	45.9	22.1	138.1	87.7	147.7
Unit Wet Weight, pcf	107.3	130.9	83.4	85.6	89.1
Unit Dry Weight, pcf	73.5	107.2	35.0	45.6	36
Saturation, %	96.2	105.2	97.9	88.8	108.3

TEST CONDITIONS

Permeant	Potable Water	Potable Water	Potable Water	Potable Water	Potable Water
Cell Pressure, psi	30	30	30	30	30
Back Pressure, psi	27-25	27-25	27-25	27-25	27-25
B-value	0.960	0.99	0.1	0.99	0.1
Average Gradient	30.2	27.6	33.6	29	27.9
Hydraulic Conductivity, cm/sec @ 20 deg. C	8.698×10^{-6}	1.167×10^{-6}	8.247×10^{-8}	6.704×10^{-8}	1.291×10^{-7}

SOIL CONSULTANTS, INC.



UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER GDG-01D

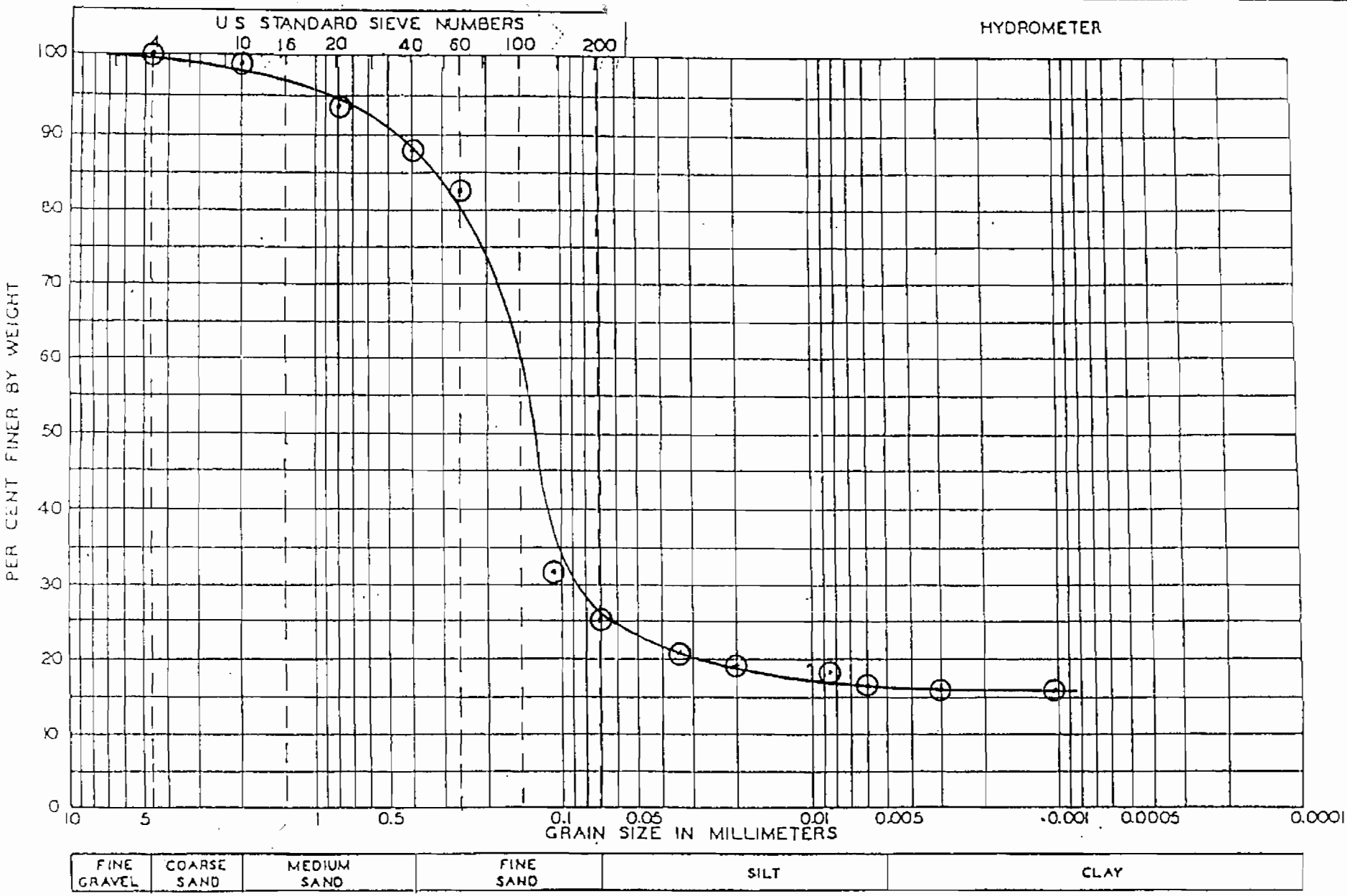
ZONE G (SUBCONTRACT 0376/96)

DEPTH 65'-67.5' ELEVATION _____ REMARKS Visually identified as brownish green calcareous claye silt with slight sand content. **(MH)

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM

**Locally called Marl



UNIFIED SOIL CLASSIFICATION SYSTEM

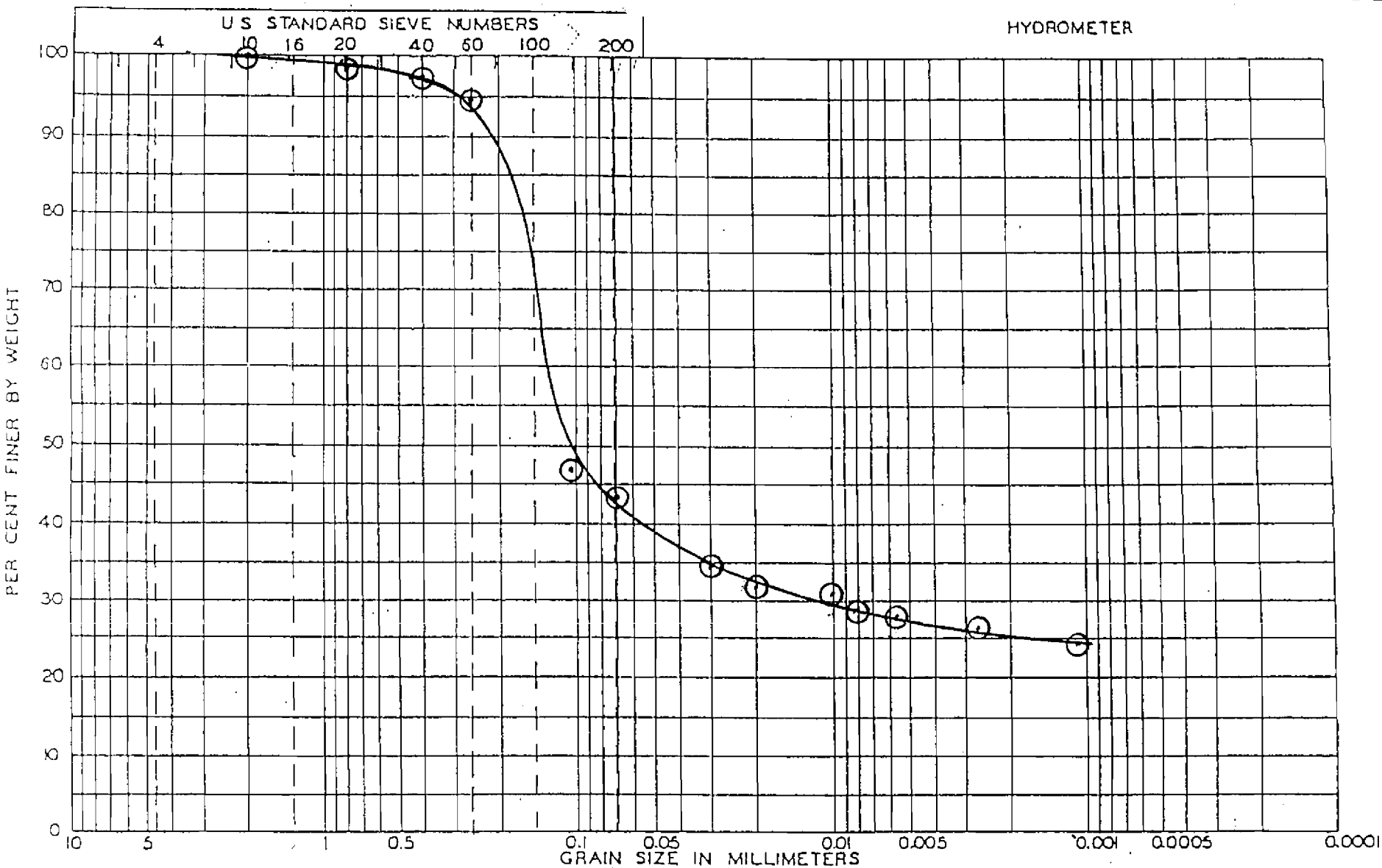
PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER 011-001

ZONE G (SUBCONTRACT 0376/96)

DEPTH 8'-10' ELEVATION _____ REMARKS Visually identified as light gray & tan fine sand with slight to medium inorganic clay content. (SM-SC)

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM



FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

UNIFIED SOIL CLASSIFICATION SYSTEM

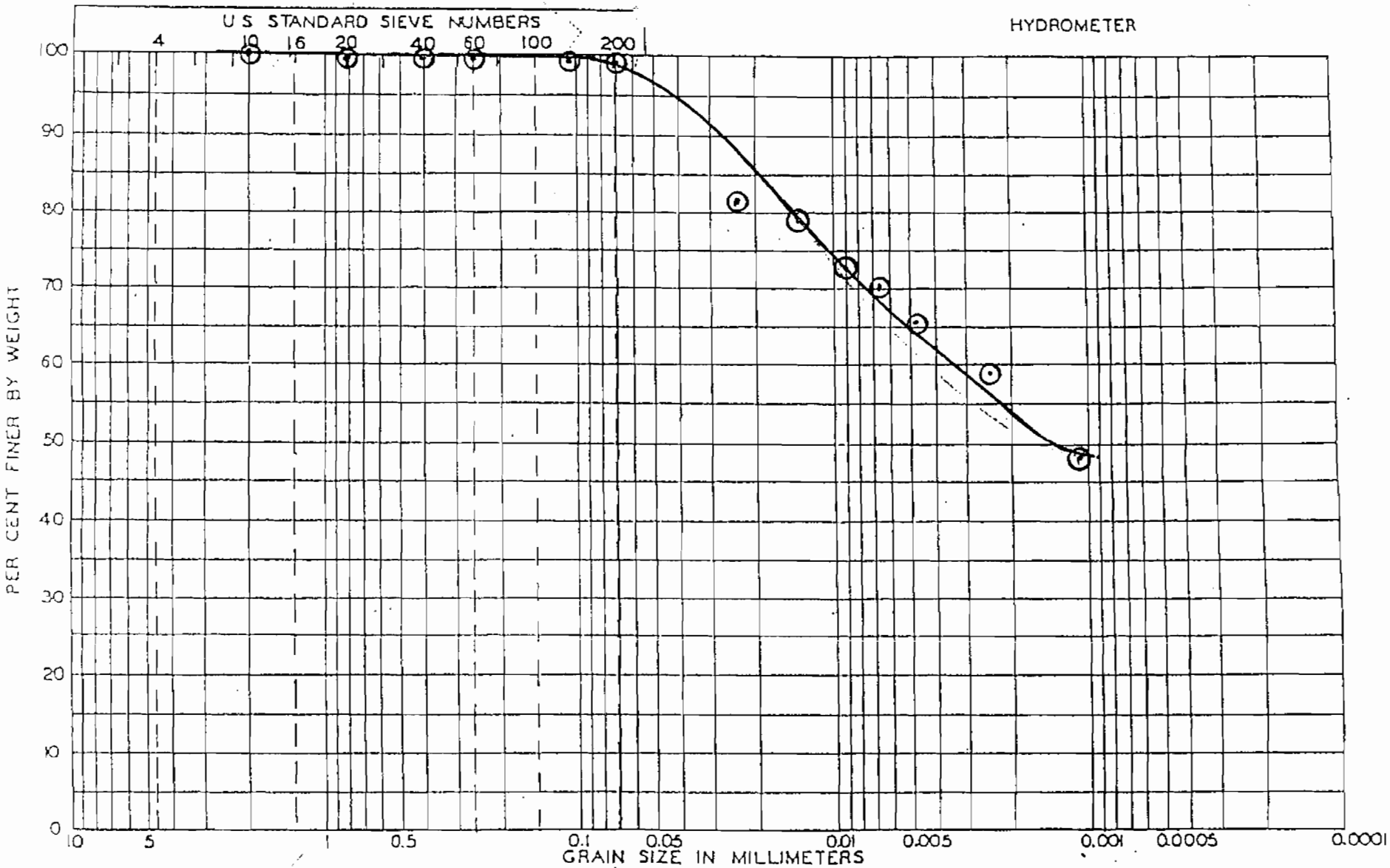
PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER 011-003

ZONE G (SUBCONTRACT 0376/96)

DEPTH 8'-10' ELEVATION _____ REMARKS Visually identified as grayish brown fine sand with high inorganic clay content (SC)

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM



UNIFIED SOIL CLASSIFICATION SYSTEM

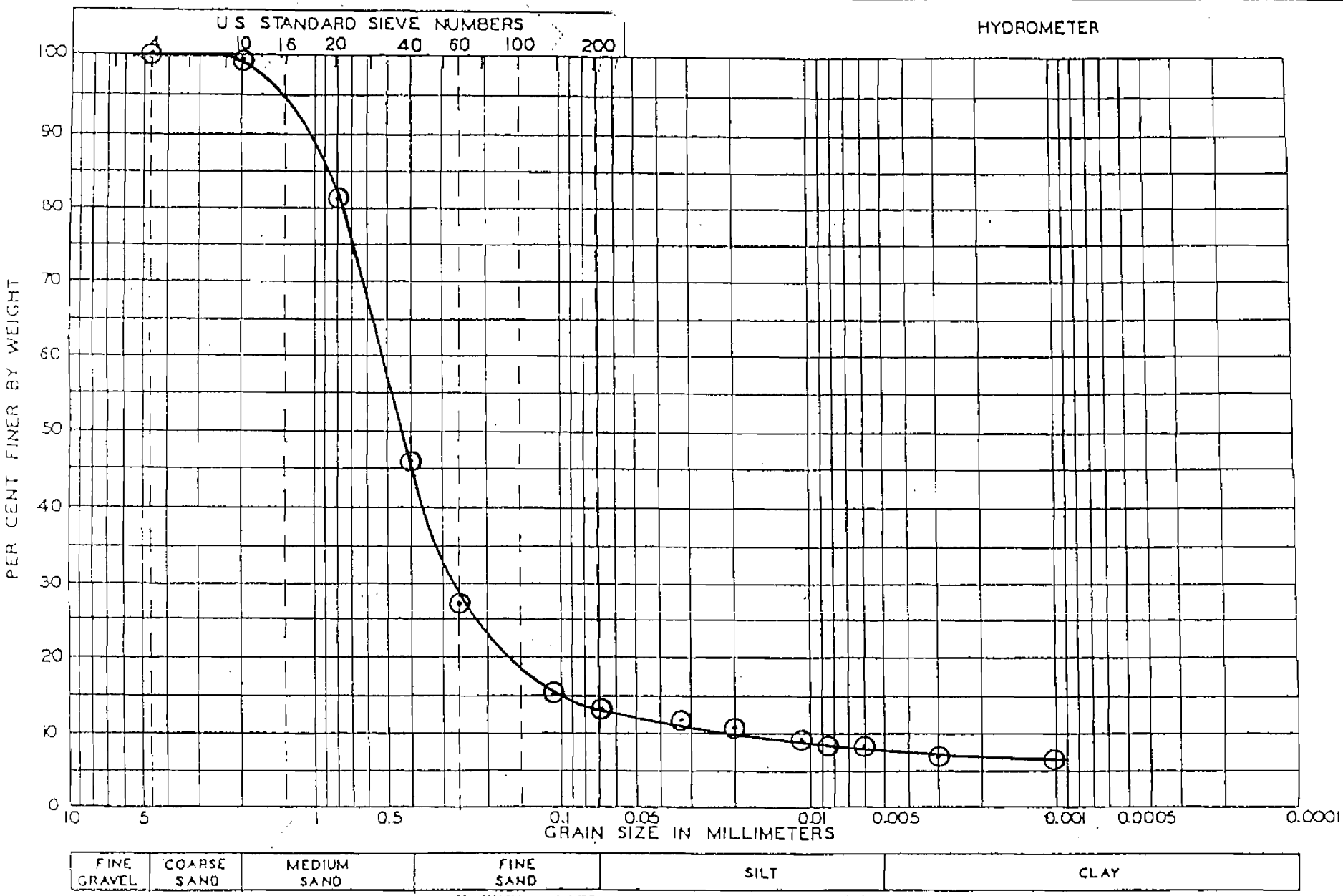
PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER 120-001

ZONE G (SUBCONTRACT 0376/96)

DEPTH 6' - 8' ELEVATION _____ REMARKS Visually identified as gray & black silty clay with very slight sand content (OH)

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM



UNIFIED SOIL CLASSIFICATION SYSTEM

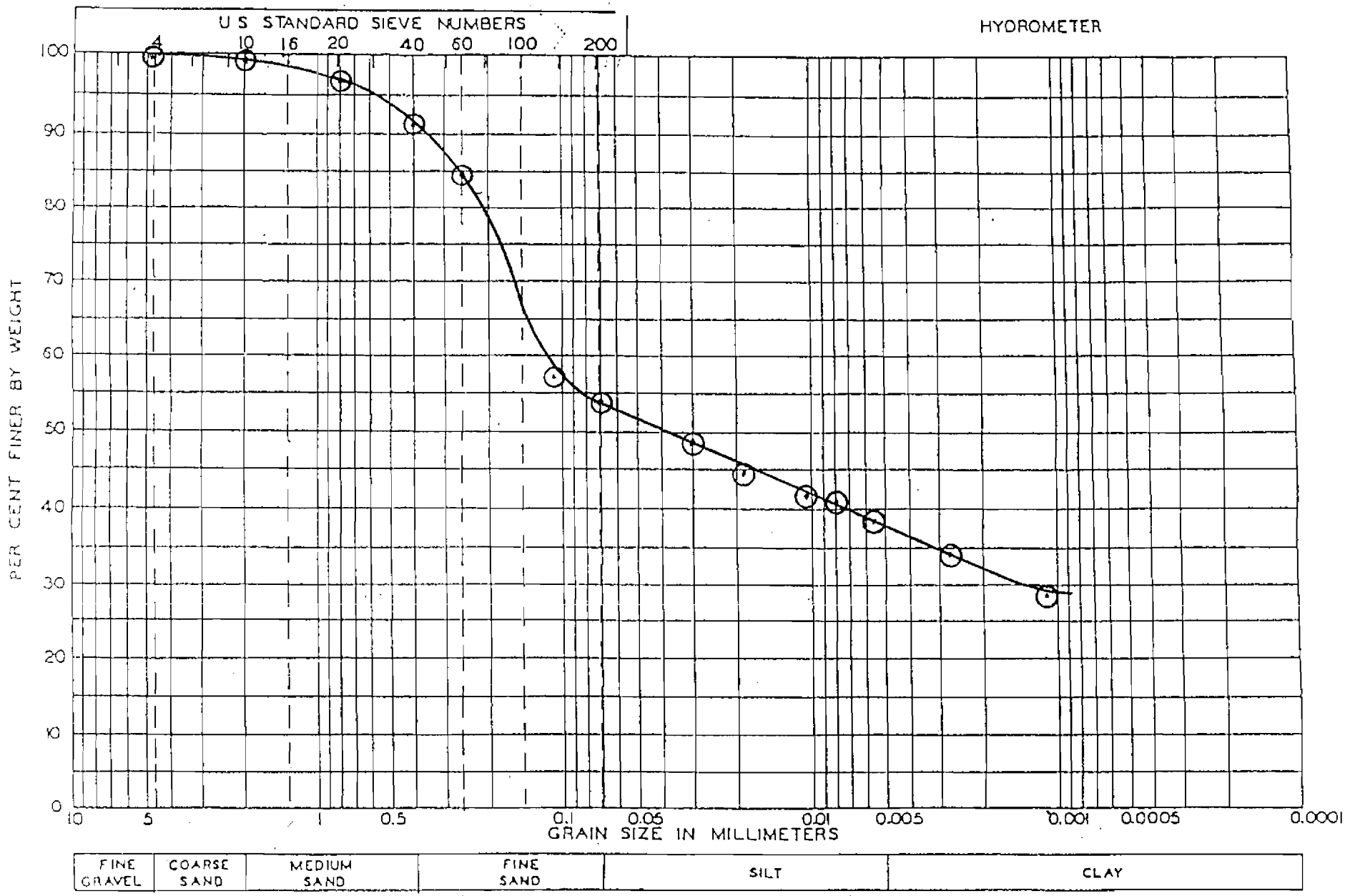
PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER 120-002

ZONE G (SUBCONTRACT 0376/96)

DEPTH 8'-10' ELEVATION _____ REMARKS Visually identified as gray fine to medium sand with slight organic clay content. (SM)

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM



UNIFIED SOIL CLASSIFICATION SYSTEM

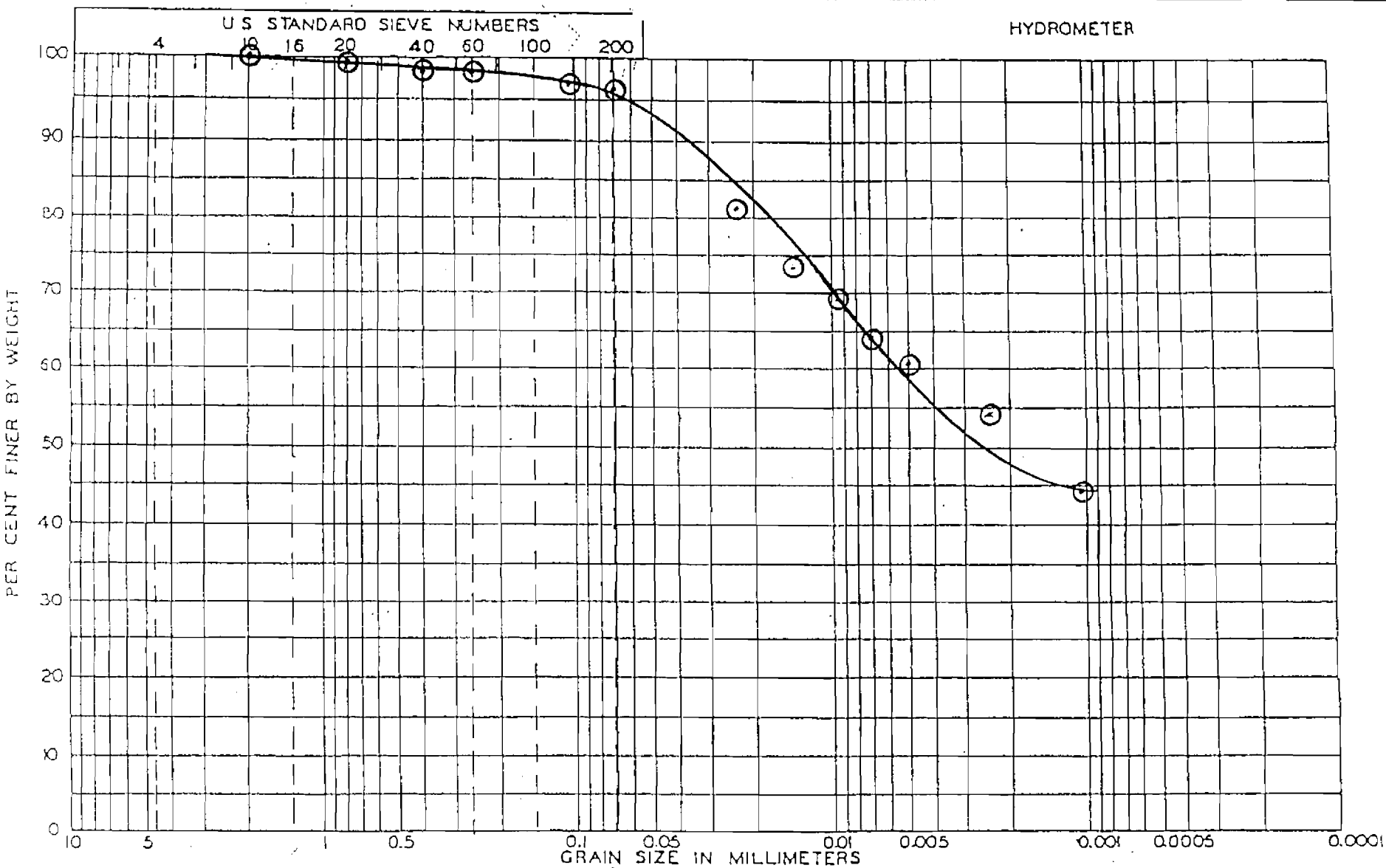
PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER 636-001

ZONE G (SUBCONTRACT 0376/96)

DEPTH 9'-11' ELEVATION _____ REMARKS Visually identified as dark gray & black organic silty clay with slight to medium sand & decayed root and slight shell content. (OH-OL)

ASTM D422

GRAIN SIZE DISTRIBUTION DIAGRAM



UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT NAVAL BASE CHARLESTON, RCRA FACILITY INVESTIGATION, CHARLESTON, S.C. BORING NUMBER _____ SAMPLE NUMBER 638-001

ZONE G (SUBCONTRACT 0376/96)

DEPTH 8'-10' ELEVATION _____ REMARKS Visually identified as black & gray organic silty clay with very slight sand content. (OH)

ASTM D422

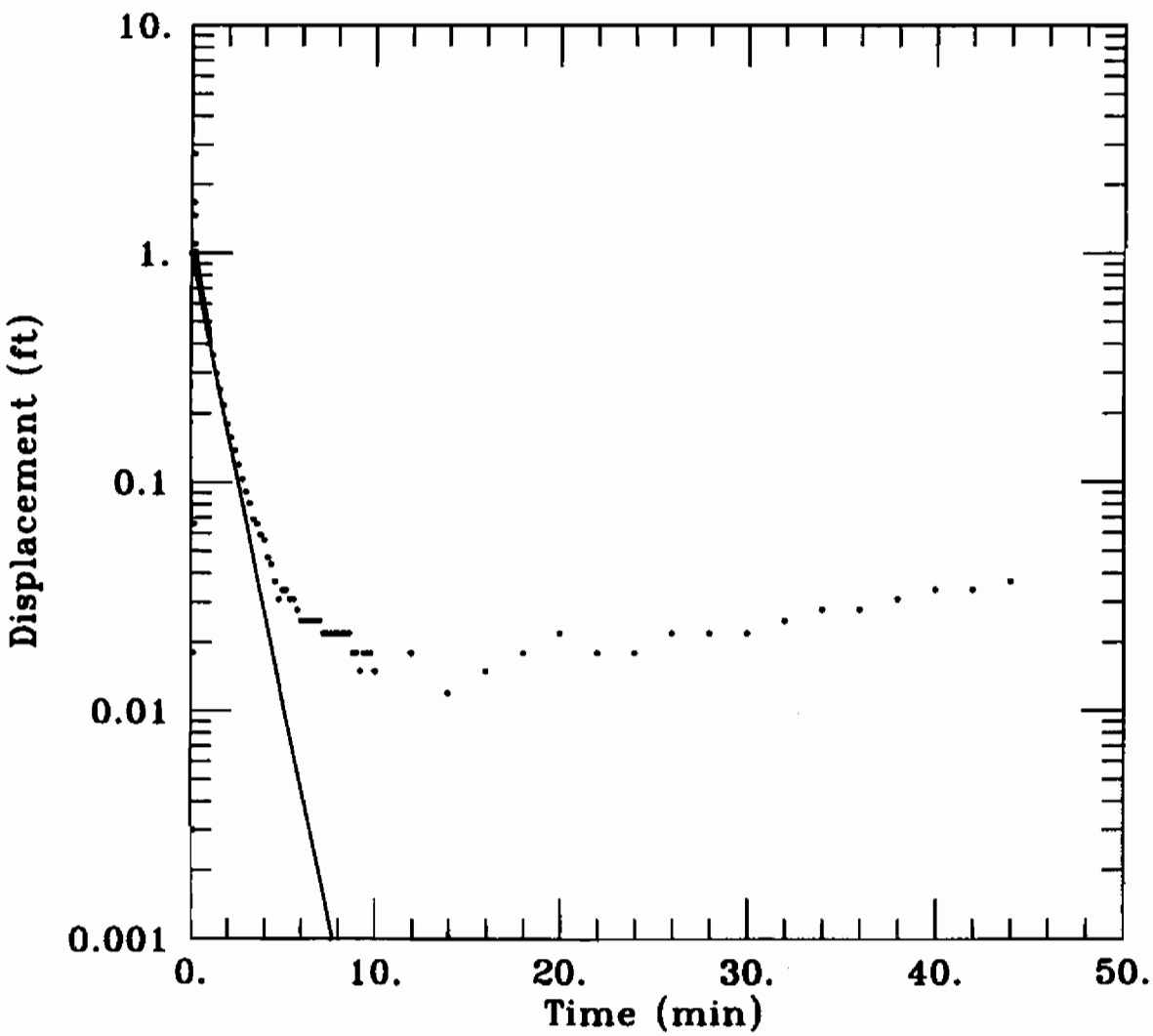
GRAIN SIZE DISTRIBUTION DIAGRAM

SECTION C

Appendix C
Zone G
AQTESOLV Results

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCGGDG001



DATA SET:
G001FAL.AQT
04/09/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

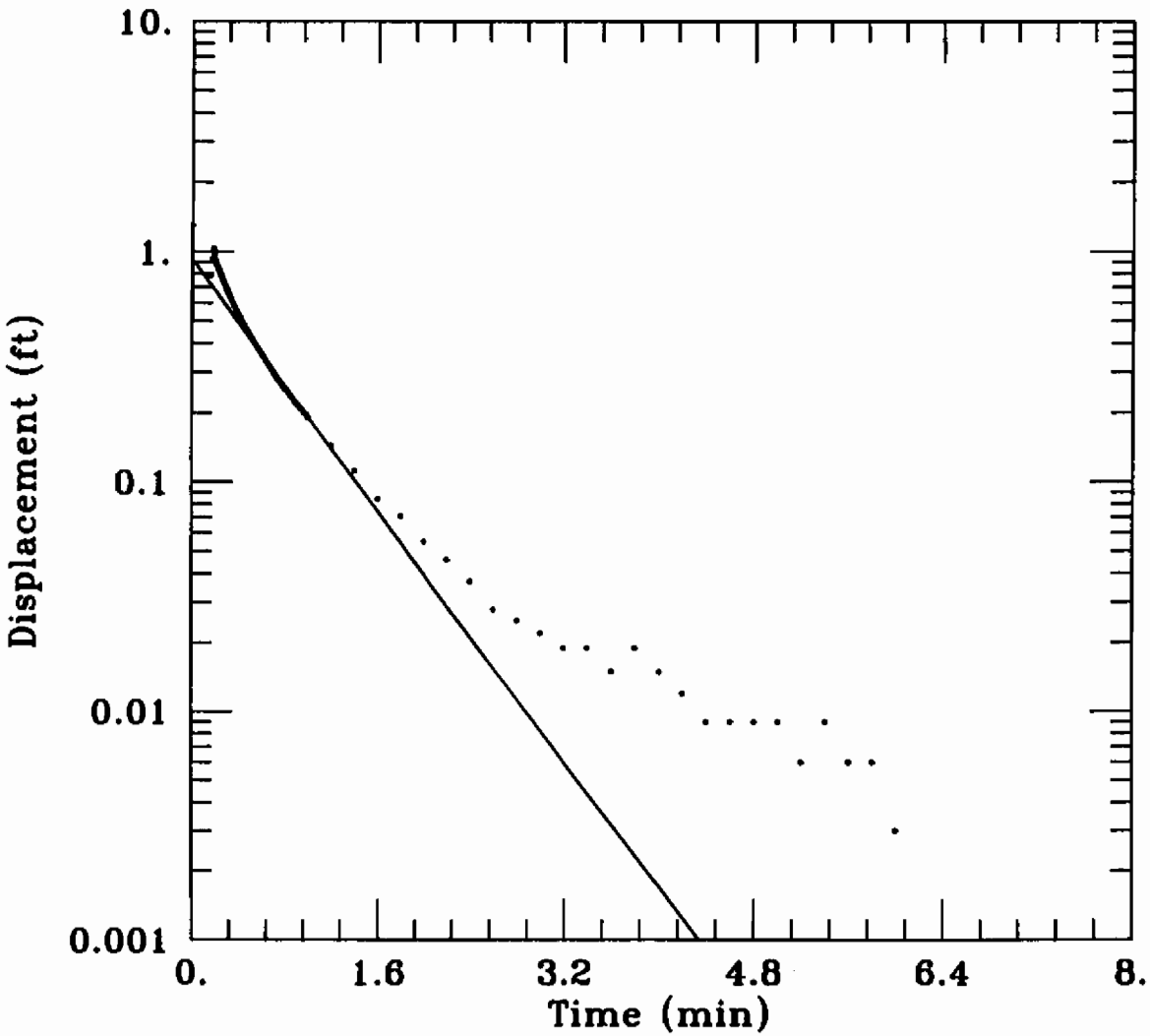
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 11. ft
b = 11. ft
H = 11. ft

PARAMETER ESTIMATES:
K = 0.00076 ft/min
y0 = 0.9928 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCGGDG001



DATA SET:
G001RIS.AQT
04/09/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

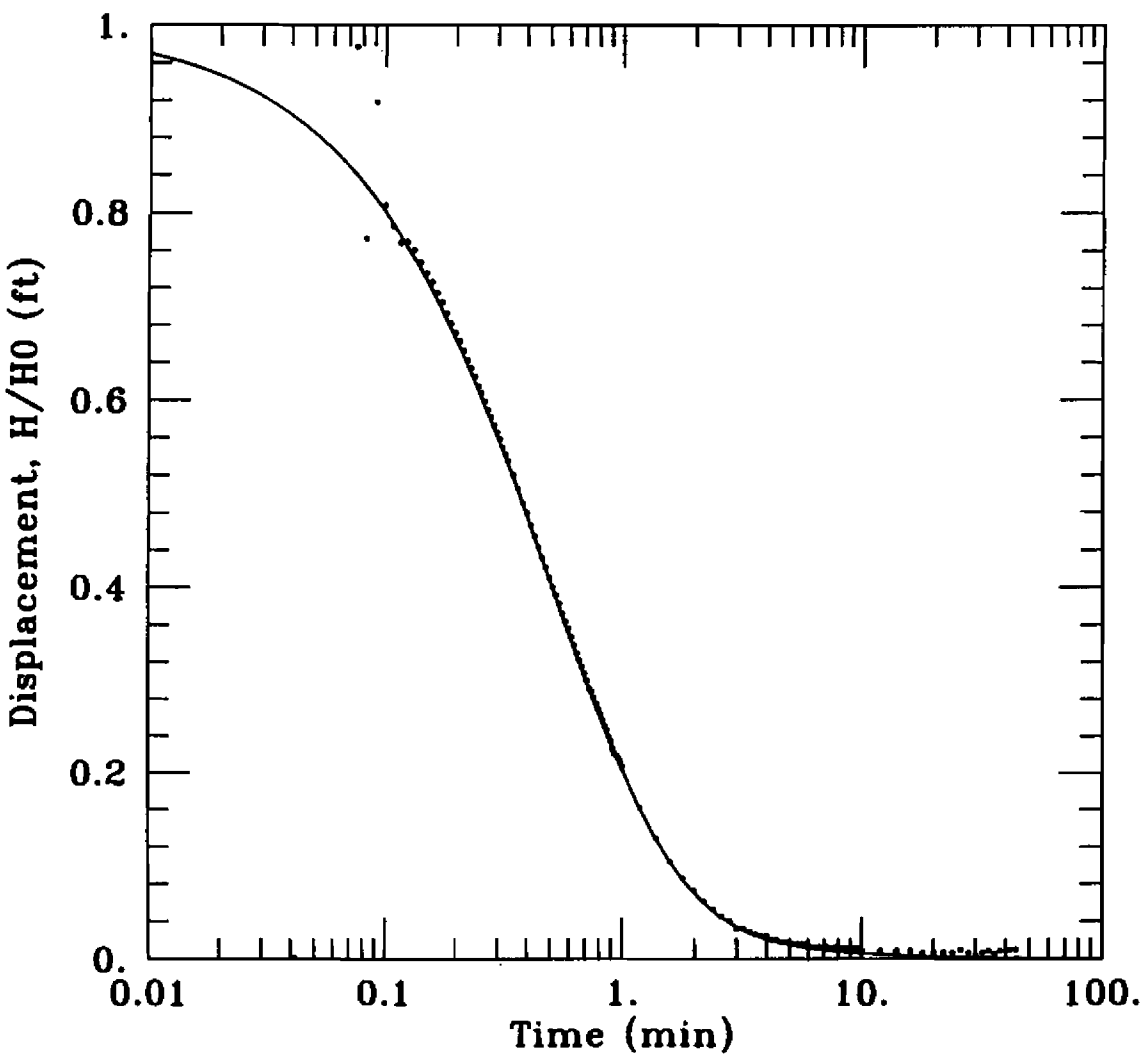
TEST DATA:
H0 = 1.3 ft
rc = 0.083 ft
rw = 0.3125 ft
L = 11. ft
b = 11. ft
H = 11. ft

PARAMETER ESTIMATES:
K = 0.001334 ft/min
y0 = 0.9249 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCGGDG01D



DATA SET:
G001DFAL.AQT
04/09/97

AQUIFER MODEL:
Confined

SOLUTION METHOD:
Cooper et al.

PROJECT DATA:
test date: January 1997

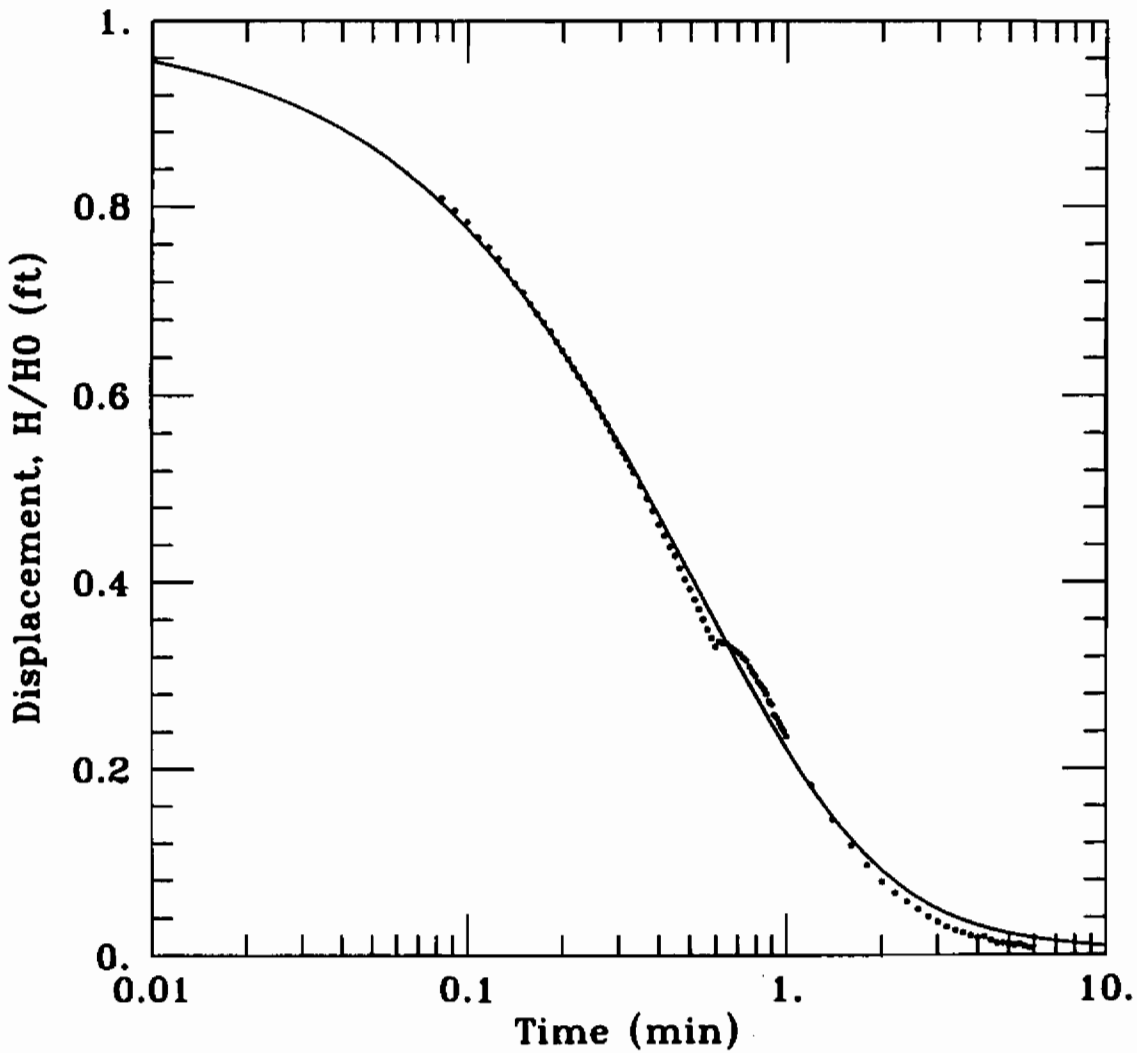
TEST DATA:
H0 = 2.15 ft
rc = 0.083 ft
rw = 0.27 ft

PARAMETER ESTIMATES:
T = 0.03225 ft^2/min
S = 1.E-05

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCGGDG01D



DATA SET:
G001DRIS.AQT
04/17/97

AQUIFER MODEL:
Confined

SOLUTION METHOD:
Cooper et al.

PROJECT DATA:
test date: January 1997

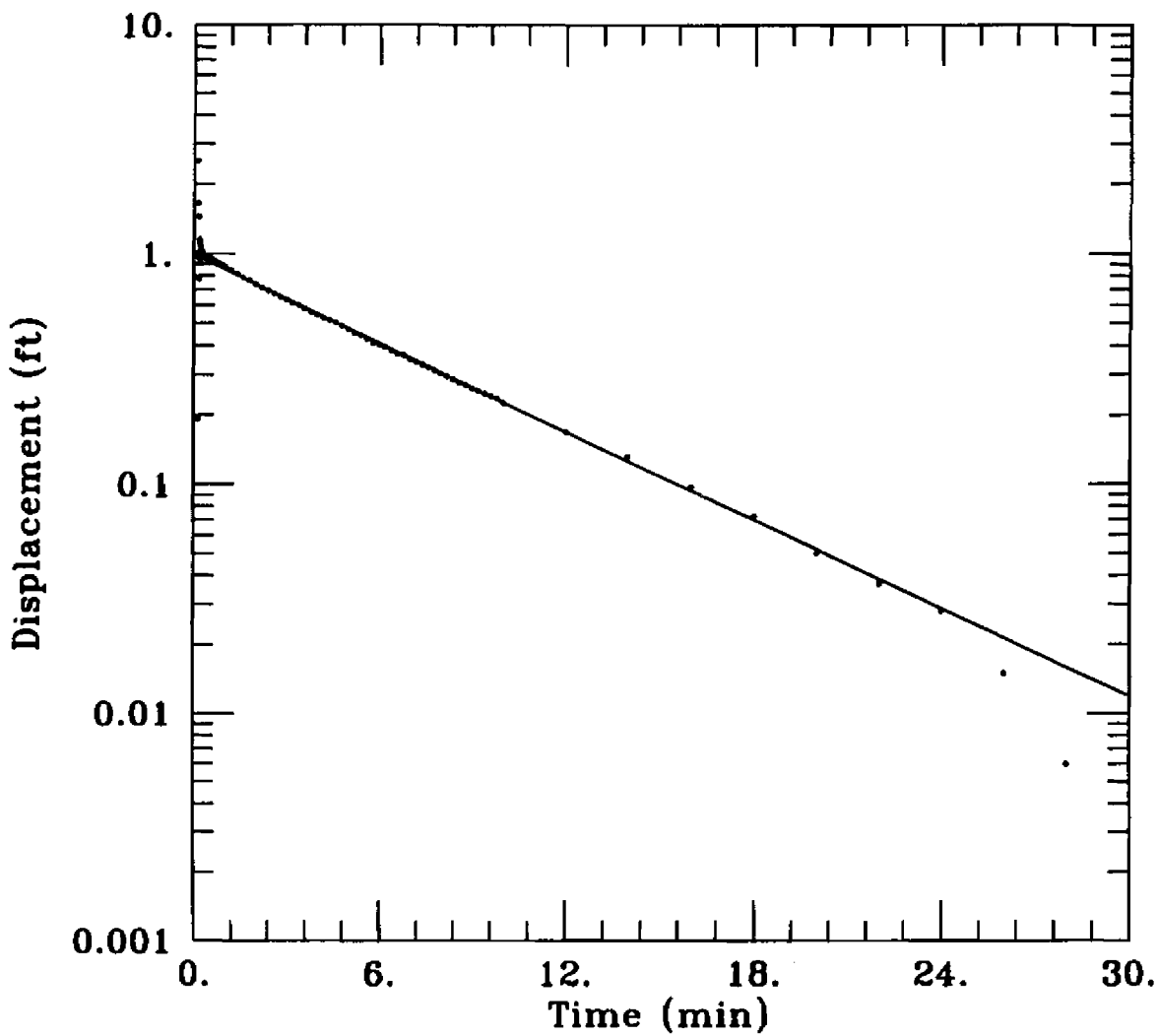
TEST DATA:
H0 = 2.37 ft
rc = 0.083 ft
rw = 0.27 ft

PARAMETER ESTIMATES:
T = 0.0208 ft^2/min
S = 0.0002859

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCGGDG002



DATA SET:
G002FAL.AQT
04/09/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

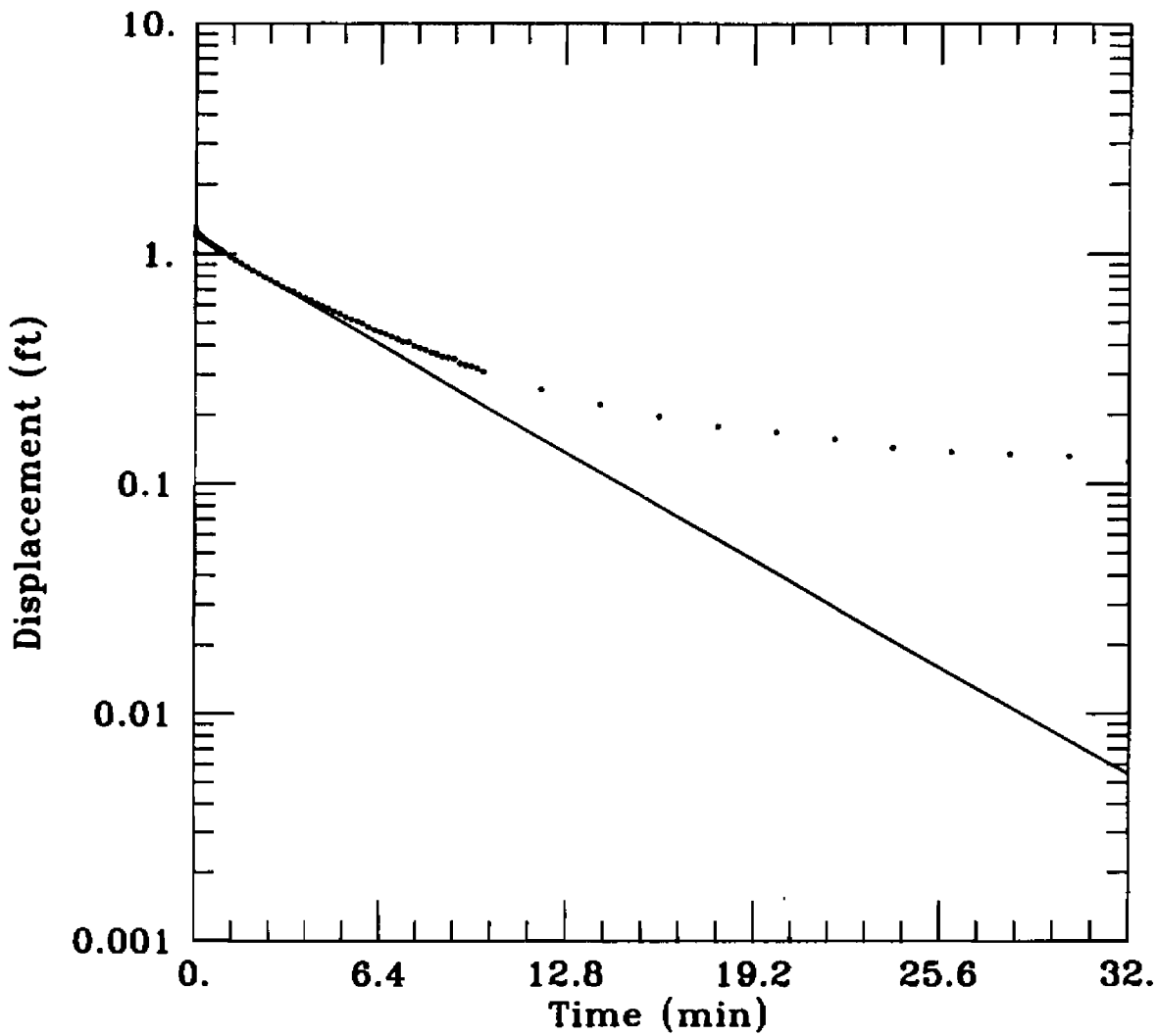
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 5. ft
b = 5. ft
H = 5. ft

PARAMETER ESTIMATES:
K = 0.0002064 ft/min
y0 = 0.9928 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCGGDG002



DATA SET:
G002RIS.AQT
04/09/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

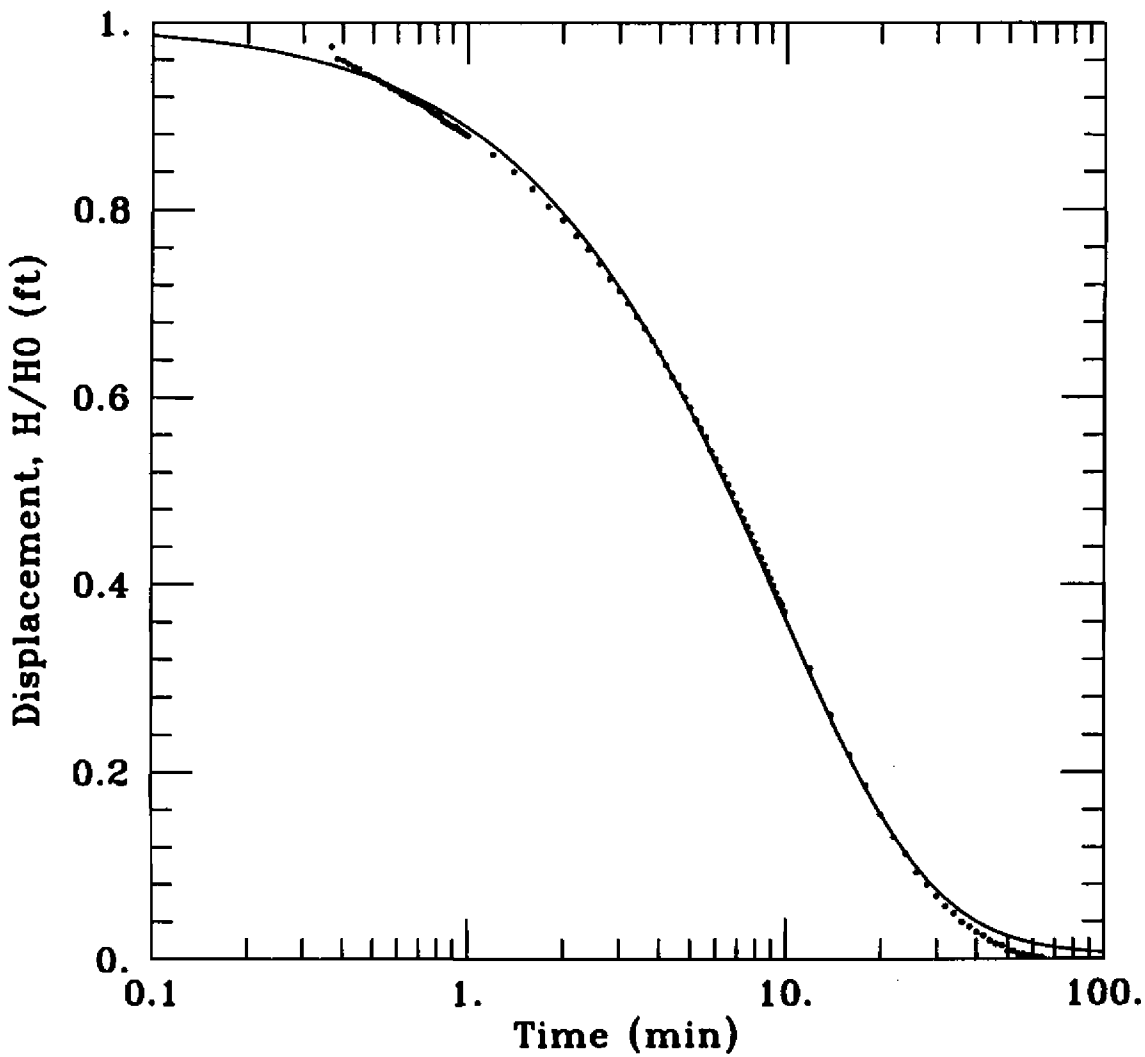
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 5. ft
b = 5. ft
H = 5. ft

PARAMETER ESTIMATES:
K = 0.0002353 ft/min
y0 = 1.184 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCGGDG02D



DATA SET:
G002DFAL.AQT
04/17/97

AQUIFER MODEL:
Confined

SOLUTION METHOD:
Cooper et al.

PROJECT DATA:
test date: January 1997

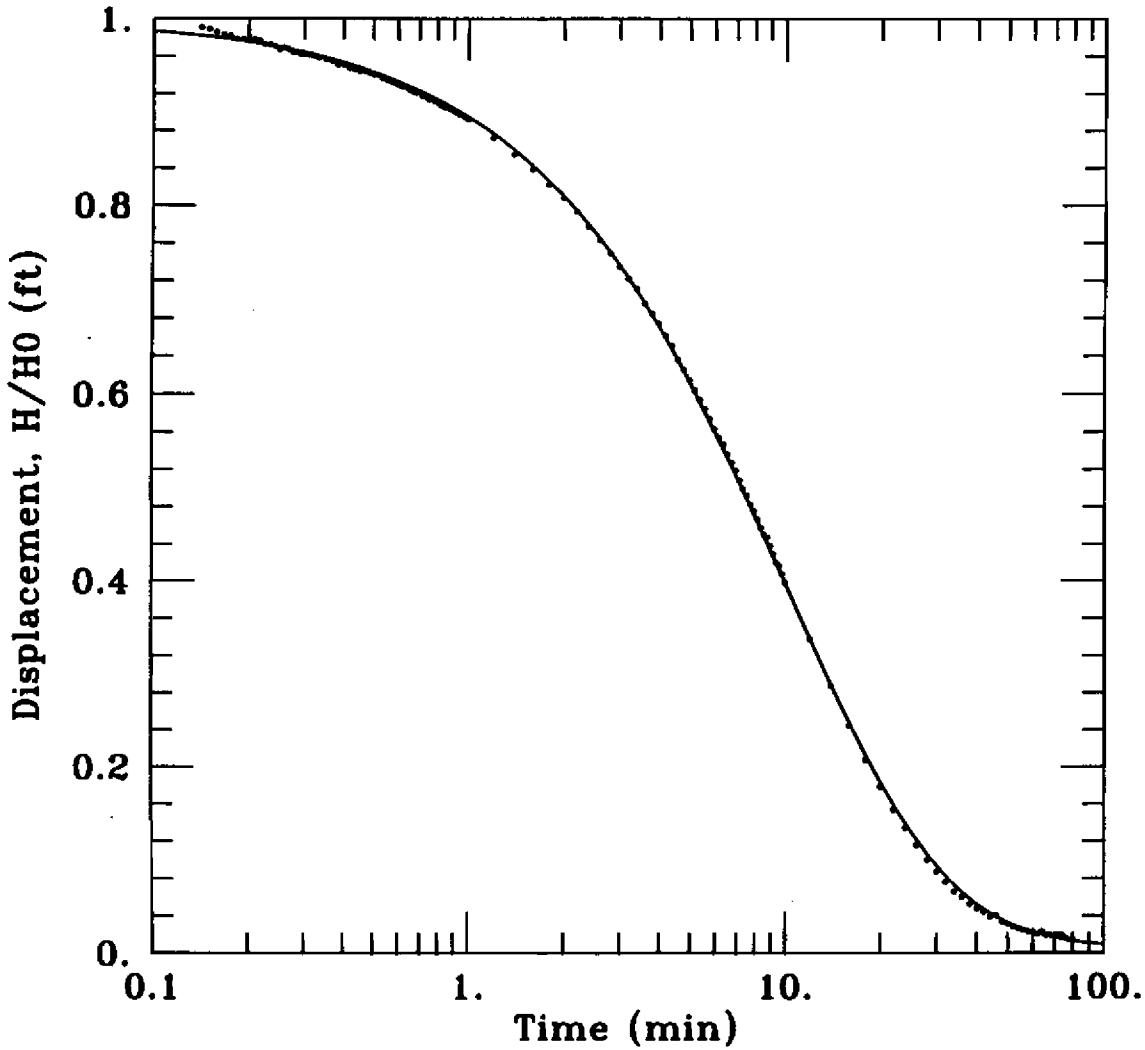
TEST DATA:
H0 = 1.73 ft
rc = 0.083 ft
rw = 0.27 ft

PARAMETER ESTIMATES:
T = 0.003217 ft^2/min
S = 6.418E-09

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCGGDG02D



DATA SET:
G002DRIS.AQT
04/17/97

AQUIFER MODEL:
Confined

SOLUTION METHOD:
Cooper et al.

PROJECT DATA:
test date: January 1997

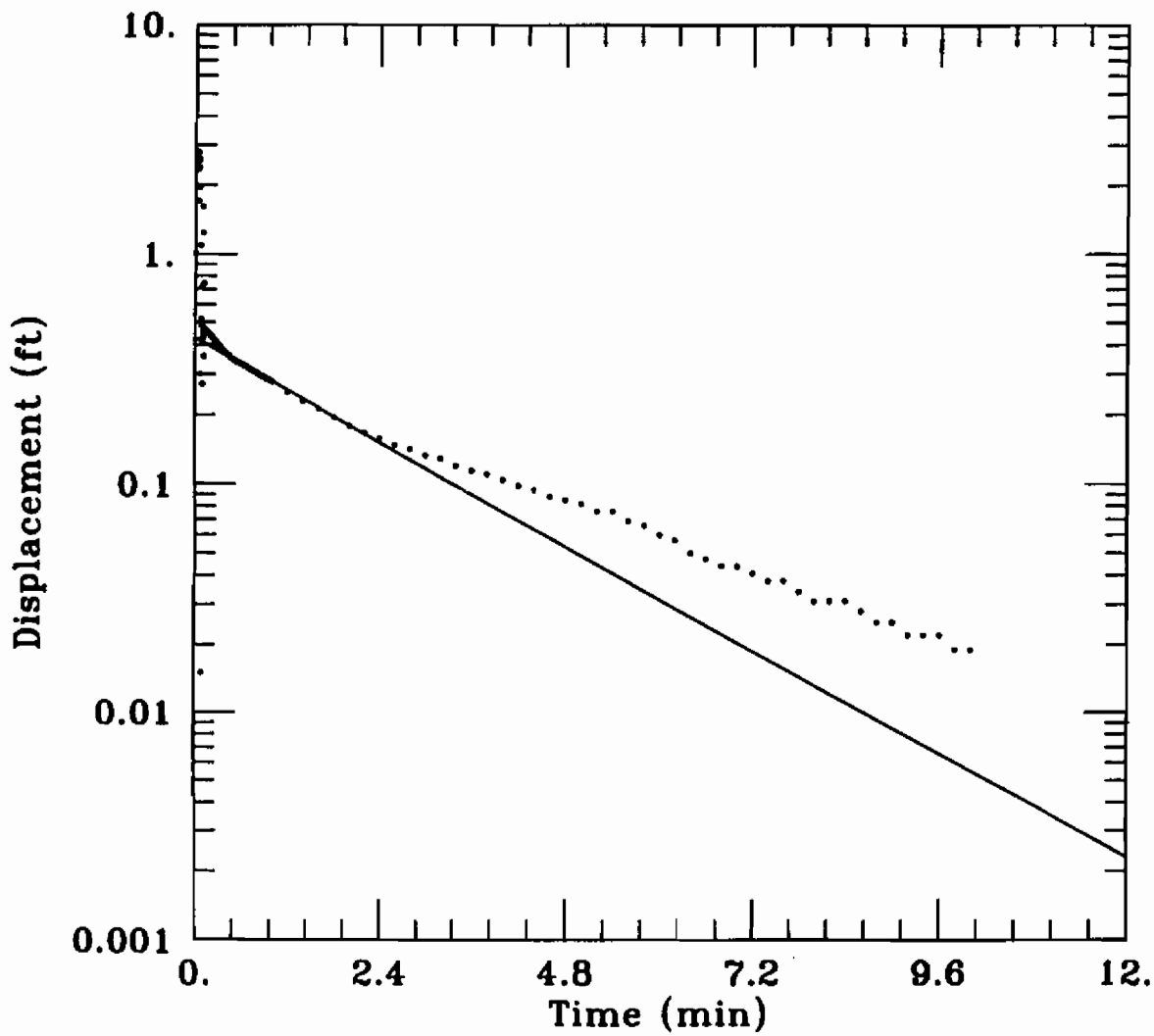
TEST DATA:
H0 = 1.77 ft
rc = 0.083 ft
rw = 0.27 ft

PARAMETER ESTIMATES:
T = 0.002611 ft^2/min
S = 3.83E-08

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCG011001



DATA SET:
11001FAL.AQT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

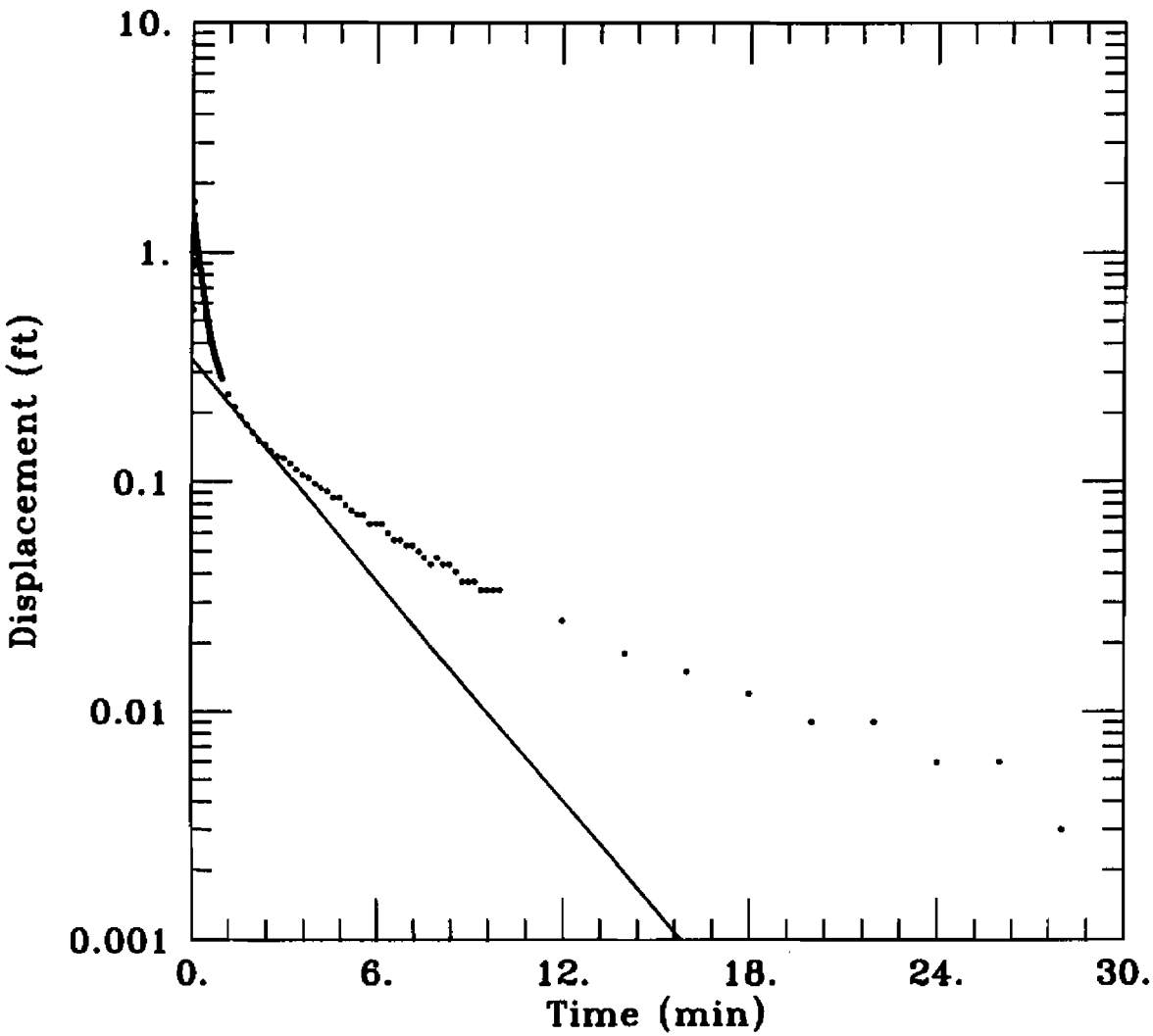
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 4. ft
b = 4. ft
H = 4. ft

PARAMETER ESTIMATES:
K = 0.002975 ft/min
y0 = 0.4302 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCG011001



DATA SET:
11001RIS.AQT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

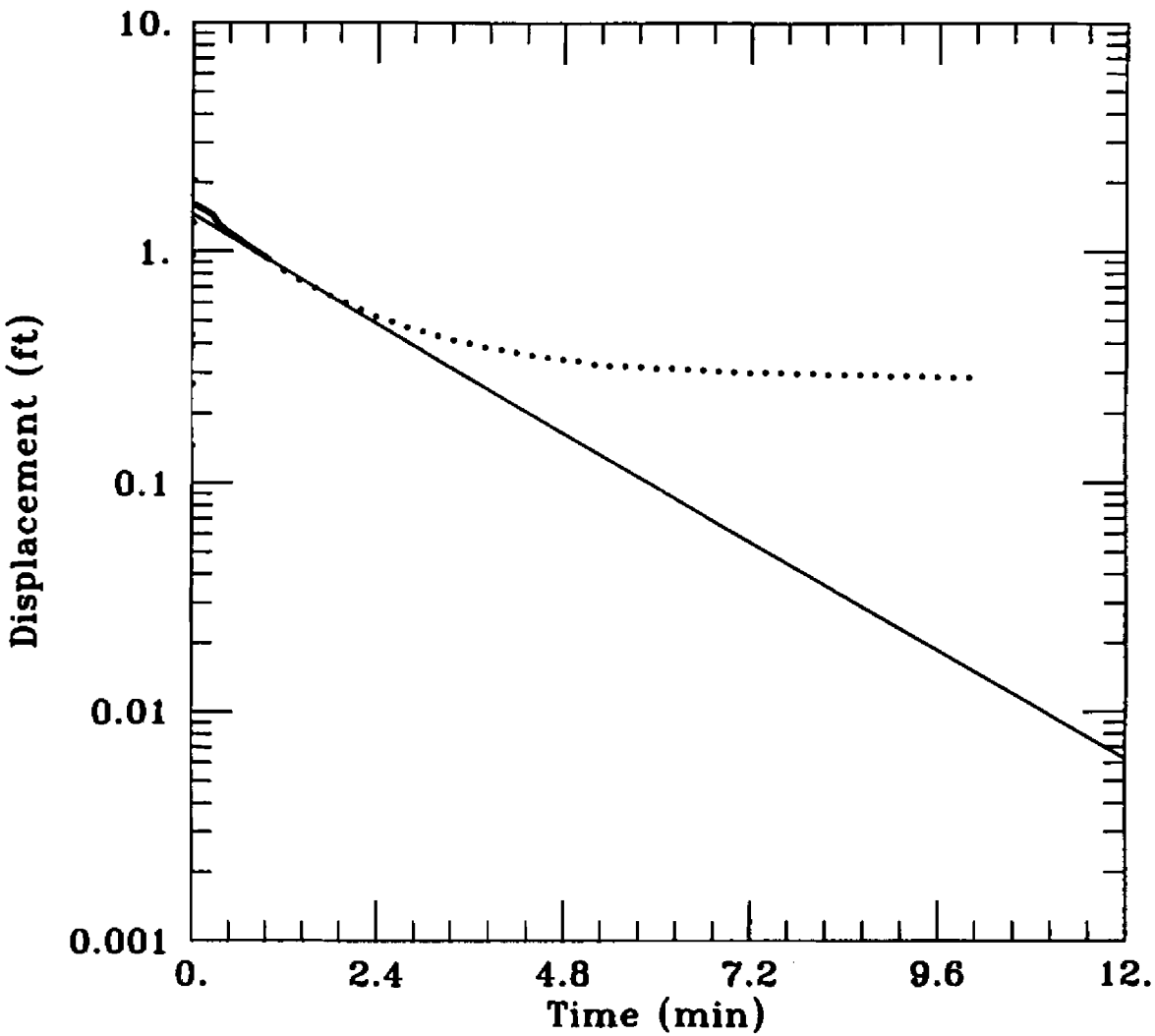
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 4. ft
b = 4. ft
H = 4. ft

PARAMETER ESTIMATES:
K = 0.00252 ft/min
y0 = 0.3437 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCG011002



DATA SET:
11002RIS.AQT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

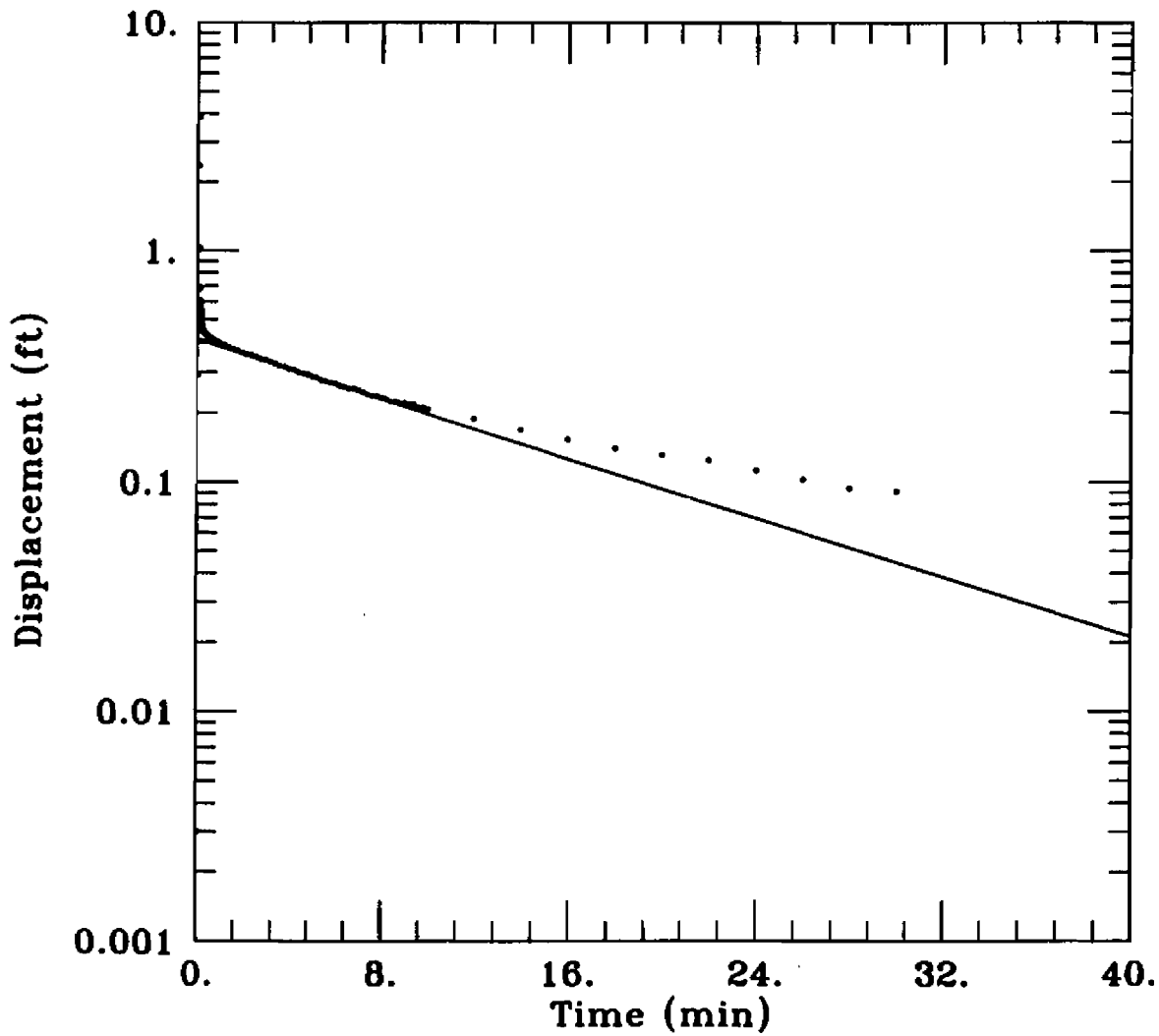
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 7.5 ft
b = 7.5 ft
H = 7.5 ft

PARAMETER ESTIMATES:
K = 0.00213 ft/min
y0 = 1.453 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCG636001



DATA SET:
63601FAL.AGT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

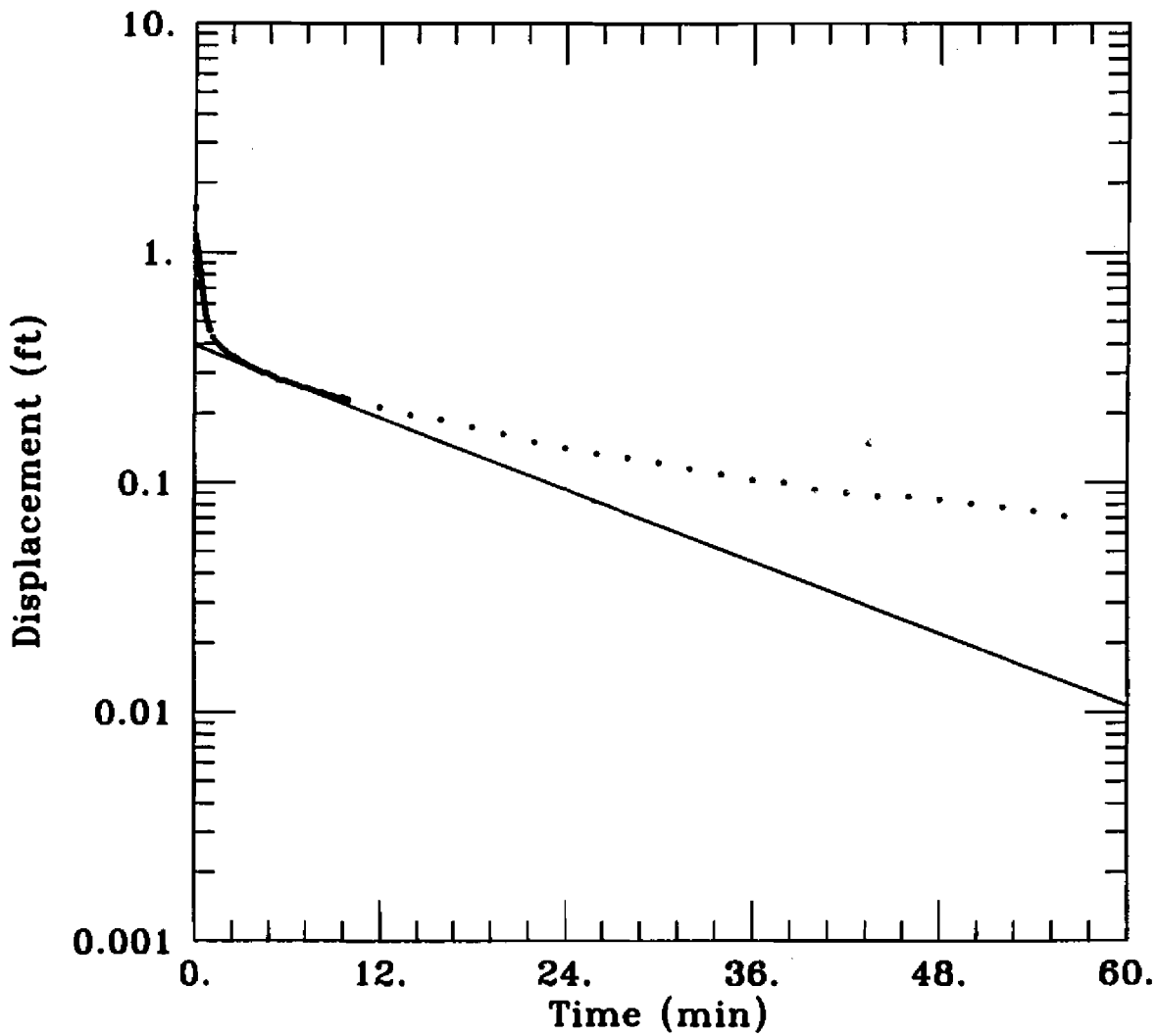
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 10. ft
b = 10. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.0002885 ft/min
y0 = 0.4145 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCG636001



DATA SET:
63601RIS.AQT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

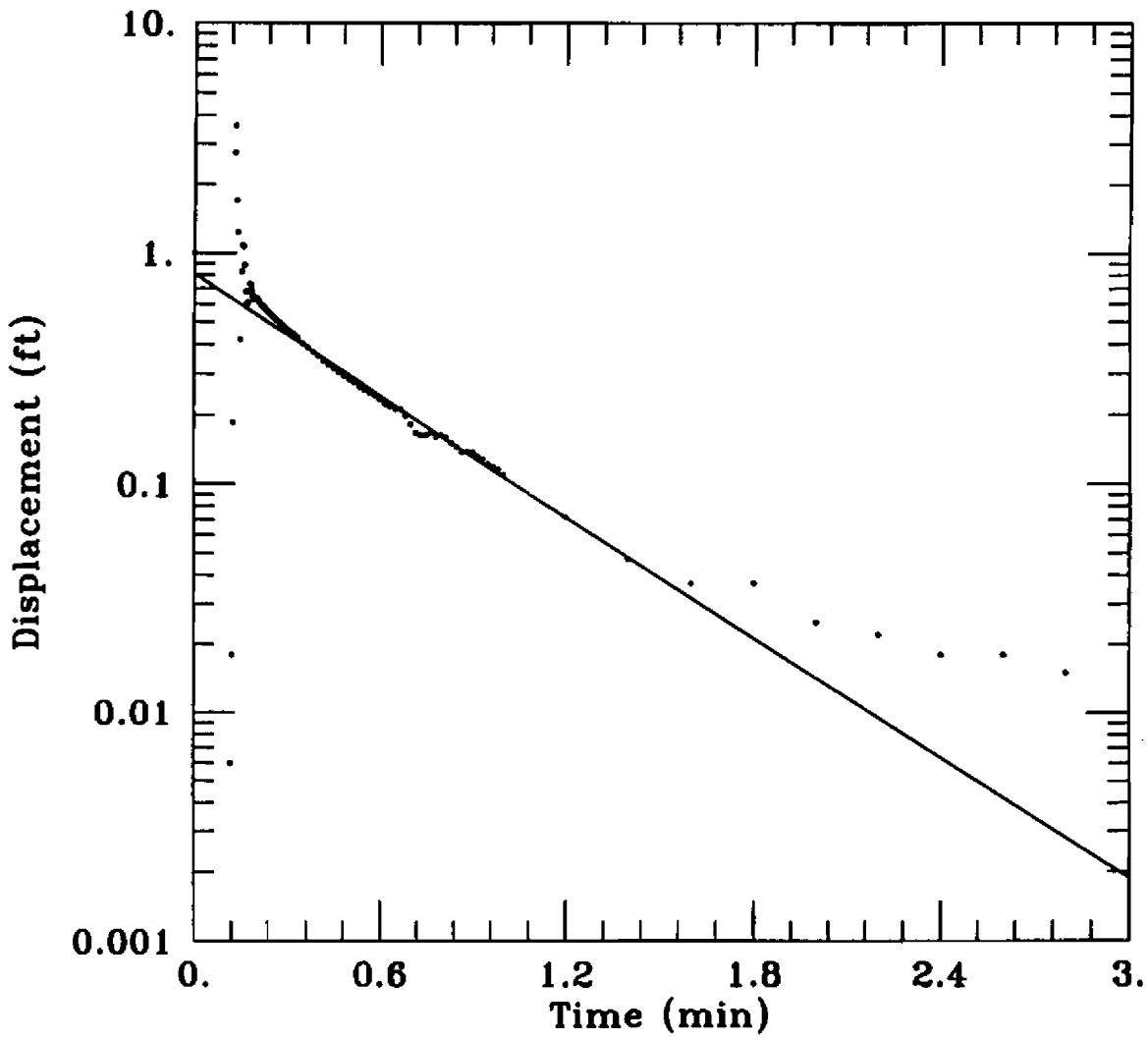
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 10. ft
b = 10. ft
H = 10. ft

PARAMETER ESTIMATES:
K = 0.0002338 ft/min
y0 = 0.3951 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST NBCG637001



DATA SET:
63701FAL.AQT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

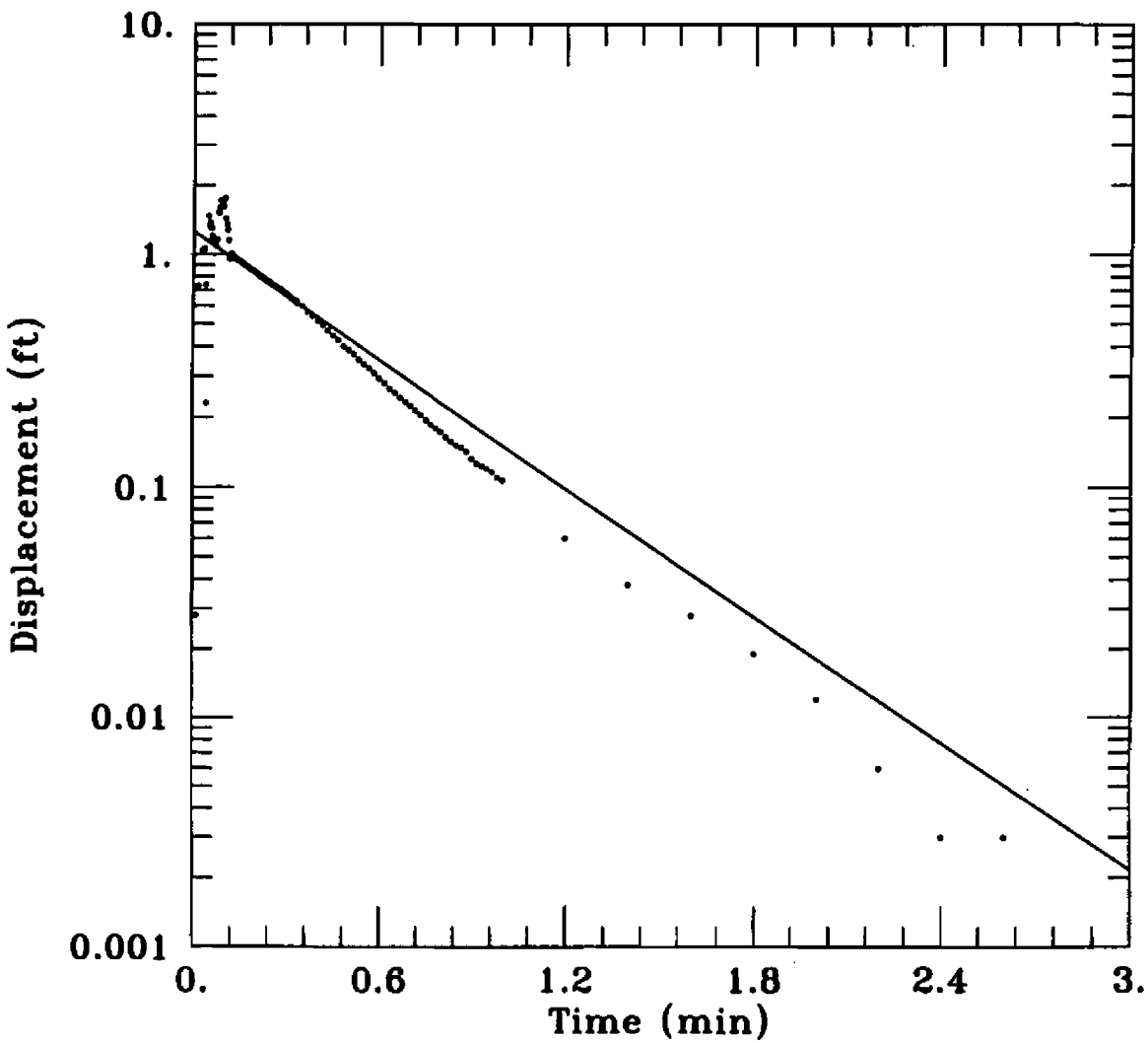
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 7.5 ft
b = 7.5 ft
H = 7.5 ft

PARAMETER ESTIMATES:
K = 0.00221 ft/min
y0 = 0.8114 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST NBCG637001



DATA SET:
63701RIS.AQT
04/15/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

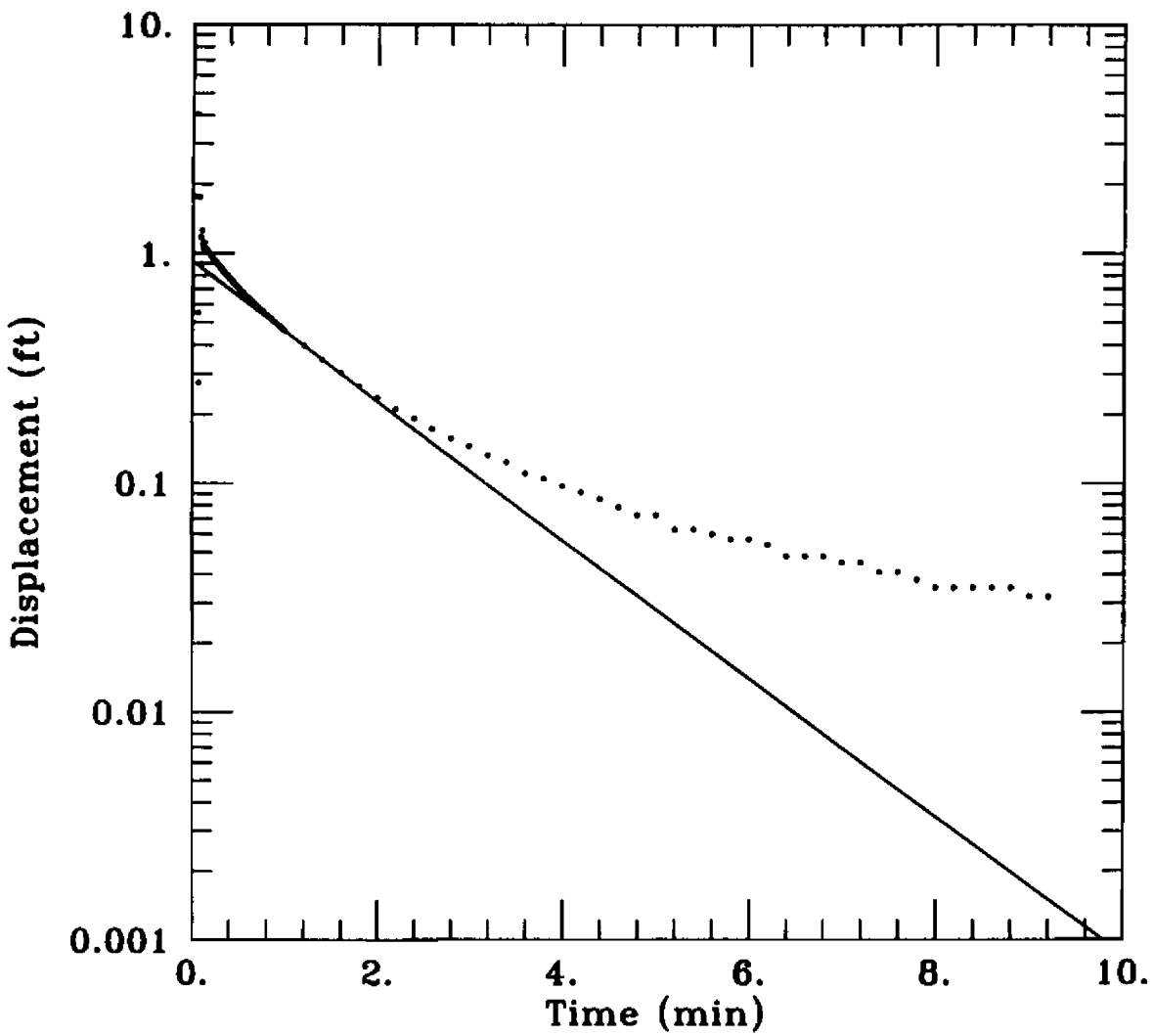
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 7.5 ft
b = 7.5 ft
H = 7.5 ft

PARAMETER ESTIMATES:
K = 0.002317 ft/min
y0 = 1.254 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST CNSY0804



DATA SET:
8004FAL.AQT
04/16/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

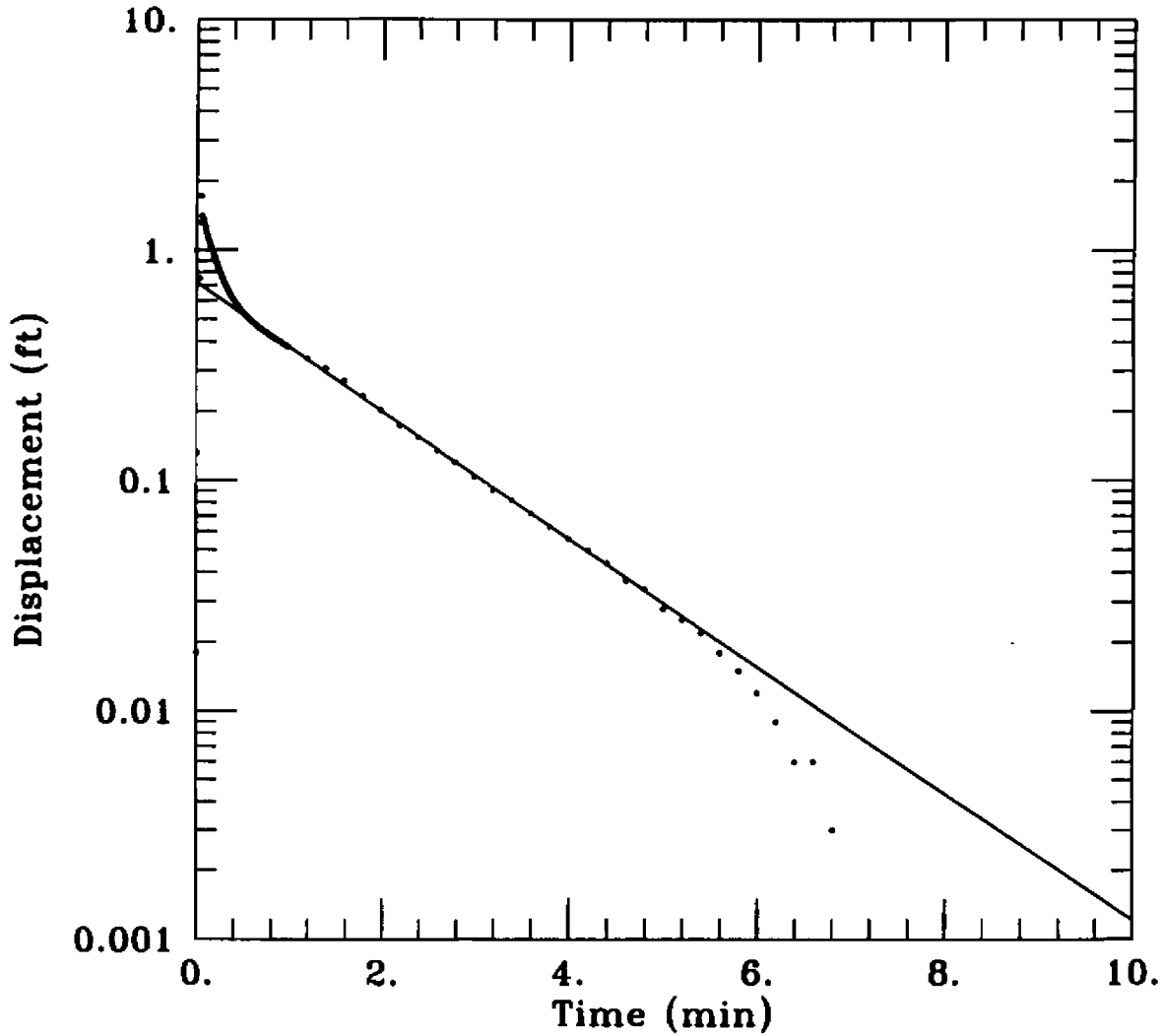
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 5. ft
b = 6. ft
H = 6. ft

PARAMETER ESTIMATES:
K = 0.004407 ft/min
y0 = 0.9201 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST CNSY0804



DATA SET:
B004RIS.AQT
04/16/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

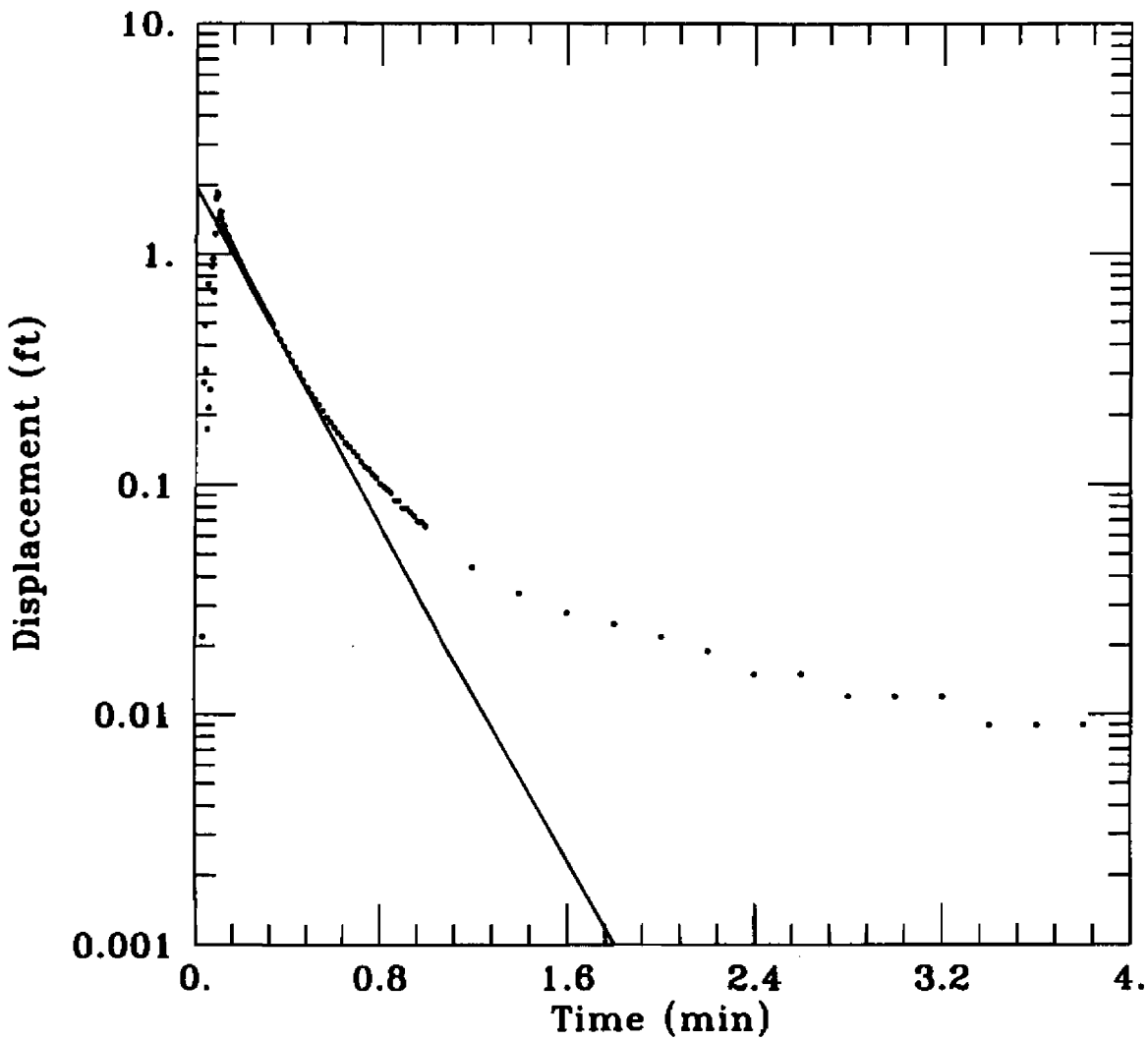
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 5. ft
b = 6. ft
H = 6. ft

PARAMETER ESTIMATES:
K = 0.00404 ft/min
y0 = 0.7212 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

FALLING HEAD SLUG TEST CNSY0806



DATA SET:
8006FAL.AQT
04/16/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

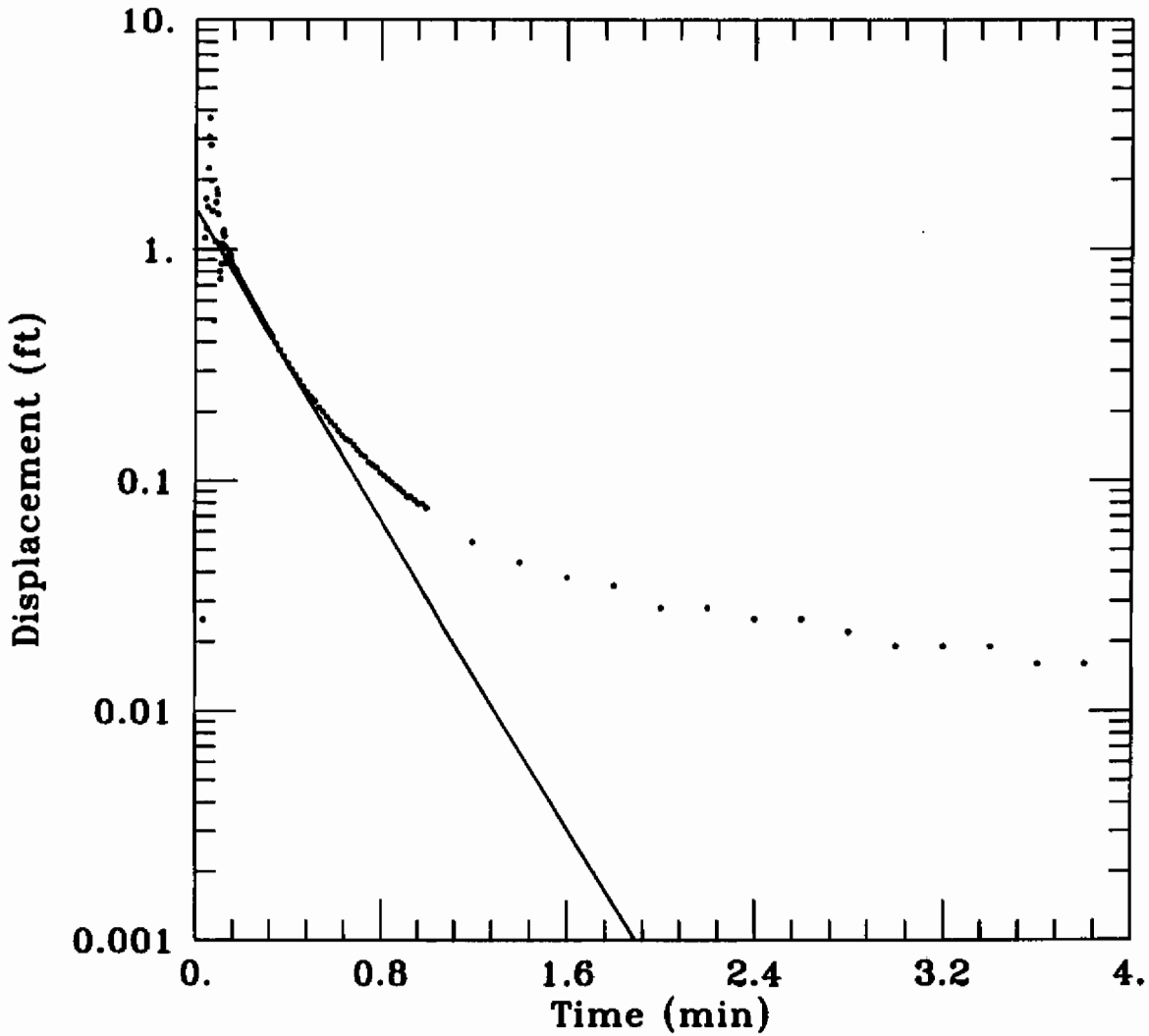
TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 5.5 ft
b = 5.5 ft
H = 5.5 ft

PARAMETER ESTIMATES:
K = 0.005564 ft/min
y0 = 1.941 ft

AQTESOLV

Client: **CLEAN**	Company: **E/A&H**
Location: **NAVAL BASE CHARLESTON**	Project: **2907-08450**

RISING HEAD SLUG TEST CNSY0806



DATA SET:
B006RIS.AQT
04/16/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: January 1997

TEST DATA:
H0 = 1. ft
rc = 0.083 ft
rw = 0.3125 ft
L = 5.5 ft
b = 5.5 ft
H = 5.5 ft

PARAMETER ESTIMATES:
K = 0.005115 ft/min
y0 = 1.493 ft

AQTESOLV