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CNC CHARLESTON
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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT
ZONE F VOLUME II OF V SECTIONS 10 TO 10.4 CNC CHARLESTON SC
12/31/1997
ENSAFE

ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVBASE CHARLESTON

VOLUME II of V
SECTIONS 10 to 10.4

CONTRACT N62467-89-D-0318
CTO-029

Prepared for:

Comprehensive Long-Term Environmental Action Navy
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Revision: 0

10.3 SWMU 109, Abrasive Blast Media Storage Area

SWMU 109 (a CSI site) is the abrasive blast media storage area. The site consists of three hoppers identified as Buildings 1364, 1365, and 1393, used to store the abrasive blast media. Hoppers 1364 and 1365 began operation in 1949, while hopper 1393 was added in 1962. Particulate air emissions were permitted at the site in 1992. Materials released, stored, or disposed of at the site included aluminum oxide and "black beauty" blast media.

10.3.1 Site Geology and Hydrogeology

The soil boring, sediment sampling, and groundwater monitoring well locations for SWMU 109 are shown in Figure 10.3-1. Appendix A contains the boring log and the monitoring well construction diagram for the SWMU 109 monitoring well, 109001. The general stratigraphy at SWMU 109, based on one monitoring well boring, consists of silty clay overlying clayey sand. The silty clay extends to a depth of approximately six ft bgs. The clayey sand, in which monitoring well 109001 is completed, exhibits a grain size distribution of 43% sand, 15% silt and 42% clay. The total depth reached by the boring was 12.4 ft bgs.

Figure 10.3-2 depicts the shallow groundwater potentiometric surface and inferred flow direction at low tide. Because only one well was installed at SWMU 109, static water levels from additional adjacent monitoring wells, not shown on Figure 10.3-2, were used to determine the flow pattern. Very little difference in the static water levels and the overall flow pattern at SWMU 109 were observed between high and low tide, therefore, no high tide potentiometric map is provided. Monitoring well 109001 was not slug tested. However, the hydraulic conductivity of the nearby shallow well, GDF001, calculated from slug testing, was 7.1 ft/day. The horizontal hydraulic gradient, based on Figure 10.3-2 is 7.4E-04. The horizontal groundwater flow velocity was calculated at 9.5E-03 ft/day in the shallow deposits at SWMU 109.

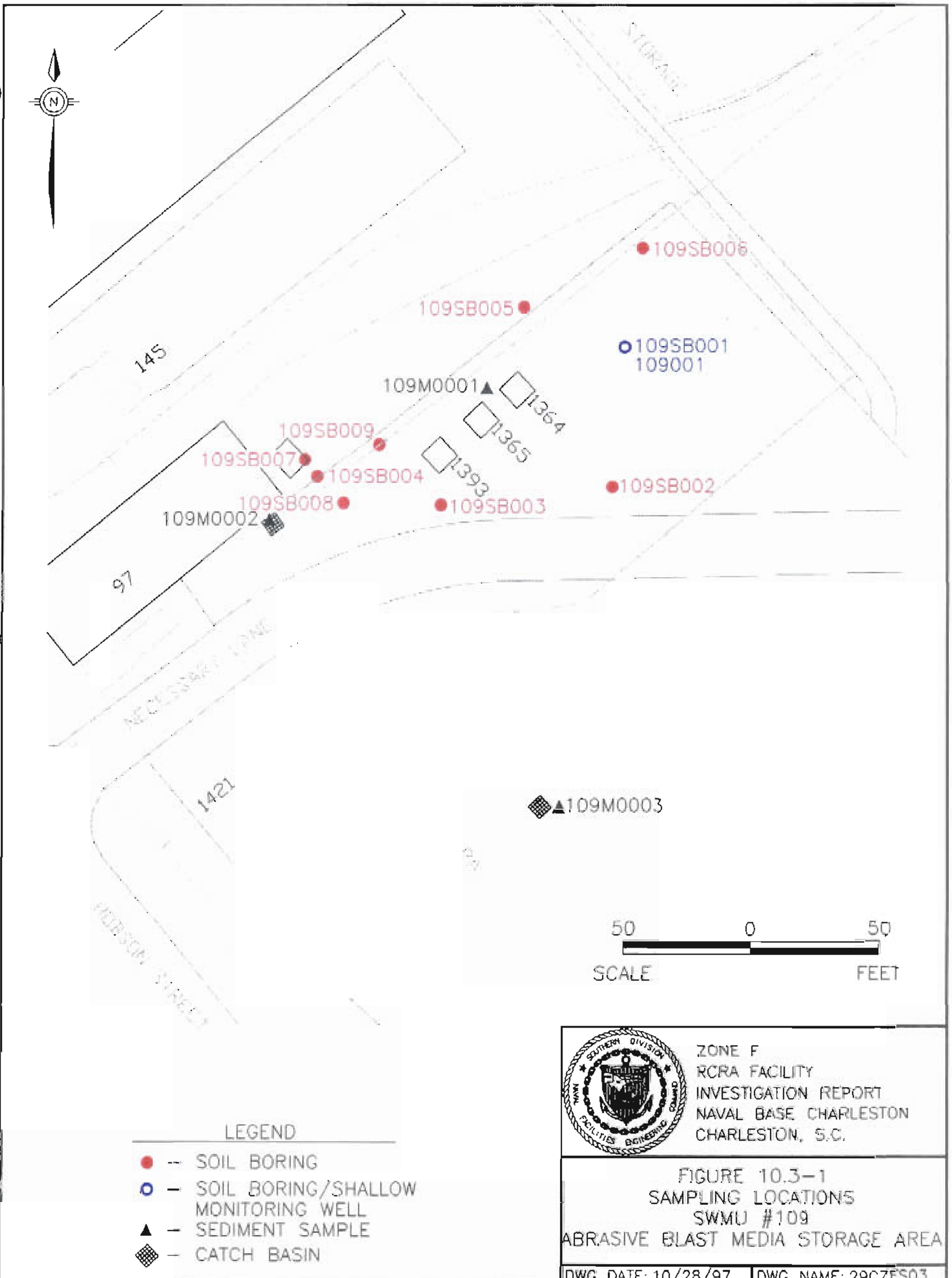

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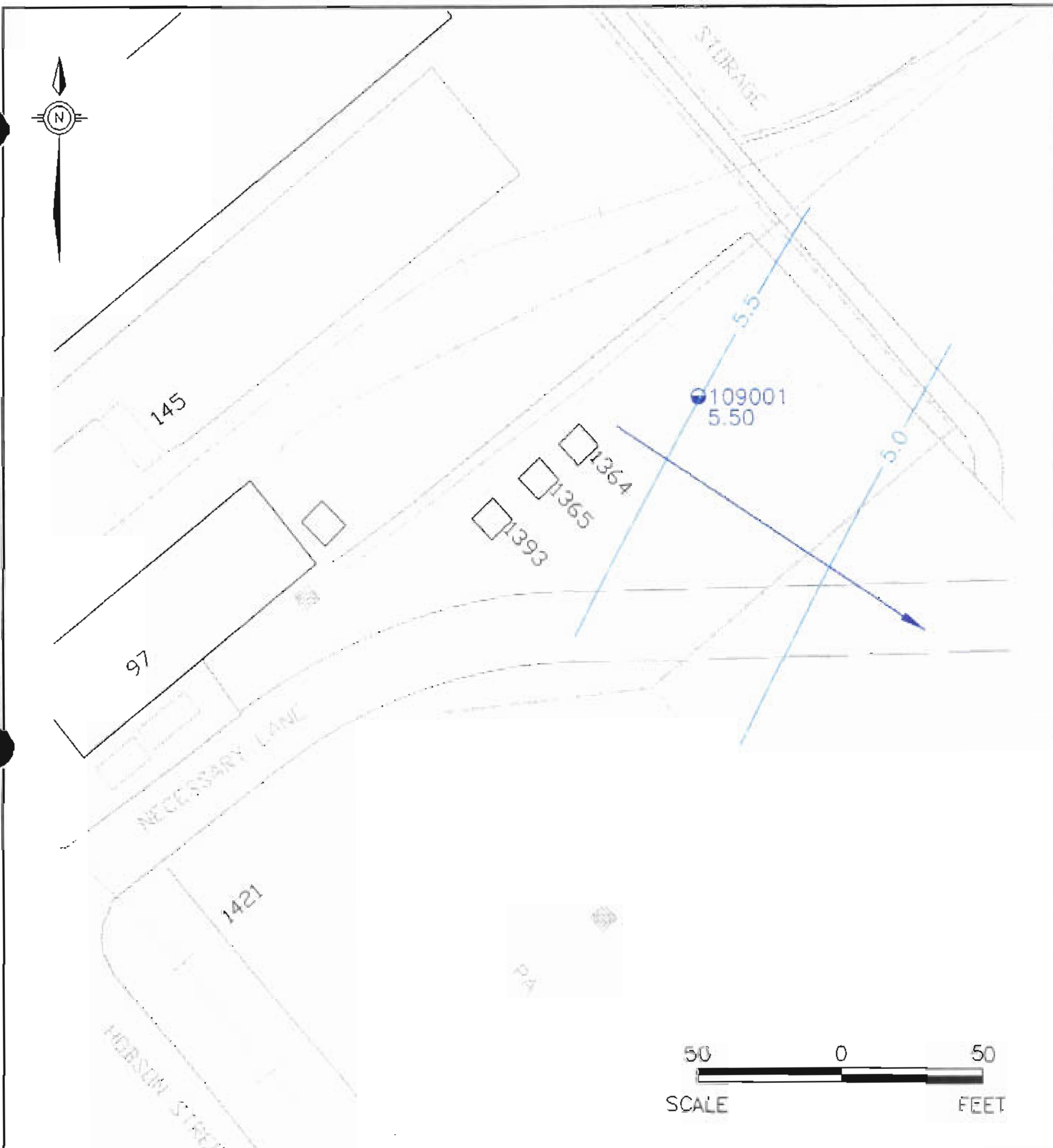
FIGURE 10.3-1
SAMPLING LOCATIONS
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 10/28/97 | DWG NAME: 29CZFS03



LEGEND

- SHALLOW MONITORING WELL
- CATCH BASIN
- —4— CONTOUR INTERVAL – 0.5 FOOT
- FLOW DIRECTION

NOTE:
GROUNDWATER FLOW DIRECTION BASED ON ADDITIONAL WELLS ASSOCIATED WITH OTHER SITES.

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FIGURE 10.3-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 10/30/97	DWG NAME: 29CZFS04

10.3.2 Field Investigation Approach

The objectives of the field investigation at SWMU 109 were 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, sediment from storm sewer basins, and shallow groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hollow stem auger drilling procedures used for shallow well installation; the hand-auger procedures used for soil sampling; sediment and groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix A contains the construction diagram for the monitoring well installed onsite. Appendix D contains the data report for samples collected in Zone F.

10.3.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing six soil borings within the SWMU 109 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Nine soil borings were advanced during the field investigation, in two phases (Figure 10.3-1). Six borings were advanced during the first round of the field investigation, with upper and lower interval samples collected at each location. In accordance with the approved final RFI work plan, first-round samples were analyzed for metal and SVOAs at DQO Level III. In addition, four of the first-round borings included analyses for pesticides/PCBs, while samples from three of the borings were also analyzed for cyanide. One upper interval duplicate soil sample was also collected for Appendix IX analyses at DQO Level IV. To delineate surface soil arsenic contamination identified during the initial sampling round, three additional borings were advanced. Only upper interval samples were proposed and collected during the second sampling round. Second-round samples were analyzed for arsenic at DQO Level III. Table 10.3.1 presents the SWMU 109 soil samples and analyses.

Table 10.3.1
SWMU 109
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
109SB001	109SB00101 109SB00102	Upper Lower	8/27/96	Note 1/pesticides/ PCBs	
109SB002	109SB00201 109SB00202	Upper Lower	9/23/96	Note 1/pesticides/ PCBs, cyanide	
109SB003	109SB00301 109CB00301* 109SB00302	Upper Lower	9/23/96	Note 1/pesticides/ PCBs, cyanide Note 3	*Duplicate Sample
109SB004	109SB00401 109SB00402	Upper Lower	9/23/96	Note 1/pesticides/ PCBs, cyanide	
109SB005	109SB00501 109SB00502	Upper Lower	9/23/96	Note 1	
109SB006	109SB00601 109SB00602	Upper Lower	9/23/96	Note 1	
109SB007	109SB00701	Upper	3/19/97	Note 2	Upper sample interval only Second-round sample
109SB008	109SB00801	Upper	3 /19/97	Note 2	Upper sample interval only Second-round sample
109SB009	109SB00901	Upper	3/19/97	Note 2	Upper sample interval only Second-round sample

Notes:

1 = SW-846 (metals and SVOAs) at DQO Level III
2 = Arsenic at DQO Level III
3 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample collected

10.3.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.3.2. Inorganic analytical results for soil are summarized in Table 10.3.3. Table 10.3.4 presents a summary of all analytes detected in soil at SWMU 109. Appendix D contains a complete analytical data report for all Zone F samples collected.

Semivolatile Organic Compounds in Soil

Benzo(a)pyrene and dibenz(a,h)anthracene exceeded their respective RBCs in surface soil samples at SWMU 109. Figure 10.3-3 presents total BEQ concentrations detected in surface soil.

No SVOCs in subsurface soil exceeded their SSLs at SWMU 109.

Pesticides and PCBs in Soil

No pesticides or PCBs exceeded their RBCs or SSLs in surface or subsurface soil samples, respectively.

Other Organic Compounds in Soil

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

Inorganic Elements in Soil

Twenty-two metals, plus cyanide, were detected in soil samples collected at SWMU 109. Arsenic, beryllium, chromium, manganese, and vanadium were detected in surface soil samples at concentrations exceeding both their respective RBCs and background concentrations for Zone F surface soil. Iron exceeded its surface soil RBC; however, no background concentration for iron

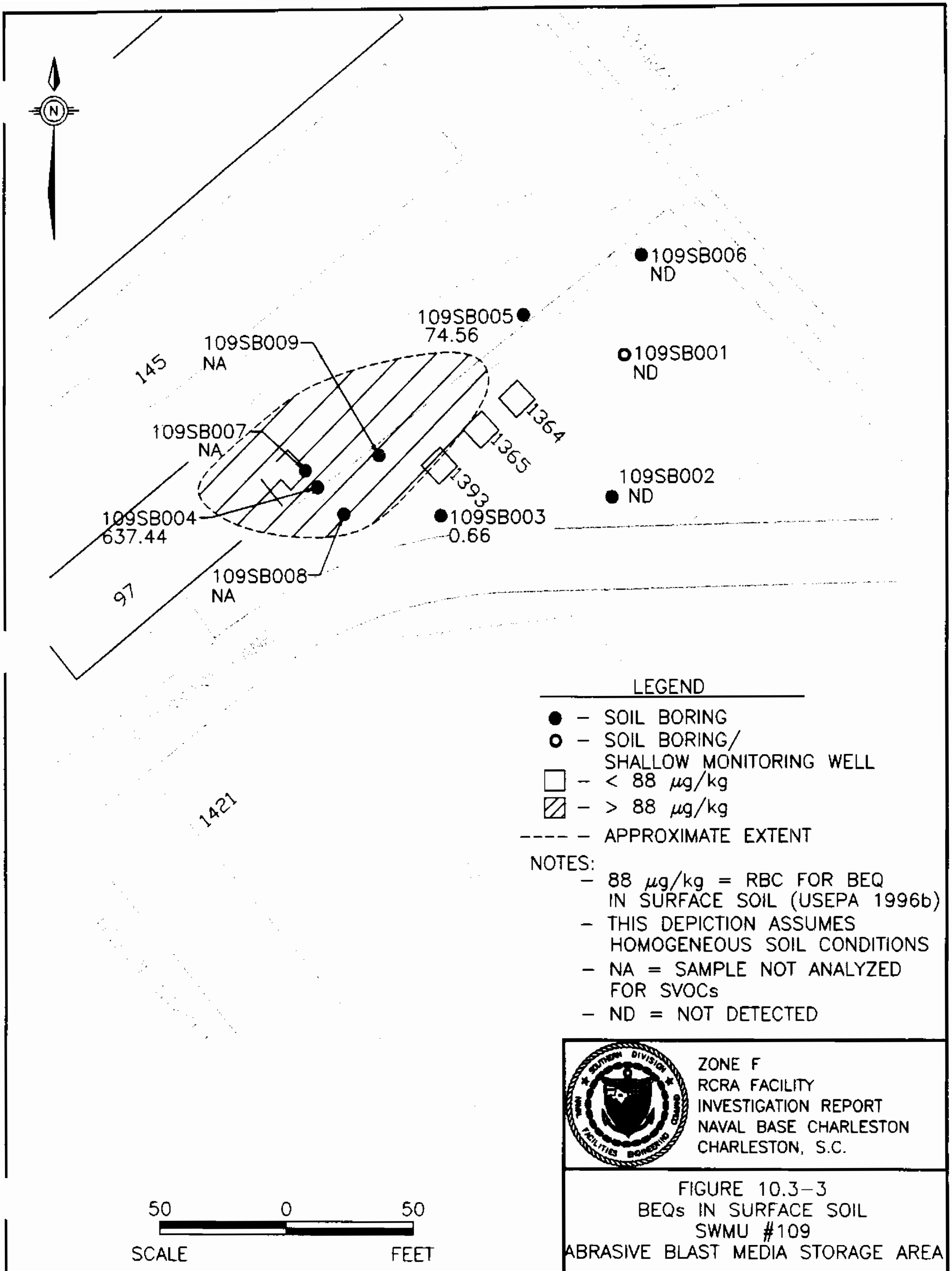

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FIGURE 10.3–3
BEQs IN SURFACE SOIL
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 12/15/97 | DWG NAME: 2906B109

Table 10.3.2
SWMU 109
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
Semivolatile Organic Compounds (Upper Interval - 6 Samples plus 1 Duplicate Sample/Lower Interval - 6 Samples) (μg/kg)						
BEQs[1]	Upper	3/6	0.66 - 637.44	237.33	88.00	1
	Lower	0/0	NA	NA	NA	NA
Anthracene	Upper	1/6	73.0	73.0	2300000	0
	Lower	0/6	ND	ND	12000000[a]	0
Benzo(a)anthracene	Upper	2/6	58.0 - 420.0	239	880	0
	Lower	0/6	ND	ND	2000[b]	0
Benzo(a)pyrene	Upper	2/6	68.0 - 450.0	259.0	88	1
	Lower	0/6	ND	ND	8000	0
Benzo(g,h,i)perylene	Upper	1/6	240.0	240.0	230000	0
	Lower	0/6	ND	ND	4.66E+08	NA
Benzo(k)fluoranthene	Upper	3/6	66.0 - 500.0	212.0	8800	0
	Lower	0/6	ND	ND	49000[b]	0
Benzoic acid	Upper	1/6	70.0	70.0	31000000	0
	Lower	1/6	52.0	52.0	400000[a,c]	0
Chrysene	Upper	2/6	62.0 - 440.0	251.0	88000	0
	Lower	0/6	ND	ND	160000[b]	0
Dibenz(a,h)anthracene	Upper	1/6	120.0	120.0	88	1
	Lower	0/6	ND	ND	2000[b]	0
Fluoranthene	Upper	2/6	72.0 - 790.0	431.0	310000	0
	Lower	0/6	ND	ND	4300000[a]	0

Table 10.3.2
SWMU 109
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
Semivolatile Organic Compounds (Upper Interval - 6 Samples plus 1 Duplicate Sample/Lower Interval - 6 Samples) (μg/kg)						
Indeno(1,2,3-cd)pyrene	Upper	1/6	200.0	200.0	880	0
	Lower	0/6	ND	ND	14000[b]	0
Naphthalene	Upper	1/6	220.0	220.0	310000	0
	Lower	0/6	ND	ND	84000[a]	0
Phenanthrene	Upper	1/6	270.0	270.0	230000	0
	Lower	0/6	ND	ND	1380000	NA
Pyrene	Upper	2/6	72.0 - 600.0	336.0	230000	0
	Lower	0/6	ND	ND	4200000[a]	0
Pesticides and PCBs (Upper Interval - 4 Samples plus 1 Duplicate Sample/Lower Interval - 4 Samples) (μg/kg)						
4,4'-DDE	Upper	1/4	8.0	8.0	1900	0
	Lower	0/4	ND	ND	54000[b]	0
Aroclor-1260	Upper	1/4	160.0	160.0	320	0
	Lower	0/4	ND	ND	1000	NA
Dioxins (Upper Interval - 1 Duplicate Sample) (μg/kg) (ng/kg)						
Dioxin (2,3,7,8-TCDD TEQs[1])	Upper	1/1	1.0229	1.0229	1000	1
	Lower	0/0	NA	NA	1900	NA

Notes:

[1]	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
[a]	=	Calculated values correspond to a noncancer hazard quotient of 1.
[b]	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000.
[c]	=	SSL for pH of 6.8.
*	=	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.
ND	=	Not detected
NA	=	Not applicable
ng/kg	=	Nanograms per kilogram
μg/kg	=	Micrograms per kilogram

Table 10.3.3
SWMU 109
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 - 6 Samples Full TAL/3 Samples Arsenic Only plus 1 Duplicate Sample/Lower Interval - 6 Samples plus 1 Duplicate Sample) (mg/kg)						
Aluminum	**Upper**	**6/6**	**660 - 16000**	**6700**	**7800**	**3**
	Lower	**6/6**	**1880 - 10800**	**6070.0**	**1000000**	**NA**
Antimony	Upper	1/6	1.5	1.5	3.1	0
	Lower	0/6	ND	ND	5	0
Arsenic	**Upper**	**9/9**	**1.4 - 134.0**	**25.2**	**0.43**	**9**
	Lower	**6/6**	**1.5 - 16.0**	**6.9**	**29[b]**	**0**
Barium	Upper	6/6	4.3 - 118.0	34.7	550	0
	Lower	6/6	6.1 - 29.8	17.3	1600[b]	0
Beryllium	**Upper**	**6/6**	**0.17 - 1.30**	**0.56**	**0.15**	**6**
	Lower	**6/6**	**0.30 - 0.96**	**0.53**	**63[b]**	**0**
Cadmium	Upper	5/6	0.09 - 1.2	0.35	3.9	0
	Lower	2/6	0.06 - 0.07	0.065	8[b]	0
Calcium	**Upper**	**6/6**	**4620.0 - 26200.0**	**13792.0**	**NL**	**NA**
	Lower	**6/6**	**2000.0 - 16000.0**	**8647.0**	**NL**	**NA**
Chromium	Upper	6/6	3.0 - 45.1	18.6	39	1
	Lower	6/6	5.6 - 24.0	13.4	38[b]	0
Cobalt	**Upper**	**6/6**	**1.20 - 27.10**	**9.95**	**470**	**0**
	Lower	**6/6**	**0.96 - 5.60**	**2.94**	**2000**	**NA**
Copper	Upper	4/6	4.0 - 138.0	61.4	310	0
	Lower	3/6	6.0 - 18.1	10.2	920	NA

Table 10.3.3
SWMU 109
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 - 6 Samples Full TAL/3 Samples Arsenic Only plus 1 Duplicate Sample/Lower Interval - 6 Samples plus 1 Duplicate Sample) (mg/kg)						
Iron	Upper	6/6	1160.0 - 29500	12765.0	2300	4
	Lower	6/6	2850.0 - 14500.0	9325.0	NL	NA
Lead	Upper	6/6	6.5 - 362.0	93.8	400[c]	0
	Lower	6/6	3.9 - 35.5	17.1	400[c]	0
Magnesium	Upper	6/6	160.0 - 3480.0	1271.3	NL	NA
	Lower	6/6	385.0 - 3100.0	1231.3	NL	NA
Manganese	Upper	6/6	19.3 - 427.0	178.4	180	3
	Lower	6/6	26.0 - 210.0	90.5	1100	NA
Mercury	Upper	3/6	0.23 - 0.90	0.48	2.3	0
	Lower	1/6	0.07	0.07	2.0[b]	0
Nickel	Upper	4/6	2.8 - 114.0	38.4	160	0
	Lower	4/6	3.9 - 13.8	7.0	130[b]	0
Potassium	Upper	4/6	253.0 - 1320.0	816.3	NL	NA
	Lower	4/6	426.0 - 1480.0	855.5	NL	NA
Selenium	Upper	4/6	0.52 - 0.84	0.72	39	0
	Lower	6/6	0.47 - 1.20	0.79	5[b]	0
Silver	Upper	1/6	1.3	1.3	39	0
	Lower	0/6	ND	ND	34[a,b]	0
Sodium	Upper	1/6	203.0	203.0	NL	NA
	Lower	2/6	216.0 - 590.0	403.0	NL	NA

Table 10.3.3
SWMU 109
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 - 6 Samples Full TAL/3 Samples Arsenic Only plus 1 Duplicate Sample/Lower Interval - 6 Samples plus 1 Duplicate Sample) (mg/kg)						
Vanadium	Upper	6/6	2.4 - 64.5	23.5	55	1
	Lower	6/6	5.3 - 30.8	17.02	6000[a]	0
Zinc	Upper	5/6	15.8 - 822.0	288.1	2300	0
	Lower	5/6	17.2 - 97.6	39.6	12000[a,b]	0
Cyanide	Upper	3/3	0.12 - 0.61	0.29	160	0
	Lower	2/3	0.16 - 0.21	0.19	40 amenable	0

Notes:

a	=	Calculated values correspond to a noncancer hazard quotient of 1.
b	=	SSL for pH of 6.8
c	=	A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA 1994a).
*	=	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.
mg/kg	=	Milligrams per kilogram.
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable

Table 10.3.4
SWMU 109
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
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	**109SB003**	**0.66**	**88.0**	**NA**	**NA**	**NL**	**NA**
	109SB004	**637.44**			**NA**		
	109SB005	**74.56**			**NA**		
Anthracene	109SB004	73.0	2300000	NA	ND	12000000[a]	NA
Benzo(a)anthracene	**109SB004**	**420.0**	**880.0**	**NA**	**ND**	**2000[b]**	**NA**
	109SB005	**58.0**			**ND**		
Benzo(a)pyrene	109SB004	450.0	88.0	NA	ND	8000	NA
	109SB005	68.0			ND		
Benzo(g,h,i)perylene	**109SB004**	**240.0**	**230000.0**	**NA**	**ND**	**4.66E+08**	**NA**
Benzo(k)fluoranthene	109SB003	66.0	8800.0	NA	ND	49000[b]	NA
	109SB004	500.0			ND		
	109SB005	70.0			ND		
Benzoic acid	**109SB001**	**70.0**	**31000000**	**NA**	**52.0**	**400000[a,c]**	**NA**
Chrysene	109SB004	440.0	88000.0	NA	ND	160000[b]	NA
	109SB005	62.0			ND		
Dibenz(a,h)anthracene	**109SB004**	**120.0**	**88**	**NA**	**ND**	**2000[b]**	**NA**
Fluoranthene	109SB004	790.0	310000.0	NA	ND	4300000[a]	NA
	109SB005	72.0			ND		
Indeno(1,2,3-cd)pyrene	**109SB004**	**200.0**	**880**	**NA**	**ND**	**14000[b]**	**NA**
Naphthalene	109SB001	220.0	310000	NA	ND	84000[a]	NA

Table 10.3.4
SWMU 109
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
Semivolatile Organic Compounds (μg/kg)							
Phenanthrene	109SB004	270.0	230000.0	NA	ND	1380000	NA
Pyrene	109SB004	600.0	230000.0	NA	ND	4200000[a]	NA
	109SB005	72.0			ND		
Pesticides and PCBs (μg/kg)							
4,4'-DDE	109SB004	8.0	1900.0	NA	ND	54000[b]	NA
Aroclor-1260	109SB004	160.0	320	NA	ND	1000	NA
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	109SB003	1.0229	1000	NA	ND	1900	NA
Inorganics (mg/kg)							
Aluminum (Al)	109SB001	2560.0	7800.0	18500	10600.0	1000000	17100
	109SB002	660.0			1880.0		
	109SB003	8970.0			2770.0		
	109SB004	11300.0			10800.0		
	109SB005	16000.0			4880.0		
	109SB006	707.0			5640.0		
Antimony (Sb)	109SB002	1.5	3.1	0.79	ND	5	NL

Table 10.3.4
SWMU 109
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)							
Arsenic (As)	109SB001	4.0	0.43	19.9	5.0	29[c]	18.2
	109SB002	1.4			1.5		
	109SB003	10.2			12.9		
	109SB004	134.0			16.0		
	109SB005	20.2			6.4		
	109SB006	6.1			3.6		
	109SB007	25.9			ND		
	109SB008	20.0			ND		
	109SB009	5.1			ND		
Barium (Ba)	109SB001	11.4	550.0	61.5	16.4	1600[c]	51.8
	109SB002	4.3			6.1		
	109SB003	25.8			10.1		
	109SB004	118.0			29.8		
	109SB005	41.8			21.9		
	109SB006	7.0			19.6		
Beryllium (Be)	109SB001	0.28	0.15	1.05	0.33	63[c]	1.20
	109SB002	0.17			0.30		
	109SB003	0.595			0.37		
	109SB004	0.85			0.96		
	109SB005	1.30			0.56		
	109SB006	0.19			0.66		
Cadmium (Cd)	109SB001	0.09	3.9	0.26	0.07	8[c]	0.09
	109SB002	ND			0.06		
	109SB003	0.175			ND		
	109SB004	1.2			ND		
	109SB005	0.19			ND		
	109SB006	0.09			ND		

Table 10.3.4
SWMU 109
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)							
Calcium (Ca)	109SB001	6170.0	NL	NL	2000.0	NL	NL
	109SB002	15000.0			5570.0		
	109SB003	15960.0			7200.0		
	109SB004	26200.0			11800.0		
	109SB005	14800.0			9310.0		
	109SB006	4620.0			16000.0		
Chromium (Cr)	109SB001	6.3	39 VI 7800 III	34.8	19.0	38[c] (total)	32.2
	109SB002	3.0			5.6		
	109SB003	19.65			6.2		
	109SB004	45.1			24.0		
	109SB005	33.8			10.9		
	109SB006	4.0			14.8		
Cobalt (Co)	109SB001	1.4	470.0	15.1	1.5	2000	6.85
	109SB002	1.5			1.6		
	109SB003	27.1			0.96		
	109SB004	16.6			4.8		
	109SB005	11.9			5.6		
	109SB006	1.2			3.2		
Copper (Cu)	109SB001	4.0	310.0	48.2	ND	920	30.4
	109SB003	53.75			ND		
	109SB004	138.0			18.1		
	109SB005	49.9			6.5		
	109SB006	ND			6.0		
Cyanide (CN)	109SB002	0.12	160.0	0.29	ND	40 (Amenable)	0.24
	109SB003	0.14			0.16		
	109SB004	0.61			0.21		

Table 10.3.4
SWMU 109
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
Inorganics (mg/kg)							
Iron (Fe)	**109SB001**	**4820.0**	**2300.0**	**NL**	**14400.0**	**NL**	**NL**
	109SB002	**1160.0**			**2850.0**		
	109SB003	**11670.0**			**4380.0**		
	109SB004	**29500.0**			**14500.0**		
	109SB005	**28000.0**			**9620.0**		
	109SB006	**1440.0**			**10200.0**		
Lead(Pb)	109SB001	6.7	400.0[d]	180	9.8	400[d]	51.7
	109SB002	9.4			3.9		
	109SB003	47.1			10.7		
	109SB004	362.0			35.5		
	109SB005	131.0			22.9		
	109SB006	6.5			19.6		
Magnesium (Mg)	**109SB001**	**522.0**	**NL**	**NL**	**663.0**	**NL**	**NL**
	109SB002	**246.0**			**385.0**		
	109SB003	**1350.0**			**520.0**		
	109SB004	**1870.0**			**3100.0**		
	109SB005	**3480.0**			**1060.0**		
	109SB006	**160.0**			**1660.0**		
Manganese (Mn)	109SB001	119.0	180.0	307	26.0	1100	469
	109SB002	26.5			35.9		
	109SB003	204.5			33.8		
	109SB004	427.0			210.0		
	109SB005	274.0			105.0		
	109SB006	19.3			132.0		
Mercury (Hg)	**109SB003**	**0.30**	**2.3**	**0.62**	**ND**	**2[c]**	**0.23**
	109SB004	**0.90**			**0.07**		
	109SB005	**0.23**			**ND**		

Table 10.3.4
SWMU 109
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)							
Nickel (Ni)	109SB001	2.8	160.0	12.6	3.9	130[c]	8.85
	109SB003	22.2			ND		
	109SB004	114.0			13.8		
	109SB005	14.6			4.8		
	109SB006	ND			5.5		
Potassium (K)	109SB001	253.0	NL	NL	426.0	NL	NL
	109SB003	700.0			ND		
	109SB004	992.0			1480.0		
	109SB005	1320.0			633.0		
	109SB006	ND			883.0		
Selenium (Se)	109SB001	ND	39.0	1.15	0.50	5	1.24
	109SB002	0.52			1.10		
	109SB003	0.83			0.47		
	109SB004	0.68			1.20		
	109SB005	0.84			0.85		
	109SB006	ND			0.64		
Silver (Ag)	109SB003	1.3	39.0	1.85	ND	34[a,c]	ND
Sodium (Na)	109SB001	203.0	NL	NL	216.0	NL	NL
	109SB004	ND			590.0		
Vanadium (V)	109SB001	9.5	55.0	48.9	30.8	6000[a]	49.4
	109SB002	2.4			5.3		
	109SB003	24.75			7.9		
	109SB004	36.9			27.7		
	109SB005	64.5			13.7		
	109SB006	3.0			16.7		

Table 10.3.4
SWMU 109
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)							
Zinc (Zn)	109SB001	16.1	2300.0	198	17.2	12000[a,c]	84.2
	109SB003	112.5			18.2		
	109SB004	822.0			97.6		
	109SB005	474.0			29.9		
	109SB006	15.8			33.1		

Notes:

a = Calculated values correspond to a noncancer hazard quotient of 1.
b = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c = SSL for pH of 6.8.
d = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
* = 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.
f = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
mg/kg = Milligrams per kilogram
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 F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

in surface soil. Figures 10.3-4 through 10.3-8 present the distribution of the metals exceedances in surface soil.

No inorganics detected in subsurface soil exceeded both their respective SSLs and background concentrations for Zone F subsurface soil.

10.3.4 Sediment Sampling and Analyses

The approved final RFI work plan proposed collecting three sediment samples to identify contaminants introduced to the storm sewer system from the site. Two sediment samples (109M0001 and 190M0003) were collected during the investigation, as depicted in Figure 10.3-1. The storm sewer at location 109M0002 contained insufficient sediment for sample collection. In accordance with the approved final RFI work plan, sediment samples were analyzed for metals and SVOAs at DQO Level III. The sediment samples were also analyzed for cyanide. One duplicate sediment sample was collected for Appendix IX analyses at DQO Level IV. Table 10.3.5 presents the SWMU 109 sediment samples and analyses.

10.3.4.1 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.3.6. Inorganic analytical results for sediment are summarized in Table 10.3.7. Table 10.3.8 summarizes all analytes detected in sediment at SWMU 109.

The following sections discuss sediment sample analytical results relative to detected soil parameters as an indication of soil contaminant migration via storm water flow. Given that this sediment was collected from engineered structures (storm catch basins, storm water culverts, etc.), it is not true sediment generated in a native setting, and therefore, is not compared to reference concentrations or other criteria. The storm sewer system will be addressed in the Zone L RFI.

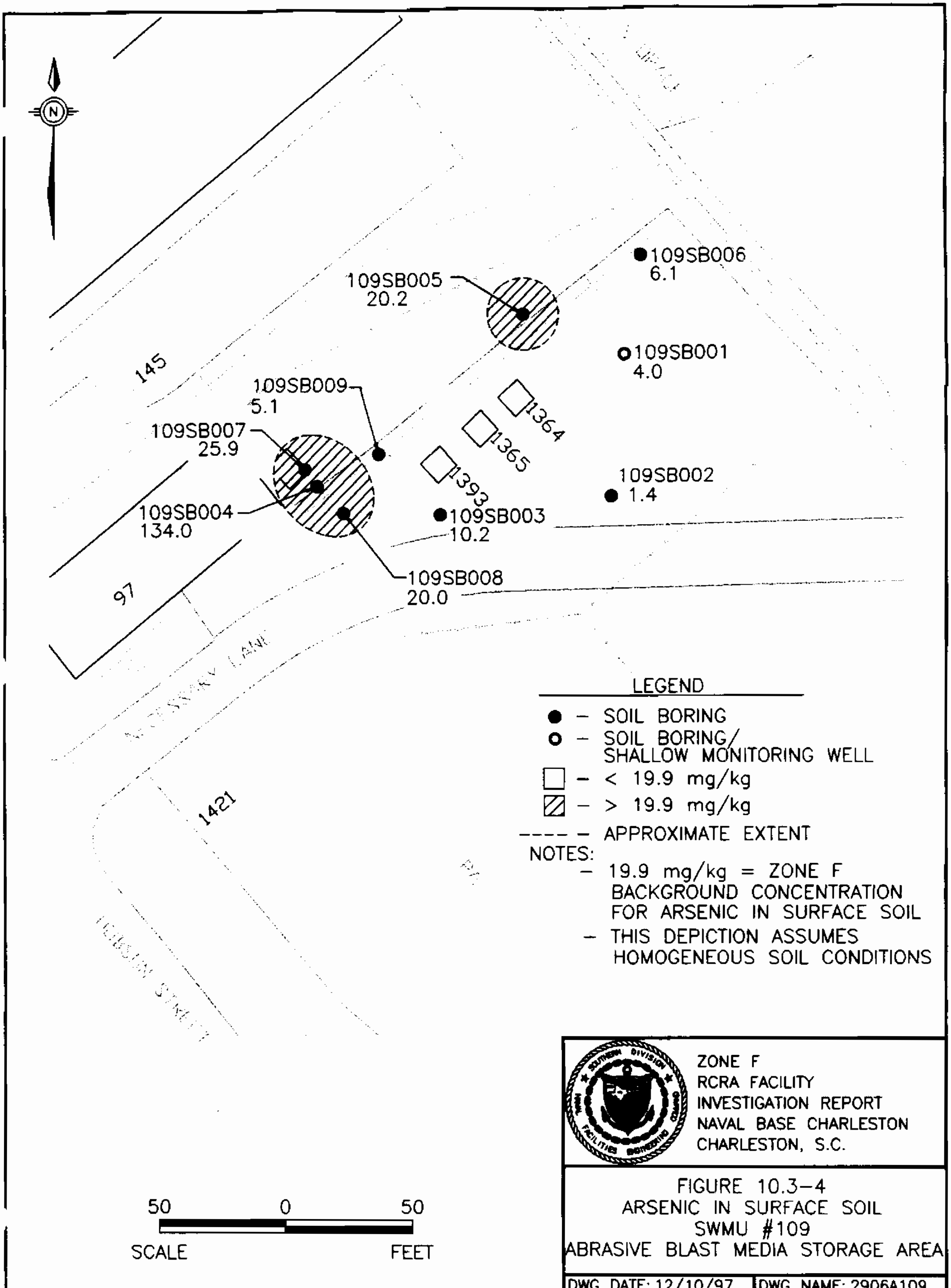


FIGURE 10.3-4
ARSENIC IN SURFACE SOIL
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

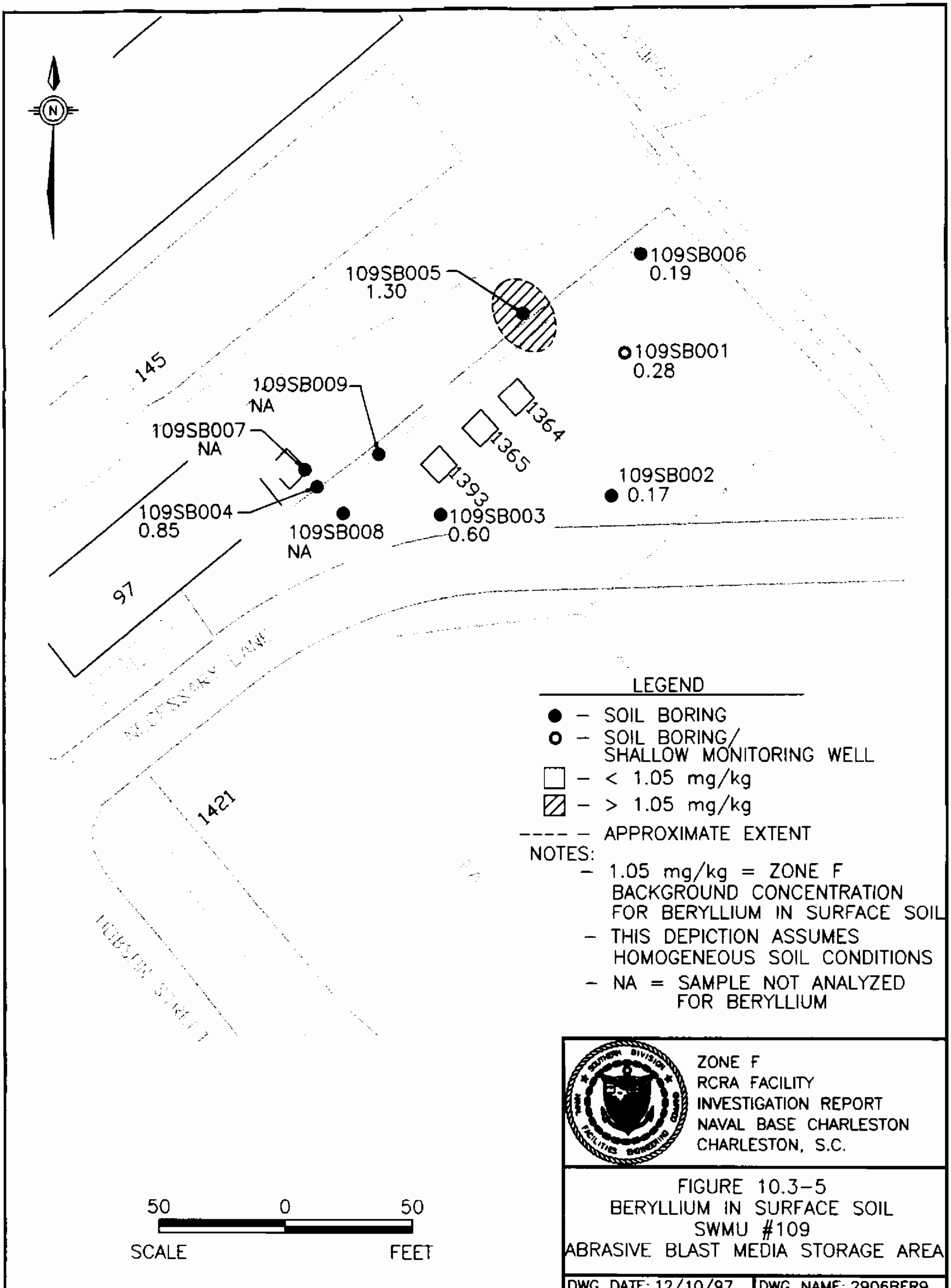
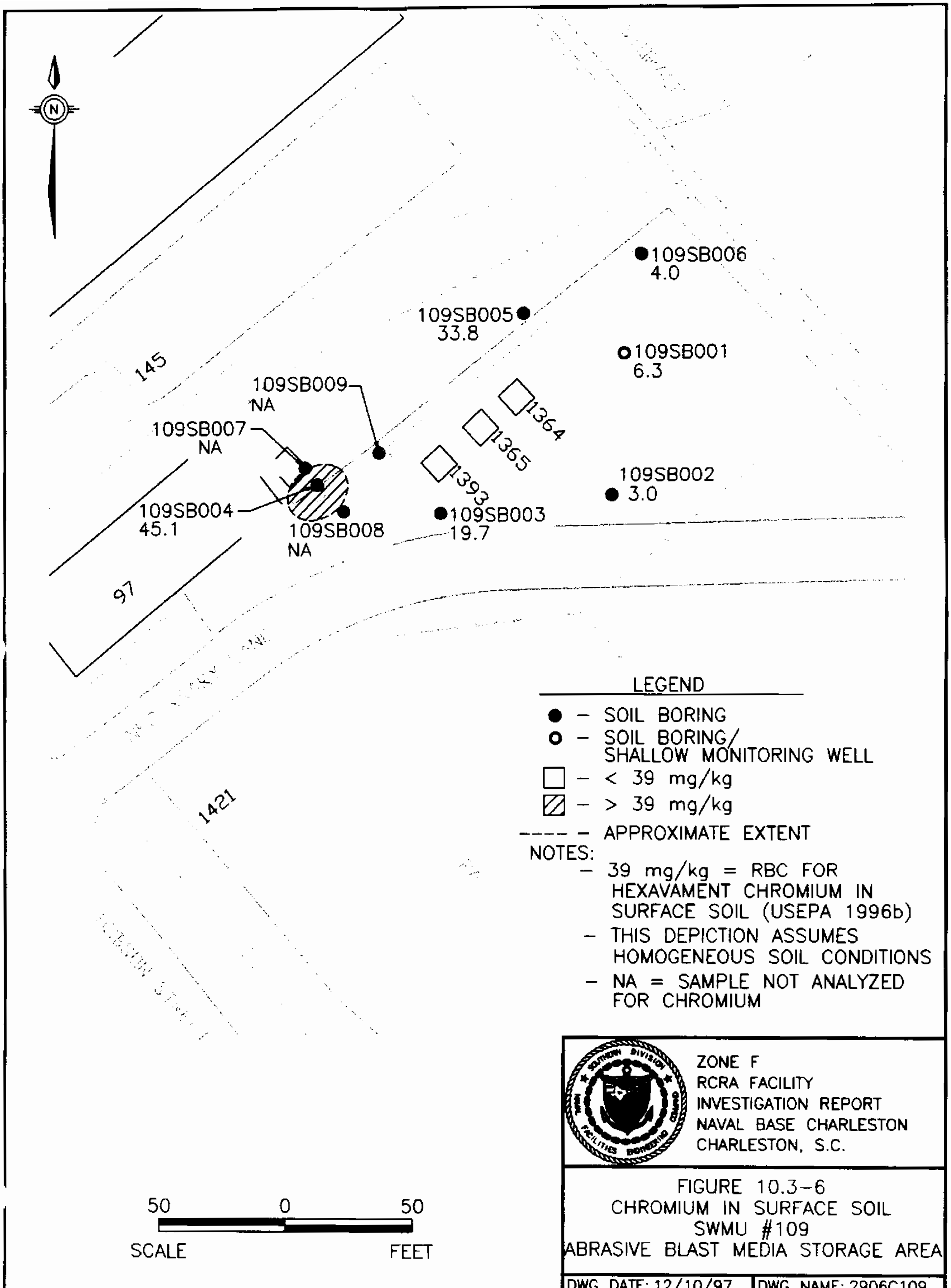


FIGURE 10.3-5
BERYLLIUM IN SURFACE SOIL
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 12/10/97 | DWG NAME: 2906BER9



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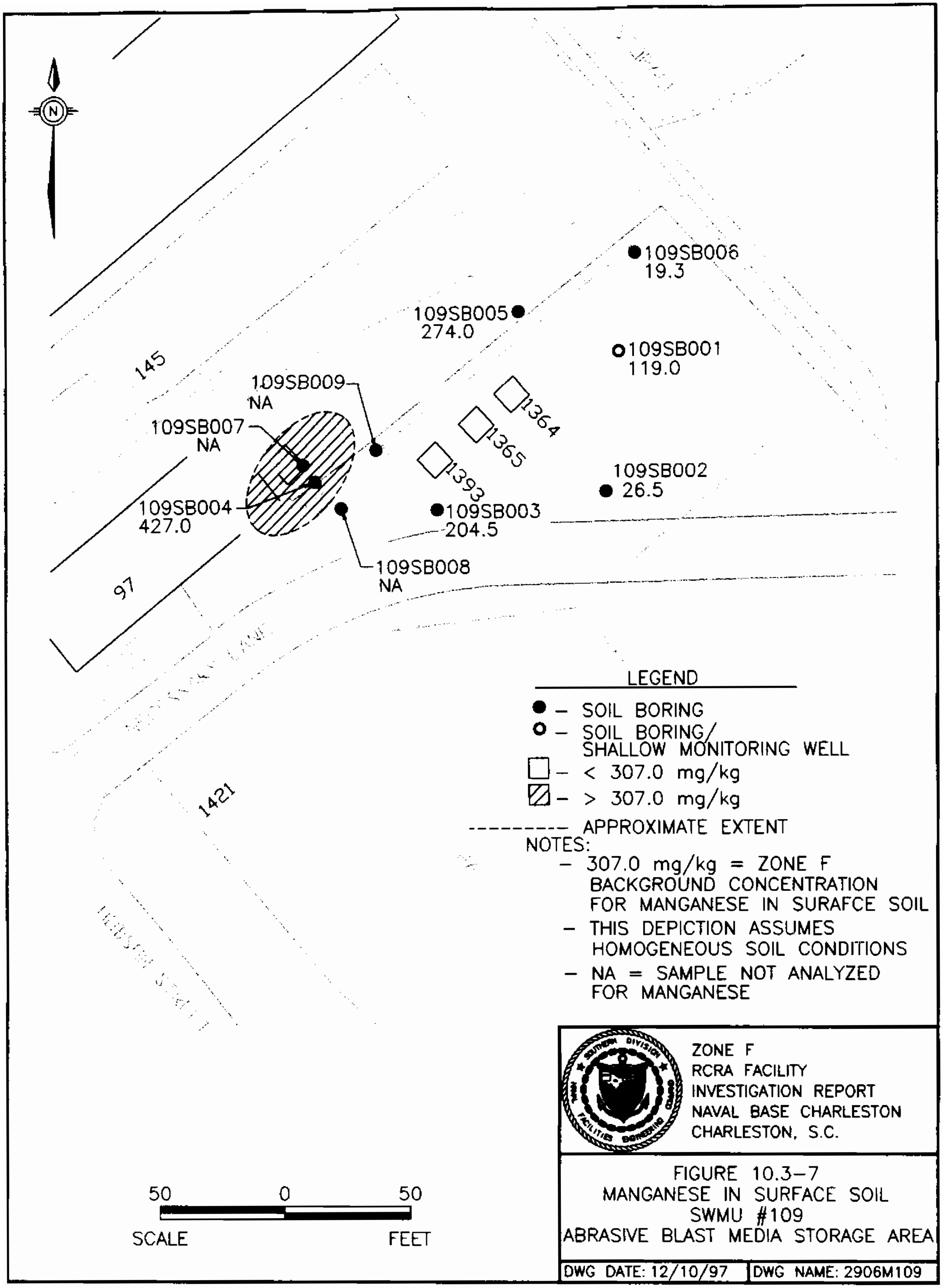
CHARLESTON, S.C.

FIGURE 10.3–6
CHROMIUM IN SURFACE SOIL
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 12/10/97 | DWG NAME: 2906C109



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CHARLESTON, S.C.

FIGURE 10.3–7
MANGANESE IN SURFACE SOIL
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 12/10/97	DWG NAME: 2906M109

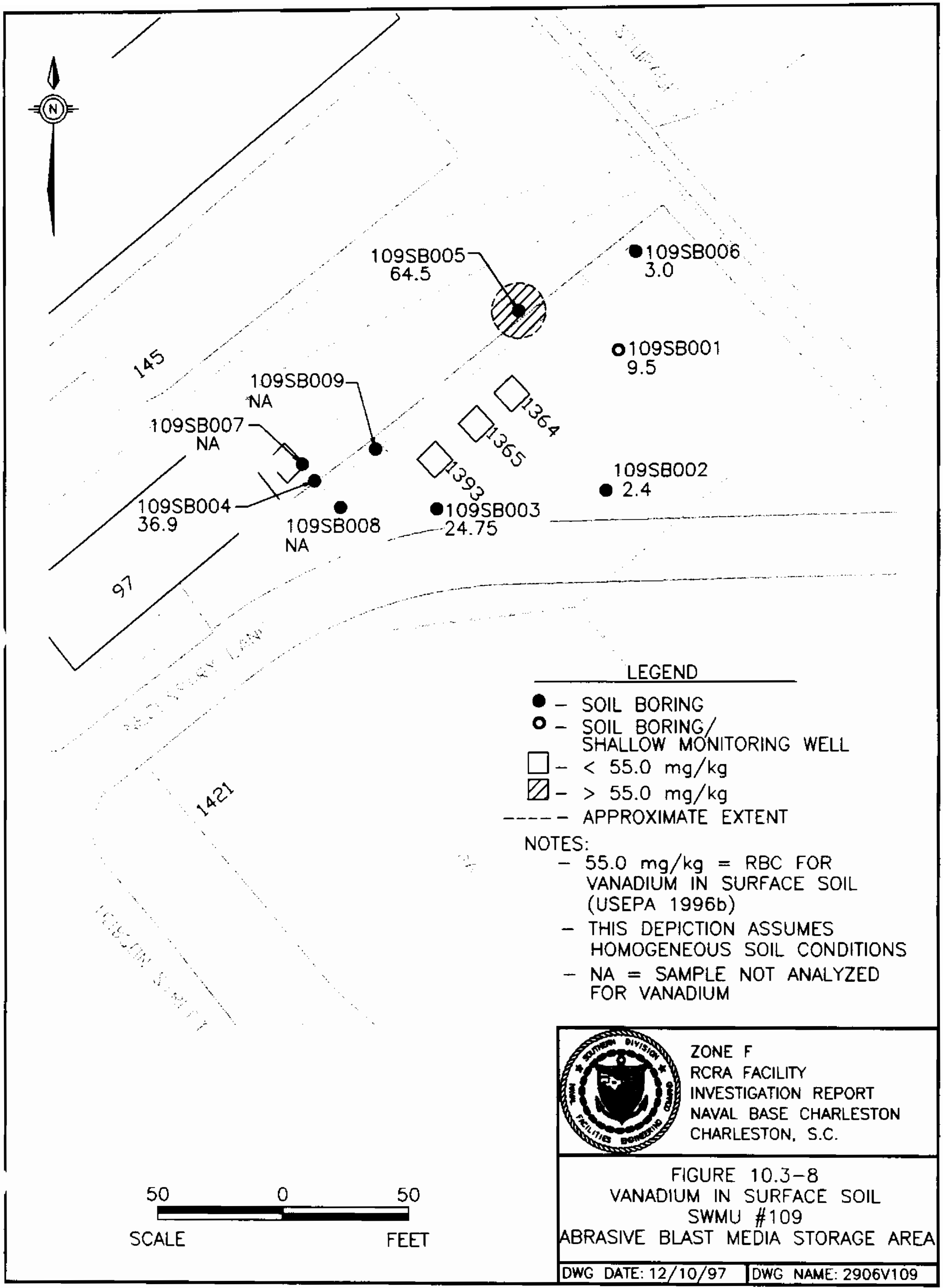

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FIGURE 10.3-8
VANADIUM IN SURFACE SOIL
SWMU #109
ABRASIVE BLAST MEDIA STORAGE AREA

DWG DATE: 12/10/97 | DWG NAME: 2906V109

Table 10.3.5
SWMU 109
Sediment Samples and Analyses

Sample Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
109M00001	109M000101	NA	10/01/96	Note 1	
109M0002	NA	NA	NA	NA	Sample not taken
109M00003	109M000301 109N000301*	NA	10/01/96	Notes 1/2	*Duplicate sample

Notes:
1 = SW-846 (metals and SVOAs); cyanide at DQO Level III
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV
NA = Not applicable
* = Duplicate sample collected

Table 10.3.6
SWMU 109
Organic Compound Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)
Semivolatile Organic Compounds (2 Samples) (μg/kg)			
2-Methylnapththalene	1/2	56.0	56.0
Di-n-octylphthalate	1/2	54.0	54.0
Naphthalene	1/2	170.0	170.0
Bis(2-ethylhexyl)phthalate (BEHP)	2/2	41.0 - 420.0	230.5
Dioxins (1 Duplicate Sample) (ng/kg)			
Dioxin (2,3,7,8-TCDD TEQs[1])	1/1	0.0711	0.0711

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

Table 10.3.7
SWMU 109
Inorganic Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)
Inorganics (2 Samples) (mg/kg)			
Aluminum	**2/2**	**1430.0 - 4865.0**	**3147.5**
Antimony	2/2	0.57 - 4.40	2.49
Arsenic	**2/2**	**0.64 - 5.35**	**3.00**
Barium	2/2	9.20 - 33.85	21.53
Beryllium	**2/2**	**0.20 - 1.55**	**0.88**
Cadmium	2/2	0.09 - 0.20	0.15
Calcium	**2/2**	**633.0 - 71050.0**	**35841.5**
Chromium	2/2	13.0 - 88.7	50.9
Cobalt	**2/2**	**6.5 - 17.5**	**12.0**
Copper	2/2	31.1 - 3840.0	1935.6
Iron	**2/2**	**8740.0 - 142750**	**75745.0**
Lead	2/2	76.3 - 1295.0	685.7
Magnesium	**2/2**	**112.0 - 1660.0**	**886.0**
Manganese	2/2	50.6 - 860.5	455.6
Nickel	**2/2**	**10.0 - 323.5**	**166.75**
Potassium	1/2	241.5	241.5
Selenium	**2/2**	**0.52 - 2.35**	**1.43**
Sodium	1/2	586.0	586.0
Thallium	**1/2**	**4.7**	**4.7**
Tin	2/2	7.7 - 349.0	178.4
Vanadium	**2/2**	**3.4 - 47.0**	**25.2**

Table 10.3.7
SWMU 109
Inorganic Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)
Inorganics (2 Samples) (mg/kg)			
Zinc	**2/2**	**258.0 - 1560.0**	**909.0**
Cyanide	1/2	0.15	0.15

Table 10.3.8
SWMU 109
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Semivolatile Organic Compounds (μg/kg)		
2-Methylnaphthalene	**109M0001**	**56.0**
Di-n-octylphthalate	109M0001	54.0
Naphthalene	**109M0001**	**170.0**
Bis(2-ethylhexyl)phthalate (BEHP)	109M0001	420.0
	109M0003	41.0
Dioxins (ng/kg)		
Dioxin (2,3,7,8-TCDD TEQs[1])	**109M0003**	**0.0711**
Inorganics (mg/kg)		
Aluminum (Al)	**109M0001**	**1430.0**
	109M0003	**4865.0**
Antimony (Sb)	109M0001	0.57
	109M0003	4.40
Arsenic (As)	**109M0001**	**0.64**
	109M0003	**5.35**
Barium (Ba)	109M0001	9.20
	109M0003	33.85
Beryllium (Be)	**109M0001**	**0.20**
	109M0003	**1.55**

Table 10.3.8
SWMU 109
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Inorganics (mg/kg)		
Cadmium (Cd)	109M0001	0.2
	109M0003	0.09
Calcium (Ca)	109M0001	633.0
	109M0003	71050.0
Chromium (Cr)	109M0001	13.0
	109M0003	88.7
Cobalt (Co)	109M0001	6.5
	109M0003	17.5
Copper (Cu)	109M0001	31.1
	109M0003	3840.0
Cyanide (CN)	109M0003	0.15
Iron (Fe)	109M0001	8740.0
	109M0003	142750.0
Lead (Pb)	109M0001	76.3
	109M0003	1295.0
Magnesium (Mg)	109M0001	112.0
	109M0003	1660.0
Manganese (Mn)	109M0001	50.6
	109M0003	860.5
Nickel (Ni)	109M0001	10.0
	109M0003	323.5
Potassium (K)	109M0003	241.5
Selenium (Se)	109M0001	0.52
	109M0003	2.35
Sodium (Na)	109M0003	586.0
Thallium (Tl)	109M0003	4.7
Tin (Sn)	109M0001	7.7
	109M0003	349.0
Vanadium (V)	109M0001	3.4
	109M0003	47.0

Table 10.3.8
SWMU 109
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Inorganics (mg/kg)		
Zinc (Zn)	109M0001	258.0
	109M0003	1560.0

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

Semivolatile Organic Compounds in Sediment

Concentrations of four SVOCs 2-methylnapthalene, di-n-octylphthalate, napthalene, and bis(2-ethylhexyl)pthalate were detected in sediment. Napthalene was the only parameter which was also detected in site surface soil.

Other Organic Compounds in Sediment

Dioxin (2,3,7,8-TCDD TEQ) was detected in the duplicate sediment sample. Dioxin was also detected in the surface soil at the site.

Inorganic Elements in Sediment

Metals were as commonly detected in sediment as they were in site soil. The metals detected in site soil at relatively elevated levels, arsenic, beryllium, chromium, manganese, and vanadium were also detected in sediment.

10.3.5 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of one shallow monitoring well within the SWMU 109 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. One shallow monitoring well (109001) was installed and sampled during the field investigation, as depicted in Figure 10.3-1. This well was installed at approximately 12 ft bgs in the upper sand layer of the Wando Formation. In accordance with the approved final RFI work plan, the groundwater sample from this well was analyzed for metals and SVOAs at DQO Level III. Table 10.3.9 summarizes groundwater sampling and analyses at this site.

Table 10.3.9
SWMU 109
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
109001	Shallow	10900101	11/04/96	See note	No deviations from work plan.

Note:
SW-846 (metals and SVOAs) at DQO Level III

10.3.5.1 Nature of Contamination in Groundwater

Inorganic analytical results for the first quarter groundwater sampling are summarized in Table 10.3.10. Table 10.3.11 summarizes all analytes detected in the first three quarters of groundwater sampling at SWMU 109.

Semivolatile Organic Compounds in Groundwater

No organic compounds were detected in the SWMU 109 groundwater samples.

Inorganic Elements in Groundwater

Eleven metals were detected in the first quarter's groundwater samples. No inorganic analytes were detected in the shallow groundwater at concentrations exceeding tap water RBCs and the Zone F background. The two subsequent quarters of sampling exhibit reduced concentrations of metals in all detections.

Table 10.3.10
SWMU 109
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)							
Aluminum	**Shallow**	**1/1**	**606.0**	**606.0**	**3700**	**50**	**0**
Barium	Shallow	1/1	21.1	21.1	260	2000	0
Calcium	**Shallow**	**1/1**	**87500.0**	**87500.0**	**NL**	**NL**	**NA**
Chromium	Shallow	1/1	1.4	1.4	18	100	0
Iron	**Shallow**	**1/1**	**755.0**	**755.0**	**1100**	**300**	**0**
Magnesium	Shallow	1/1	11500.0	11500.0	NL	NL	NA
Manganese	**Shallow**	**1/1**	**38.8**	**38.8**	**2010**	**50**	**0**
Potassium	Shallow	1/1	7700.0	7700.0	NL	NL	NA
Sodium	**Shallow**	**1/1**	**17200.0**	**17200.0**	**NL**	**NL**	**NA**
Thallium	Shallow	1/1	3.5	3.5	0.29	2	1
Vanadium	**Shallow**	**1/1**	**2.4**	**2.4**	**26**	**NL**	**0**

Notes:
NL = Not listed
NA = Not applicable
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
Data presented are from initial sampling event only.

Table 10.3.11
SWMU 109
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
Inorganics (μg/L)							
Aluminum (Al)	**109001**	**606.0**	**134**	**262**	**3700**	**50**	**224**
Barium (Ba)	109001	21.1	15	15.9	260	2000	94.3
Calcium (Ca)	**109001**	**87500.0**	**91600**	**72800**	**NL**	**NL**	**NL**
Chromium (Cr)	109001	1.4	ND	ND	18	100	2.05
Iron (Fe)	**109001**	**755.0**	**192**	**384**	**1100**	**300**	**NL**
Magnesium (Mg)	109001	11500.0	10200	8970	NL	NL	NL
Manganese (Mn)	**109001**	**38.8**	**58**	**36.4**	**84**	**50**	**2010**
Potassium (K)	109001	7700.0	6220	6420	NL	NL	NL
Sodium (Na)	**109001**	**17200.0**	**18200**	**14600**	**NL**	**NL**	**NL**
Thallium (Tl)	109001	3.5	ND	ND	0.29	2	5.58
Vanadium (V)	**109001**	**2.4**	**ND**	**1.5**	**26**	**NL**	**1.58**

Notes:
ND = Not detected
NL = Not listed
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background values for groundwater are based on two sampling rounds in two wells at each depth.
Data presented are from initial sampling event only.

10.3.6 Fate and Transport Assessment for SWMU 109

Environmental media sampled as part of the SWMU 109 investigation include surface soil, subsurface soil, sediment, and shallow groundwater. Potential constituent migration pathways investigated for SWMU 109 include soil-to-groundwater, groundwater-to-surface water, surface soil-to-sediment, and emission of volatiles from surface soil to air.

10.3.6.1 SWMU 109 — Soil-to-Groundwater Cross-Media Transport

Table 10.3.12 compares maximum detected organic constituent 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).

No organic constituents were detected in SWMU 109 surface or subsubsurface soil at concentrations exceeding groundwater protection SSLs. As a result, the soil-to-groundwater migration pathway for organics is not expected to be significant at SWMU 109. Two inorganics, arsenic and chromium, were detected in surface soil above their respective SSLs. However, concentrations of these same inorganics were significantly reduced in subsurface soil, and did not exceed their respective SSLs. Consequently, the soil-to-groundwater pathway for inorganics is not expected to be significant at SWMU 109.

10.3.6.2 SWMU 109 — Groundwater-to-Surface Water Cross-Media Transport

Table 10.3.12 also compares maximum detected organic constituent concentrations in shallow groundwater samples to tap water RBCs 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) tap water

Table 10.3.12
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 F: SWMU 109
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
Semivolatile Organic Compounds												
Anthracene	73	ND	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	70	52	ND	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	240	ND	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	420	ND	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	450	ND	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	500	ND	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	440	ND	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	120	ND	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	200	ND	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	790	ND	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Naphthalene	220	ND	ND	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	270	ND	ND	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	600	ND	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	160	ND	NA	NA	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	8	ND	NA	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	1.0229	NA	NA	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	16000	10800	606	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	1.5	ND	ND	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	134	16	ND	NA	29	16.7	36	MG/KG	UG/L	YES	NO	NO
Barium	118	29.8	21.1	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1.3	0.96	ND	NA	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	1.2	0.07	ND	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	45.1	24	1.4	NA	38	180	50	MG/KG	UG/L	YES	NO	NO
Cobalt	27.1	5.6	ND	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	138	18.1	ND	NA	920	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.61	0.21	ND	NA	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	362	35.5	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	427	210	38.8	NA	1100	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.9	0.07	ND	NA	2	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	114	13.8	ND	NA	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	0.84	1.2	ND	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	1.3	ND	ND	NA	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Thallium	ND	ND	3.5	NA	1.24	2.9	21.3	MG/KG	UG/L	NO	YES	NO
Vanadium	64.5	30.8	2.4	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	822	97.6	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, June 3, 1996

Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 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 reference value.

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
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

RBCs 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.

Thallium was the only constituent to be detected above an applicable RBC, and no constituents were detected above their respective surface water criteria. Thallium background concentration was present at 3.5 μg/L, only slightly above its RBC of 2.9 μg/L and below the Zone F backgound concentration of 5.58 μg/L. The source of thallium is unknown, but may be related to past site activities; however, an accompanying elevated concentration in soil linking these two media is not present. At any rate, assuming that groundwater downgradient of SWMU 109 does not become enriched in thallium from another source, and given the specific properties of the aquifer (porosity, local gradient, and expected longitudinal dispersivity in the range of 10E01 to 10E01 to 10E02 meters [typical values for alluvial sediments]) attenuation simply through mechanical dispersion to the RBC will occur over very short travel distances. However, groundwater within the surficial aquifer is not used for consumption, nor is it reasonably anticipated to be in the future. Therefore, the risk-based groundwater migration pathway is invalid due to an incomplete exposure pathway.

10.3.6.3 SWMU 109 — Surface Soil to Sediment Cross-Media Transport

Two sediment samples were collected from stormwater catch basins that drain the general site area. Table 10.3.8 summarizes the analytes detected in sediment samples. The only organic found in common between the surface soil and sediment was napthalene - this constituent was detected in only one sediment sample at the same order of magnitude as the surface soil maximum concentration. For inorganics, nearly all of the constituents detected in soil samples were also detected in sediment samples at the site. Of 22 species present in surface soil, 20 were also detected in sediment. Only mercury and silver were present in surface soil and not in sediment - thallium, and tin were present in sediment and not in soil. This relationship establishes a link between surface soil and sediment, and implies either that surface soil is a source of these constituents in sediment, or at least contributes to the sediment load present in the stormwater drainage system.

10.3.6.4 SWMU 109 — Soil-to-Air Cross-Media Transport

No COCs were detected in the surficial duplicate sample. In accordance with the work plan, no other soil samples were analyzed for VOCs. Because no COCs were detected, the soil-to-air pathway is invalid.

10.3.6.5 SWMU 109 — Fate and Transport Summary

Only arsenic and chromium were present in surface soil above SSLs; however, these exceedances were not reproduced in subsurface soil, and as a result, the migration pathway for soil contamination to groundwater is invalid. Thallium was the only constituent present in groundwater above its RBC; however, this concentration was below the Zone F background, and no constituents were present above surface water criteria. There is no link of thallium to a site source, and the low concentration detected can be expected to attenuate over a short travel distance simply due to dispersion. Additionally, the risk-based groundwater migration pathway is invalid due to an incomplete exposure pathway.

10.3.7 Human Health Risk Assessment

10.3.7.1 Site Background and Investigative Approach

SWMU 109 is the abrasive blast media storage area. The site consists of three hoppers identified as Buildings 1364, 1365, and 1393, used to store the abrasive blast media. Hoppers 1364 and 1365 began operation in 1949, while hopper 1393 was added in 1962. Particulate air emissions were permitted at the site in 1992. Materials released, stored, or disposed of at the site included aluminum oxide and presumably unused "black beauty" blast media.

During the RFI, a total of six soil samples were collected from the upper and lower intervals to identify potential impacts resulting from the activities listed above. Surface and subsurface soil samples were analyzed for SVOAs and metals. Surface and subsurface samples from three of the borings were analyzed for cyanide. Surface and subsurface samples from four of the borings were analyzed for PCBs and pesticides. In March of 1997, three additional soil samples were collected from the upper interval and analyzed for arsenic. Surface soil data were used to quantitatively assess soil pathways. One monitoring well was installed in the shallow aquifer, and sampled for SVOA and metal constituents. Data from the first quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.3.3 and 10.3.5 summarizes the sampling effort for SWMU 109 soil and groundwater.

10.3.7.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.3.13, the focus of this HHRA is on the following COPCs: BEQs, arsenic, beryllium, chromium (assumed to be hexavalent), manganese, and vanadium. Aluminum was detected at a maximum concentration exceeding its RBC, however, its maximuim concentration did not exceed its background concentration. 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.

Groundwater

As shown in Table 10.3.14, no COPCs were identified for SWMU 109 groundwater. Thallium was detected at a concentration exceeding its RBC and was eliminated from consideration in the risk assessment based on comparison of its maximum concentration to its background concentration.

Table 10.3.13
Chemicals Present in Site Samples
SWMU 109 - Surface Soil
Naval Base Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Reference	Units	Number Exceeding RBC	Ref
PCBs / Pesticides													
Aroclor-1260		1	4	160	160	160	37	42	320	NA	UG/KG		
4,4'-DDE		1	4	8	8	8	1.35	1.55	1900	NA	UG/KG		
Carcinogenic PAHs													
B(a)P Equiv.	*	3	6	0.66	637.44	237.6	415.98	450.645	88	NA	UG/KG	1	
Benzo(a)anthracene		2	6	58	420	239	180	205	880	NA	UG/KG		
Benzo(a)pyrene	*	2	6	68	450	259	180	205	88	NA	UG/KG	1	
Benzo(k)fluoranthene		3	6	66	500	212	180	195	8800	NA	UG/KG		
Chrysene		2	6	62	440	251	180	205	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	1	6	120	120	120	180	250	88	NA	UG/KG	1	
Indeno(1,2,3-cd)pyrene		1	6	200	200	200	180	250	880	NA	UG/KG		
TCDD Equivalents													
1234678-HpCDD		1	1	8.84	8.84	8.84	NA	NA	NA	NA	NG/KG		
1234678-HpCDF		1	1	4.38	4.38	4.38	NA	NA	NA	NA	NG/KG		
123789-HxCDF		1	1	7.96	7.96	7.96	NA	NA	NA	NA	NG/KG		
Dioxin Equiv.		1	1	1.0229	1.0229	1.0229	NA	NA	1000	NA	NG/KG		
OCDD		1	1	80.5	80.5	80.5	NA	NA	NA	NA	NG/KG		
OCDF		1	1	14.2	14.2	14.2	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		6	6	660	16000	6700	NA	NA	7800	18500	MG/KG	3	
Antimony (Sb)		1	6	1.5	1.5	1.5	0.165	0.225	3.1	0.79	MG/KG		1
Arsenic (As)	*	9	9	1.4	134	25.2	NA	NA	0.43	19.9	MG/KG	9	4
Barium (Ba)		6	6	4.3	118	34.7	NA	NA	550	61.5	MG/KG		1
Beryllium (Be)	*	6	6	0.17	1.3	0.56	NA	NA	0.15	1.05	MG/KG	6	1
Cadmium (Cd)	N	5	6	0.09	1.2	0.35	0.02	0.02	3.9	0.26	MG/KG		1
Calcium (Ca)		6	6	4620	26200	13792	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	6	6	3	45.1	18.6	NA	NA	39	34.8	MG/KG	1	1
Cobalt (Co)		6	6	1.2	27.1	9.95	NA	NA	470	15.1	MG/KG		2
Copper (Cu)		4	6	4	138	61.4	0.95	1.3	310	48.2	MG/KG		3
Cyanide (CN)		3	3	0.12	0.61	0.29	NA	NA	160	0.29	MG/KG		1
Iron (Fe)	N	6	6	1160	29500	12765	NA	NA	NA	NA	MG/KG		
Lead (Pb)		6	6	6.5	362	93.78	NA	NA	400	180	MG/KG		1
Magnesium (Mg)	N	6	6	160	3480	1271	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	6	6	19.3	427	178	NA	NA	180	307	MG/KG	3	1
Mercury (Hg)		3	6	0.23	0.9	0.48	0.02	0.02	2.3	0.62	MG/KG		1
Nickel (Ni)		4	6	2.8	114	38.4	0.47	0.85	160	12.6	MG/KG		3
Potassium (K)	N	4	6	253	1320	816	110.5	112.5	NA	NA	MG/KG		
Selenium (Se)		4	6	0.52	0.84	0.72	0.17	0.18	39	1.15	MG/KG		
Silver (Ag)		1	6	1.3	1.3	1.3	0.105	0.145	39	1.85	MG/KG		
Sodium (Na)	N	1	6	203	203	203	79.5	193.5	NA	NA	MG/KG		
Vanadium (V)	*	6	6	2.4	64.5	23.5	NA	NA	55	48.9	MG/KG	1	1
Zinc (Zn)		5	6	15.8	822	288	3.7	3.7	2300	198	MG/KG		2
Semivolatile Organics													
Anthracene		1	6	73	73	73	180	250	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		1	6	240	240	240	180	250	310000	NA	UG/KG		
Benzoic acid		1	6	70	70	70	900	1200	31000000	NA	UG/KG		
Fluoranthene		2	6	72	790	431	180	205	310000	NA	UG/KG		
Naphthalene		1	6	220	220	220	180	250	310000	NA	UG/KG		
Phenanthrene		1	6	270	270	270	180	250	310000	NA	UG/KG		
Pyrene		2	6	72	600	336	180	205	230000	NA	UG/KG		

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

Table 10.3.14
Chemicals Present in Site Samples
SWMU 109 - Shallow Groundwater
Naval Base Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Reference	Units	Number Exceeding RBC	Number Exceeding Ref
Inorganics													
Aluminum (Al)		1	1	606	606	606	NA	NA	3700	224	UG/L		1
Barium (Ba)		1	1	21.1	21.1	21.1	NA	NA	260	94.3	UG/L		
Calcium (Ca)	N	1	1	87500	87500	87500	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	1	1.4	1.4	1.4	NA	NA	18	2.05	UG/L		
Iron (Fe)	N	1	1	755	755	755	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	11500	11500	11500	NA	NA	NA	NA	UG/L		
Manganese (Mn)		1	1	38.8	38.8	38.8	NA	NA	84	2010	UG/L		
Potassium (K)	N	1	1	7700	7700	7700	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	17200	17200	17200	NA	NA	NA	NA	UG/L		
Thallium (Tl)		1	1	3.5	3.5	3.5	NA	NA	0.29	5.58	UG/L	1	
Vanadium (V)		1	1	2.4	2.4	2.4	NA	NA	26	1.58	UG/L		1

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

10.3.7.3 Exposure Assessment

Exposure Setting

SWMU 109 is in a highly industrialized setting, approximately 800 feet southwest of the water front along the Cooper River. The site is mostly surrounded by buildings, roads, and railroad right-of-ways. The site is covered with asphalt, concrete or a building which would prevent direct contact with soil and would inhibit migration of potential contaminants to groundwater or air. 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. Additional potentially exposed populations are hypothetical future site residents. 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 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 (the entire area is paved). Therefore, future worker assessment is considered to be protective of current site users. 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 are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. Table 10.3.15 presents the summary for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

Since less than ten samples were collected in surface soil and groundwater, maximum detected concentrations were used as EPCs, as discussed in Section 7 of this RFI.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.3.16 and 10.3.17, respectively.

10.3.7.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.3.18 presents toxicological information specific to each COPC identified at SWMU 109. 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.

Table 10.3.15
Exposure Pathways Summary — SWMU 109
NAVBASE — Zone F
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	Little surface soil is exposed at SWMU 109, inhibiting fugitive dust generation. Therefore, 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 SWMU 109.
	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 SWMU 109.

Table 10.3.15
Exposure Pathways Summary — SWMU 109
NAVBASE — Zone F
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	Little surface soil is exposed at SWMU 109, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	No COPCs were identified in SWMU 109 groundwater.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not 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.

Table 10.3.16
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
SWMU 109
Naval Base Charleston, Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic							
Arsenic (As)	1	134	1.8E-04	1.7E-03	2.1E-04	6.6E-05	2.3E-05
Beryllium (Be)	1	1.3	1.8E-06	1.7E-05	2.0E-06	6.4E-07	2.3E-07
Chromium (Cr)	1	45.1	6.2E-05	5.8E-04	7.1E-05	2.2E-05	7.9E-06
Manganese (Mn)	1	427.0	5.8E-04	5.5E-03	6.7E-04	2.1E-04	7.5E-05
Vanadium (V)	1	64.5	8.8E-05	8.2E-04	1.0E-04	3.2E-05	1.1E-05
Semivolatile Organic Compounds							
Benzo(a)pyrene equivalents	1	0.6	8.7E-07	8.1E-06	1.0E-06	3.1E-07	1.1E-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 10.3.17
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
SWMU 109
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic								
Arsenic (As)	1	134	0.001	7.5E-06	2.5E-05	4.7E-06	5.4E-06	1.9E-06
Beryllium (Be)	1	1.3	0.001	7.3E-08	2.4E-07	4.6E-08	5.2E-08	1.9E-08
Chromium (Cr)	1	45.1	0.001	2.5E-06	8.4E-06	1.6E-06	1.8E-06	6.5E-07
Manganese (Mn)	1	427.0	0.001	2.4E-05	7.9E-05	1.5E-05	1.7E-05	6.1E-06
Vanadium (V)	1	64.5	0.001	3.6E-06	1.2E-05	2.3E-06	2.6E-06	9.2E-07
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	1	0.6	0.01	3.6E-07	1.2E-06	2.2E-07	2.6E-07	9.1E-08

NOTES :

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.
\- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.3.18
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 109
NAVBASE Charleston
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
emical	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
enic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
uzo(a)pyrene Equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	6.1	e	B2	mutagen
yllium	0.005	a	L	microscopic organ changes	100	ND				ND	4.3	a	8.4	a	B2	osteosarcoma
romium III	1	a	L	NA	100/10	NA		NA	NA	NA	NA		42	a	D	NA
romium VI	0.005	a	L	NA	500	NA		NA	NA	NA	NA		42	a	A	lung
nganese (food)	0.047	a	NA	neurological effects	1	ND				ND	ND		ND		D	
nganese (water)	0.023	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000	ND		ND		D	
nadium	0.007	a	NA	unclear	100	NA		NA	NA	NA	NA		NA		D	NA

rs:

= Integrated Risk Information System (IRIS)
= Withdrawn from IRIS/HEAST
= Not applicable or not available
= Low confidence
= Medium confidence

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 RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. 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 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS the basis for the classification is sufficient evidence from 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. 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.

Beryllium exposure via the inhalation route can cause inflammation of the lungs, a condition known as Acute Beryllium Disease, as a result of short-term exposure to high concentrations. Removal from exposure results in a reversal of the symptoms. Chronic exposure to much lower levels of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.005 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined no adverse effect occurs at 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. It has been shown to induce lung cancer via inhalation in rats and monkeys, and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies of beryllium are considered to be inadequate. As listed in IRIS the basis for the classification is that beryllium has been shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies are considered inadequate. An inhalation slope factor of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA. As listed in IRIS, the critical effect of this chemical is no adverse effect. The uncertainty factor was 100 and the modifying factor was 1.

Chromium exists in two stable, natural forms: trivalent (III) and hexavalent (VI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS, 1995). Oral RfD values for both forms of chromium are 1.0 and 5E-03 (mg/kg-day). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a SFo of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from soil and water. In addition, the body is roughly twice as efficient absorbing manganese in water compared to manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to (1.43E-05) mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg-day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfDo set by USEPA is 0.007 mg/kg-day.

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 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 7.3 $(mg/kg\text{-}day)^{-1}$. 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 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 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 (see

Additional Comments for Oral Exposure). 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. The classification reflects 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 presented as the risk per mg/kg-day. The unit risk is the 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.

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. Benzo(k)fluoranthene is mutagenic in bacteria (Klaassen, et al., 1986).

10.3.7.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (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 10.3.19 and 10.3.20 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 ingestion ILCR (based on the adult and child lifetime weighted average) for SWMU 109 surface soils is 3E-04. The dermal pathway ILCR is 4E-05. Arsenic was the primary contributor to the ingestion and dermal pathways, accounting for over 90% of the total risk, while beryllium and BEQs were secondary contributors.

The computed HIs for the adult resident was 0.7 for the soil ingestion pathway and 0.1 for the dermal contact pathway. The computed HIs for the child ingestion and dermal contact pathways were 6 and 0.4, respectively. The primary contributor to cumulative HI projections is arsenic, accounting for over 90% of the total HI, with chromium, manganese, and vanadium as secondary contributors.

Hypothetical Site Workers

Site worker ILCRs are 4E-05 and 2E-05 for the ingestion and dermal contact pathways, respectively. Arsenic and BEQs were the primary contributors for each pathway. HIs for the ingestion and dermal pathways were projected to be 0.2 and 0.1, respectively, for the hypothetical site worker scenario.

Table 10.3.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 109
Naval Base Charleston, Zone F
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
Inorganic							
Arsenic (As)	0.0003	1.5	0.61	5.7	3.1E-04	0.22	3.5E-05
Beryllium (Be)	0.005	4.3	0.00036	0.0033	8.8E-06	0.00013	9.8E-07
Chromium (Cr)	0.005	NA	0.012	0.12	NA	0.0044	NA
Manganese (Mn)	0.023	NA	0.025	0.24	NA	0.0091	NA
Vanadium (V)	0.007	NA	0.013	0.12	NA	0.0045	NA
Semivolatile Organic Compounds							
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	7.3E-06	ND	8.1E-07
SUM Hazard Index/ILCR			0.7	6	3E-04	0.2	4E-05

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 10.3.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 109
Naval Base Charleston, Zone F
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 Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganic								
Arsenic (As)	0.2	0.00006	7.5	0.13	0.41	3.5E-05	0.0896	1.4E-05
Beryllium (Be)	0.2	0.001	21.5	0.000073	0.00024	9.8E-07	0.000052	4.0E-07
Chromium (Cr)	0.2	0.001	NA	0.0025	0.0084	NA	0.001809	NA
Manganese (Mn)	0.2	0.005	NA	0.0052	0.017	NA	0.003724	NA
Vanadium (V)	0.2	0.001	NA	0.0026	0.0085	NA	0.001848	NA
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	3.3E-06	ND	1.3E-06
SUM Hazard Index/ILCR				0.1	0.4	4E-05	0.1	2E-05

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)

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 in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.3.21 presents the COCs identified for SWMU 109 surface soil.

Surface Soils

Future Site Residents

Arsenic, beryllium, and BEQs were identified as the soil pathway COCs based on their contribution to cumulative ILCR projections. Arsenic, chromium (assumed to be hexavalent), manganese, and vanadium were identified as soil pathway COCs based on their contribution to cumulative HI projections. Chromium was identified as a COC based on the assumption that it exists in the hexavalent state. This is a highly conservative assumption as chromium in the trivalent state is generally predominant. This issue is further discussed in the uncertainty section.

Future Site Workers

Arsenic and BEQs were identified as the soil pathway COCs based on their contribution to cumulative ILCR projections. Arsenic was also identified as a soil pathway COC based on its contribution to cumulative HI projections.

Table 10.3.21
Summary of Risk and Hazard-based COCs
SWMU 109
Naval Base Charleston, Zone F
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	**Inorganic**						
	Ingestion	Arsenic (As)	0.61	5.7	3.1E-04	0.22	3.5E-05	1 2 4
		Beryllium (Be)	0.00036	0.0033	8.8E-06	0.00013	9.8E-07	2
		Chromium (Cr)	0.012	0.12	NA	0.0044	NA	1
		Manganese (Mn)	0.025	0.24	NA	0.0091	NA	1
		Vanadium (V)	0.013	0.12	NA	0.0045	NA	1
		Semivolatile Organic Compounds						
		Benzo(a)pyrene equivalents	ND	ND	7.3E-06	ND	8.1E-07	2
	Dermal	**Inorganic**						
		Arsenic (As)	0.13	0.41	3.5E-05	0.090	1.4E-05	1 2 4
		Beryllium (Be)	0.000073	0.00024	9.8E-07	0.000052	4.0E-07	
		Chromium (Cr)	0.0025	0.0084	NA	0.0018	NA	
		Manganese (Mn)	0.0052	0.017	NA	0.0037	NA	
		Vanadium (V)	0.0026	0.0085	NA	0.0018	NA	
		Semivolatile Organic Compounds						
		Benzo(a)pyrene equivalents	ND	ND	3.3E-06	ND	1.3E-06	2 4
Surface Soil Pathway Sum			0.8	7	4E-04	0.3	5E-05	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence noncarcinogenic 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 noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

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 identified above. Arsenic was detected above its residential RBC in all nine surface soil samples analyzed for arsenic; however, it was only detected in four samples above its background concentration. Beryllium was detected above the residential soil RBC in all six surface soil samples, but the background concentration for beryllium was exceeded only once and the mean concentration for SWMU 109 surface soil (0.56 mg/kg) was below the background concentration (1.05 mg/kg). Chromium was detected above its residential RBC in only one of six surface soil samples; its mean detected concentration (18.6 mg/kg) was below the RBC for its hexavalent species (39 mg/kg). Manganese was detected above its residential RBC in only three of six surface soil samples, and only once above its background value; its mean detected concentration (178 mg/kg) was below its RBC (180 mg/kg). Vanadium was detected above its residential RBC and its background value in only one surface soil sample. Its mean detected concentration (23.5 mg/kg) was below its RBC (55 mg/kg). BEQs were detected above the residential RBC in one of six surface soil samples collected for SWMU 109. Elevated BEQs were identified in surface soil sample 109SB004, otherwise they tend to be evenly distributed across the site.

10.3.7.6 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 F. If this area were to be used as a residential site, the buildings 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 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.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentrations were used as the exposure point concentrations for this site. Use of maximum detected concentrations represent conservative assumptions 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.

Frequency of Detection and Spatial Distribution

Arsenic and beryllium were detected at concentrations above their RBCs in nine of nine and six of six surface soil samples, respectively. Conversely, chromium and vanadium (both one of six) were infrequently detected above their RBCs. Manganese exceeded RBC in three of six surface soil samples, but only once above its background value. BEQ compounds were detected above RBCs in only one of six surface soil samples; however, background levels of BEQs at NAVBASE have also exceeded RBCs. Additionally, many of the soil sample locations were situated underneath asphalt, which may explain the presence of this group of constituents.

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.

Soil

A conservative screening process was used to identify COPCs for SWMU 109. 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, only aluminum was reported at a concentration (16,000 mg/kg) exceeding its RBC (7,800 mg/kg), but was below its background value (18,500 mg/kg). No other soil constituent was reported at a concentration near its RBCs (e.g., within 10% of its RBC). Chromium was carried through the risk assessment using the toxicity parameters of the hexavalent species, which would tend to overestimate hazard projections if in fact the trivalent species is predominant for SWMU 109 soil. One surface soil sample was analyzed for hexavalent chromium which was reported as a nondetect. This would suggest that most of the total chromium exists at trivalent chromium.

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 109, 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.

Background-Related Risk

Aluminum was detected in SWMU 109 surface soil above its RBC. This element was eliminated from consideration in the risk assessment based on comparison to its background concentration. 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.

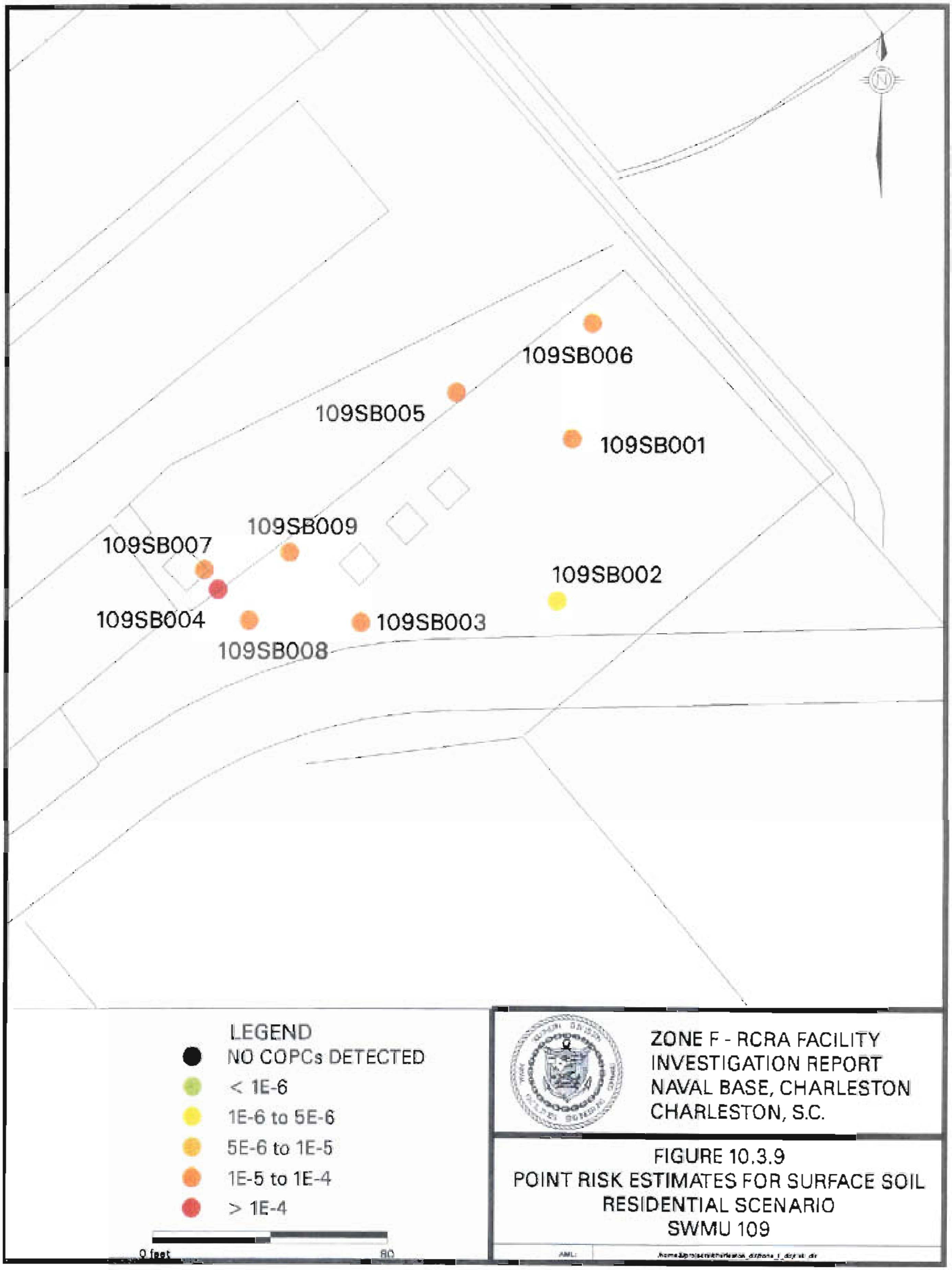
The maximum surface soil concentration of aluminum (16,000 mg/kg) for SWMU 109 equates with hazard quotients of 0.2 and 0.008 for the residential child and site worker, respectively.

10.3.7.7 Risk Summary

The risk and hazard posed by contaminants at SWMU 109 were assessed for the future site worker and the future site resident under RME 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 10.3.22 presents the risk summary for each soil pathway/receptor group evaluated for SWMU 109.

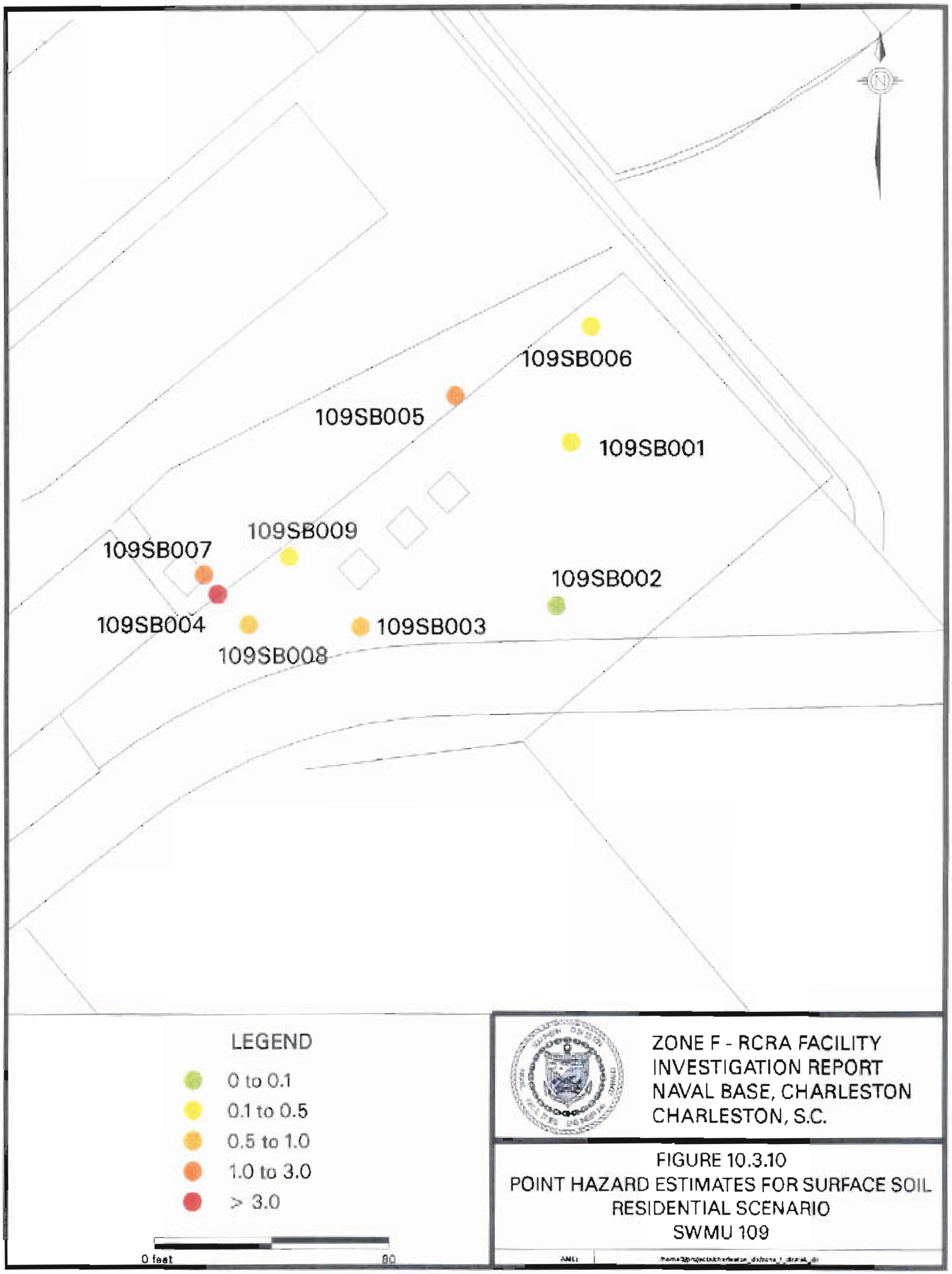
Soil — Residential Scenario

Residential soil pathway COCs identified for SWMU 109 include arsenic, BEQs, beryllium, chromium, manganese, and vanadium. Figures 10.3.9 and 10.3.10 illustrate point risk and HIs for SWMU 109 surface soil exposure by potential future site residents. Table 10.3.23 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



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

FIGURE 10.3.9
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 109



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

FIGURE 10.3.10
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 109

Table 10.3.22
Summary of Risk and Hazard
SWMU 109
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.7	6	3E-04	0.2	4E-05
	Dermal Contact	0.1	0.4	4E-05	0.1	2E-05
Sum of Soil Pathways		0.8	7	4E-04	0.3	5E-05

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

Table 10.3.23
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 109
NAVBASE Charleston, Zone F
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	%HI	Risk (E-06)	%Risk
109	B001	Arsenic (As)	4	MG/KG	0.1828	71.92	10.4480	83.29
109	B001	B(a)P Equiv.	ND	UG/KG	NA	NA	NA	NA
109	B001	Beryllium (Be)	0.28	MG/KG	0.0008	0.30	2.0966	16.71
109	B001	Chromium (Cr)	6.3	MG/KG	0.0173	6.80	NA	NA
109	B001	Manganese (Mn)	119	MG/KG	0.0347	13.66	NA	NA
109	B001	Vanadium (V)	9.5	MG/KG	0.0186	7.32	NA	NA
		Total			0.2542		12.5446	
109	B002	Arsenic (As)	1.4	MG/KG	0.0640	75.18	3.6568	74.18
109	B002	B(a)P Equiv.	ND	UG/KG	NA	NA	NA	NA
109	B002	Beryllium (Be)	0.17	MG/KG	0.0005	0.55	1.2729	25.82
109	B002	Chromium (Cr)	3	MG/KG	0.0082	9.67	NA	NA
109	B002	Manganese (Mn)	26.5	MG/KG	0.0077	9.08	NA	NA
109	B002	Vanadium (V)	2.4	MG/KG	0.0047	5.52	NA	NA
		Total			0.0851		4.9297	
109	B003	Arsenic (As)	10.2	MG/KG	0.4662	74.02	26.6424	85.64
109	B003	B(a)P Equiv.	0.66	UG/KG	NA	NA	0.0109	0.04
109	B003	Beryllium (Be)	0.595	MG/KG	0.0016	0.26	4.4552	14.32
109	B003	Chromium (Cr)	19.65	MG/KG	0.0539	8.56	NA	NA
109	B003	Manganese (Mn)	204.5	MG/KG	0.0597	9.47	NA	NA
109	B003	Vanadium (V)	24.75	MG/KG	0.0485	7.70	NA	NA
		Total			0.6299		31.1085	
109	B004	Arsenic (As)	134	MG/KG	6.1248	94.99	350.0081	95.39
109	B004	B(a)P Equiv.	637.44	UG/KG	NA	NA	10.5562	2.88
109	B004	Beryllium (Be)	0.85	MG/KG	0.0023	0.04	6.3646	1.73
109	B004	Chromium (Cr)	45.1	MG/KG	0.1237	1.92	NA	NA
109	B004	Manganese (Mn)	427	MG/KG	0.1246	1.93	NA	NA
109	B004	Vanadium (V)	36.9	MG/KG	0.0723	1.12	NA	NA
		Total			6.4477		366.9289	
109	B005	Arsenic (As)	20.2	MG/KG	0.9233	75.32	52.7624	82.79
109	B005	B(a)P Equiv.	74.562	UG/KG	NA	NA	1.2348	1.94
109	B005	Beryllium (Be)	1.3	MG/KG	0.0036	0.29	9.7341	15.27
109	B005	Chromium (Cr)	33.8	MG/KG	0.0927	7.56	NA	NA
109	B005	Manganese (Mn)	274	MG/KG	0.0799	6.52	NA	NA
109	B005	Vanadium (V)	64.5	MG/KG	0.1263	10.31	NA	NA
		Total			1.2258		63.7312	
109	B006	Arsenic (As)	6.1	MG/KG	0.2788	92.38	15.9332	91.80
109	B006	B(a)P Equiv.	ND	UG/KG	NA	NA	NA	NA
109	B006	Beryllium (Be)	0.19	MG/KG	0.0005	0.17	1.4227	8.20
109	B006	Chromium (Cr)	4	MG/KG	0.0110	3.63	NA	NA
109	B006	Manganese (Mn)	19.3	MG/KG	0.0056	1.87	NA	NA
109	B006	Vanadium (V)	3	MG/KG	0.0059	1.95	NA	NA
		Total			0.3018		17.3559	

Table 10.3.23
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 109
NAVBASE Charleston, Zone F
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	%HI	Risk (E-06)	%Risk
109	B007	Arsenic (As)	25.9	MG/KG	1.1838	100.00	67.6508	100.00
		Total			1.1838		67.6508	
109	B008	Arsenic (As)	20	MG/KG	0.9142	100.00	52.2400	100.00
		Total			0.9142		52.2400	
109	B009	Arsenic (As)	5.1	MG/KG	0.2331	100.00	13.3212	100.00
		Total			0.2331		13.3212	

allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Arsenic, BEQs, and beryllium, all of which were identified as COCs in the formal risk assessment, contribute to risk estimate above 1E-06 at most surface soil sample locations. Risks estimates ranged from 5E-06 (109SB002) to 4E-04 (109SB004). HIs only exceed unity at three sample locations, 109SB004, 109SB005, and driven mostly by arsenic.

Although chromium, manganese, and vanadium were identified as COCs in the formal risk assessment, they were not major contributors to overall surface soil pathway HIs.

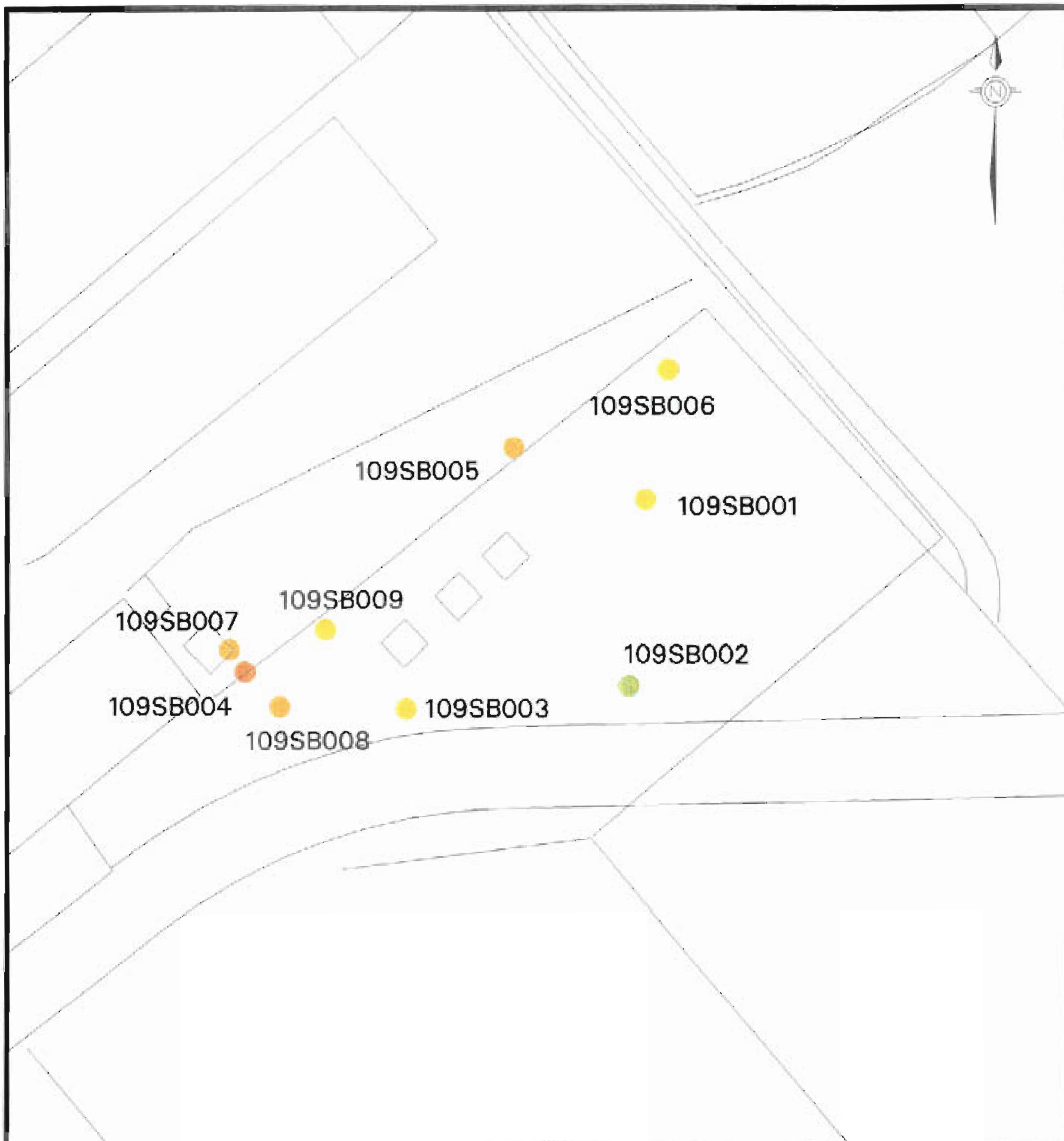
Soil — Site Worker Scenario

Site worker soil pathway COCs identified for SWMU 109 include arsenic, beryllium, and BEQs. Figure 10.3.11 illustrates point risk estimates for SWMU 109 surface soil exposure by potential future site workers. Table 10.3.24 summarizes the risk and hazard contribution of each COPC at each sample location. Industrial risks ranged from 7E-07 (109SB002) to 5E-05 (109SB004). HIs for the site worker scenario do not exceed unity at any sample location.

10.3.7.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident or site worker as presented in Table 10.3.25 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 80

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FIGURE 10.3.11
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
SWMU 109

Table 10.3.24
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 109
NAVBASE Charleston, Zone F
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	%HI	Risk (E-06)	%Risk
109	001	Arsenic (As)	4	MG/KG	0.0092	77.00	1.4780	83.29
109	001	B(a)P Equiv.	ND	UG/KG	NA		NA	
109	001	Beryllium (Be)	0.28	MG/KG	0.000039	0.32	0.2966	16.71
109	001	Chromium (Cr)	6.3	MG/KG	0.0009	7.28	NA	
109	001	Manganese (Mn)	119	MG/KG	0.0017	14.62	NA	
109	001	Vanadium (V)	9.5	MG/KG	0.000094	0.78	NA	
		Total			0.0119		1.7746	
109	002	Arsenic (As)	1.4	MG/KG	0.0032	79.11	0.5173	74.18
109	002	B(a)P Equiv.	ND	UG/KG	NA		NA	
109	002	Beryllium (Be)	0.17	MG/KG	0.000023	0.58	0.1801	25.82
109	002	Chromium (Cr)	3	MG/KG	0.00041	10.17	NA	
109	002	Manganese (Mn)	26.5	MG/KG	0.00039	9.56	NA	
109	002	Vanadium (V)	2.4	MG/KG	0.000024	0.58	NA	
		Total			0.0041		0.6974	
109	003	Arsenic (As)	10.2	MG/KG	0.0235	79.53	3.7690	85.63
109	003	B(a)P Equiv.	0.66	UG/KG	NA		0.0022	0.05
109	003	Beryllium (Be)	0.595	MG/KG	0.000082	0.28	0.6303	14.32
109	003	Chromium (Cr)	19.65	MG/KG	0.0027	9.19	NA	
109	003	Manganese (Mn)	204.5	MG/KG	0.0030	10.18	NA	
109	003	Vanadium (V)	24.75	MG/KG	0.00024	0.83	NA	
		Total			0.0295		4.4014	
109	004	Arsenic (As)	134	MG/KG	0.3081	95.96	49.5139	94.20
109	004	B(a)P Equiv.	637.44	UG/KG	NA		2.1463	4.08
109	004	Beryllium (Be)	0.85	MG/KG	0.00012	0.04	0.9004	1.71
109	004	Chromium (Cr)	45.1	MG/KG	0.0062	1.94	NA	
109	004	Manganese (Mn)	427	MG/KG	0.0063	1.95	NA	
109	004	Vanadium (V)	36.9	MG/KG	0.00036	0.11	NA	
		Total			0.3211		52.5607	
109	005	Arsenic (As)	20.2	MG/KG	0.0464	83.02	7.4640	82.09
109	005	B(a)P Equiv.	74.562	UG/KG	NA		0.2511	2.76
109	005	Beryllium (Be)	1.3	MG/KG	0.00018	0.32	1.3770	15.15
109	005	Chromium (Cr)	33.8	MG/KG	0.0047	8.33	NA	
109	005	Manganese (Mn)	274	MG/KG	0.0040	7.19	NA	
109	005	Vanadium (V)	64.5	MG/KG	0.00064	1.14	NA	
		Total			0.0559		9.0921	
109	006	Arsenic (As)	6.1	MG/KG	0.0140	94.03	2.2540	91.80

Table 10.3.24
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 109
NAVBASE Charleston, Zone F
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	%HI	Risk (E-06)	%Risk
109	006	B(a)P Equiv.	ND	UG/KG	NA		NA	
109	006	Beryllium (Be)	0.19	MG/KG	0.000026	0.18	0.2013	8.20
109	006	Chromium (Cr)	4	MG/KG	0.00055	3.70	NA	
109	006	Manganese (Mn)	19.3	MG/KG	0.00028	1.90	NA	
109	006	Vanadium (V)	3	MG/KG	0.000030	0.20	NA	
		Total			0.0149		2.4553	
109	007	Arsenic (As)	25.9	MG/KG	0.0596	100.00	9.5702	100.00
		Total			0.0596		9.5702	
109	008	Arsenic (As)	20	MG/KG	0.0460	100.00	7.3901	100.00
		Total			0.0460		7.3901	
109	009	Arsenic (As)	5.1	MG/KG	0.0117	100.00	1.8845	100.00
		Total			0.0117		1.8845	

Table 10.3.25
Remedial Goal Options for Soil
SWMU 109
Naval Base Charleston, Zone F
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
Inorganic										
Arsenic (As)	1.5	0.0003	134.0	66	22	2.2	0.38	3.8	38	19.9
Beryllium (Be)	4.3	0.005	1.3	1094	365	36	0.13	1.3	13	1.05
Chromium (Cr)	NA	0.005	45.1	1094	365	36	NA	NA	NA	34.8
Manganese (Mn)	NA	0.023	427.0	5032	1677	168	NA	NA	NA	307
Vanadium (V)	NA	0.007	64.5	1531	510	51	NA	NA	NA	48.9
Semivolatile Organic Compounds										
Benzo(a)pyrene equivalents	7.3	NA	0.6	NA	NA	NA	0.06	0.6	6	NA

Worker-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
Inorganic										
Arsenic (As)	1.5	0.0003	134.0	1305	435	43	2.7	27	271	19.9
Semivolatile Organic Compounds										
Benzo(a)pyrene equivalents	7.3	NA	0.6	NA	NA	NA	0.30	3.0	30	NA

NOTES:

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

10.3.8 Corrective Measures Considerations

For SWMU 109, the upper and lower soil intervals, sediment in storm sewer drop basins, and shallow groundwater were investigated. A total of six soil samples were collected from the upper and lower intervals, three additional samples were collected from the upper interval. Six of the nine samples were collected from beneath asphalt or concrete pavement. Two sediment samples were collected. One groundwater monitoring well was installed in the shallow aquifer. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is mostly paved with asphalt or concrete.

BEQs, arsenic, beryllium, chromium, manganese, and vanadium were identified as COCs in the upper soil interval. The soil pathway cumulative residential exposure risk is 4E-04 and the cumulative HI is 7 (resident child). Only the cumulative residential exposure risk exceeds USEPA's acceptable lower risk level of 1E-04. The HI of 7 exceeds USEPA's acceptable HI of 1.

Residential RGOs for surface soil for arsenic, beryllium, and BEQs were 0.38, 0.13, and 0.06 mg/kg, respectively, based on a target risk of 1E-06. Hazard-based remedial goals for surface soil for chromium, manganese, and vanadium were 365, 1,677, and 510 mg/kg, respectively, based on a target HI of 1. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.3.26.

Table 10.3.26
Potential Corrective Measures for SWMU 109

Medium	Compounds of Concern	Potential Corrective Measures
Soil	Arsenic, beryllium, chromium, manganese, vanadium, BEQs	a) No Action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment f) Ex-situ, chemical and physical treatment

10.2 SWMU 36, Building 68 Battery Shop; AOC 620, Battery Shop, Building 68

These two RFI sites, were combined into one investigation due to their proximity and their potential for similar COPCs. The site area is located in Building 68, a 48,000 square foot concrete structure. From 1942 to 1952, the building was a paint and oil warehouse. From 1952, the building was used for destruction, assembly, and rebuilding of submarine batteries. Most recently, the building was used for storage and charging of large acid batteries. SWMU 36 is the site of two sulfuric acid releases, where acid was discharged to floor drains which had become separated from the floor, allowing the acid to drain to the soil beneath the building. AOC 620 comprises all activities within Building 68 that were related to the battery shop. Materials released, stored or disposed of at the site included sulfuric acid, lead, paint, solvents, petroleum products, and batteries.

10.2.1 Site Geology and Hydrogeology

The soil boring and groundwater monitoring well locations associated with SWMU 36 and AOC 620 are shown in Figure 10.2-1. The representative stratigraphy at SWMU 36 and AOC 620, consists of silty clay overlying sandy clay. The sandy clay extends to the maximum depth of the wells. The silty clay exhibits an average grain size distribution of 8% sand, 32% silt, and 60% clay. The sandy clay exhibits an average grain size distribution of 55% sand, 10% silt, and 35% clay. The total depth reached by the monitoring wells is 14 ft bgs. Boring logs and well construction diagrams are contained in Appendix A.

Figures 10.2-2 and 10.2-3 depict the potentiometric surface and inferred flow direction in the shallow groundwater at low and high tide, respectively. Very minor differences in the overall flow pattern were observed between tides. From slug testing of well 620002, the horizontal hydraulic conductivity of this unit is 0.41 ft/day. Based on this value and the flow pattern shown in Figure 10.2-3, the representative horizontal hydraulic gradient was 2.7E-02. The horizontal flow velocity calculated from this gradient was 3.1E-02.

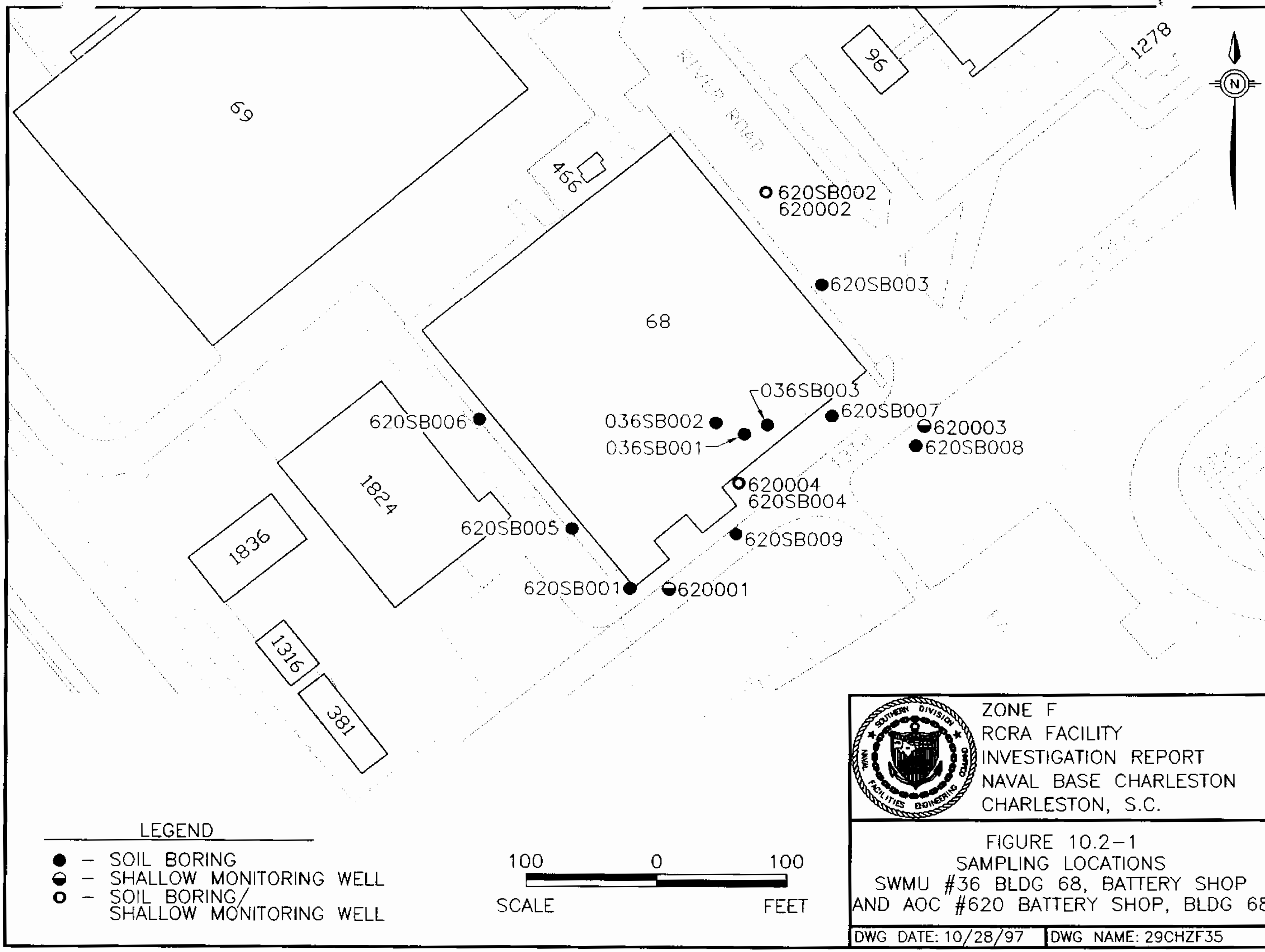

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FIGURE 10.2–1
SAMPLING LOCATIONS
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 10/28/97 | DWG NAME: 29CHZF35

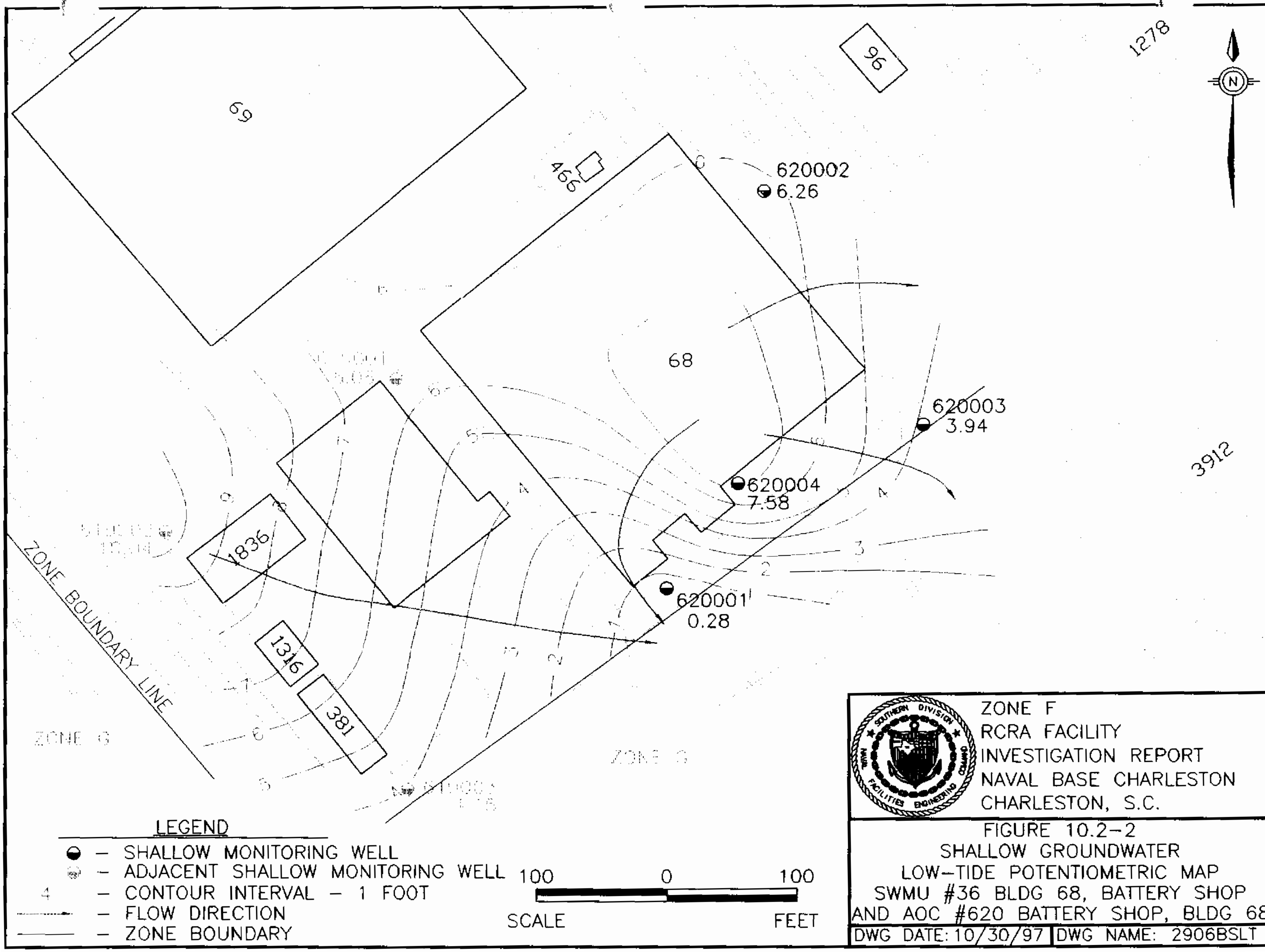

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FIGURE 10.2–2
SHALLOW GROUNDWATER
LOW–TIDE POTENTIOMETRIC MAP
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 10/30/97 | DWG NAME: 2906BSLT

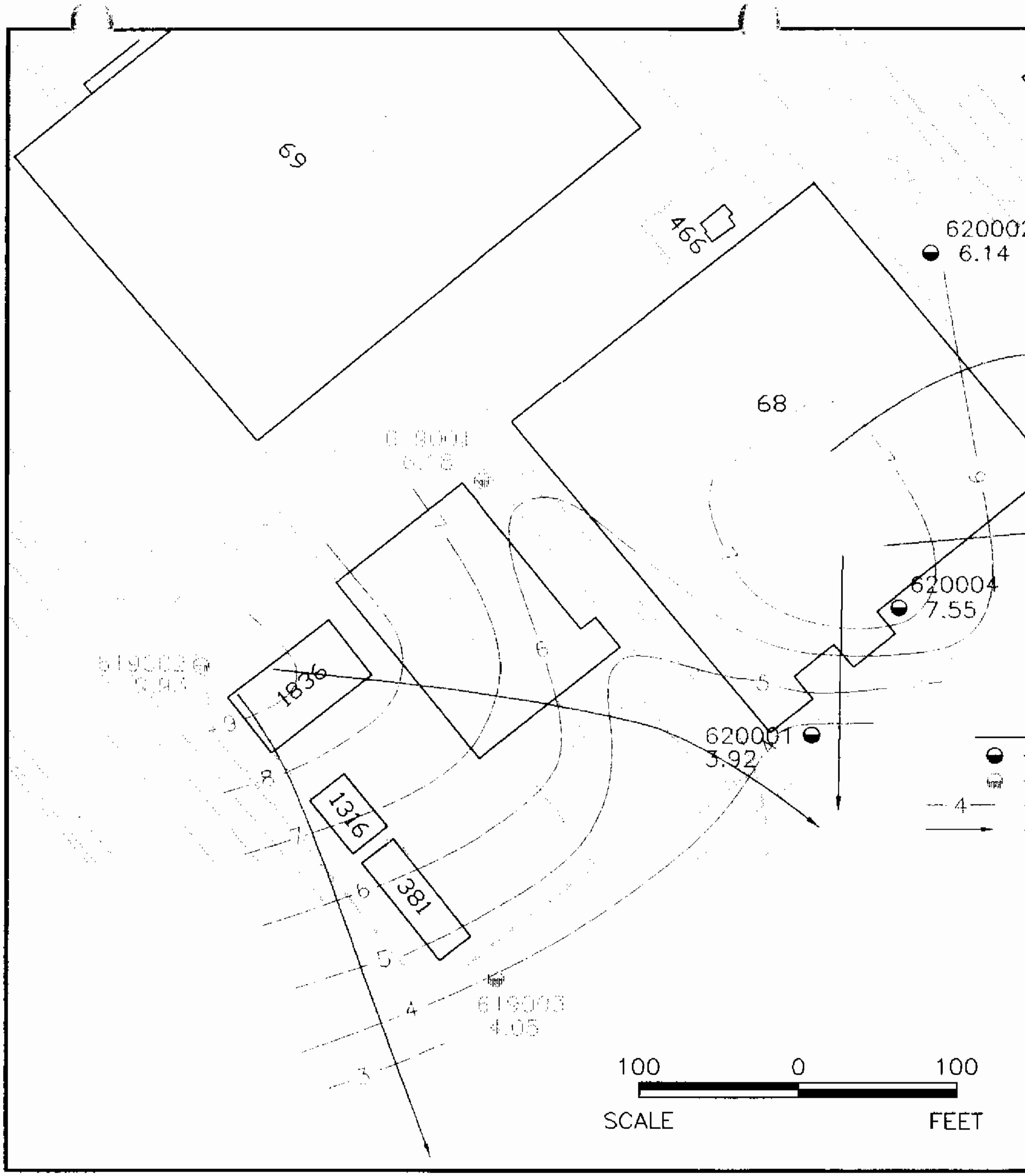

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FIGURE 10.2–3
SHALLOW GROUNDWATER
HIGH–TIDE POTENTIOMETRIC MAP
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 10/30/97 | DWG NAME: 2906BSHT

10.2.2 Field Investigation Approach

The objective of the field investigation at SWMU 36 and AOC 620 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. Also included in this section are descriptions of the hollow stem auger drilling procedures used for shallow well installation; 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. Figure 10.2-2 depicts the soil boring and groundwater monitoring well locations within the SWMU 36 and AOC 620 area. Appendix A documents the construction diagrams for installed monitoring wells. Appendix D contains the data report for samples collected in Zone F.

10.2.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing nine soil borings within the SWMU 36/AOC 620 area to assess the presence of any soil contamination at these two sites. Upper and lower interval soil samples were proposed from each boring. Twelve soil borings were advanced during the field investigation, in two phases (Figure 10.2-1). Nine borings were advanced during the first phase of the field investigation, as proposed in the approved final RFI work plan. Upper and lower interval samples were collected from three borings, while six borings included only the upper interval. Where not collected, the lower interval sample was not collected due to obstructions in the borehole, or because of a shallow water table. In accordance with the approved final RFI work plan, first phase samples were analyzed for metals, SVOAs, and VOAs at DQO Level III. In addition, soil samples from four first-round borings from AOC 620 included pesticide/PCB analysis, while one first-round AOC 620 sample included cyanide. Two upper interval duplicate soil samples were collected during the first phase for Appendix IX analyses at

DQO Level IV. Later, three additional borings were advanced to delineate lead and PCBs detected during the first sampling round. Upper and lower interval samples were collected from the second-round soil borings. Second-round soil samples were analyzed for metals, pesticides/PCBs, and SVOAs at DQO Level III. Table 10.2.1 presents the SWMU 36 and AOC 620 soil samples and analyses.

Table 10.2.1
Zone F
SWMU 36 and AOC 620
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
036SB001	036SB00101 036SB00102	Upper Lower	10/09/96	Note 1	
036SB002	036SB00201	Upper	10/08/96	Note 1	Lower interval not sampled
036SB003	036SB00301	Upper	10/09/96	Note 1	Lower interval not sampled
620SB001	620SB00101 620CB00101*	Upper	9/16/96	Note 1/ pesticides/PCBs Note 2	Lower interval not sampled *Duplicate sample
620SB002	620SB00201	Upper	8/27/96	Note 1/ pesticides/PCBs	Lower interval not sampled
620SB003	620SB00301	Upper	9/16/96	Note 1/ pesticides/PCBs	Lower interval not sampled
620SB004	620SB00401 620CB00401*	Upper	9/10/96	Note1/ pesticides/PCBs, cyanide Note 2	Lower interval not sampled *Duplicate sample
620SB005	6120B00501 620SB00502	Upper Lower	9/16/96	Note 1/ pesticides/PCBs	
620SB006	620SB00601 620SB00602	Upper Lower	10/04/96	Note 1	
620SB007	620SB00701 620SB00702	Upper Lower	1/09/97	Note 3	Second-round sample

Table 10.2.1
Zone F
SWMU 36 and AOC 620
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
620SB008	620SB00801 620SB00802	Upper Lower	1/09/97	Note 3	Second-round sample
620SB009	620SB00901 620SB00902	Upper Lower	1/10/97	Note 3	Second-round sample

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

10.2.3.1 Nature of Contamination in Soil

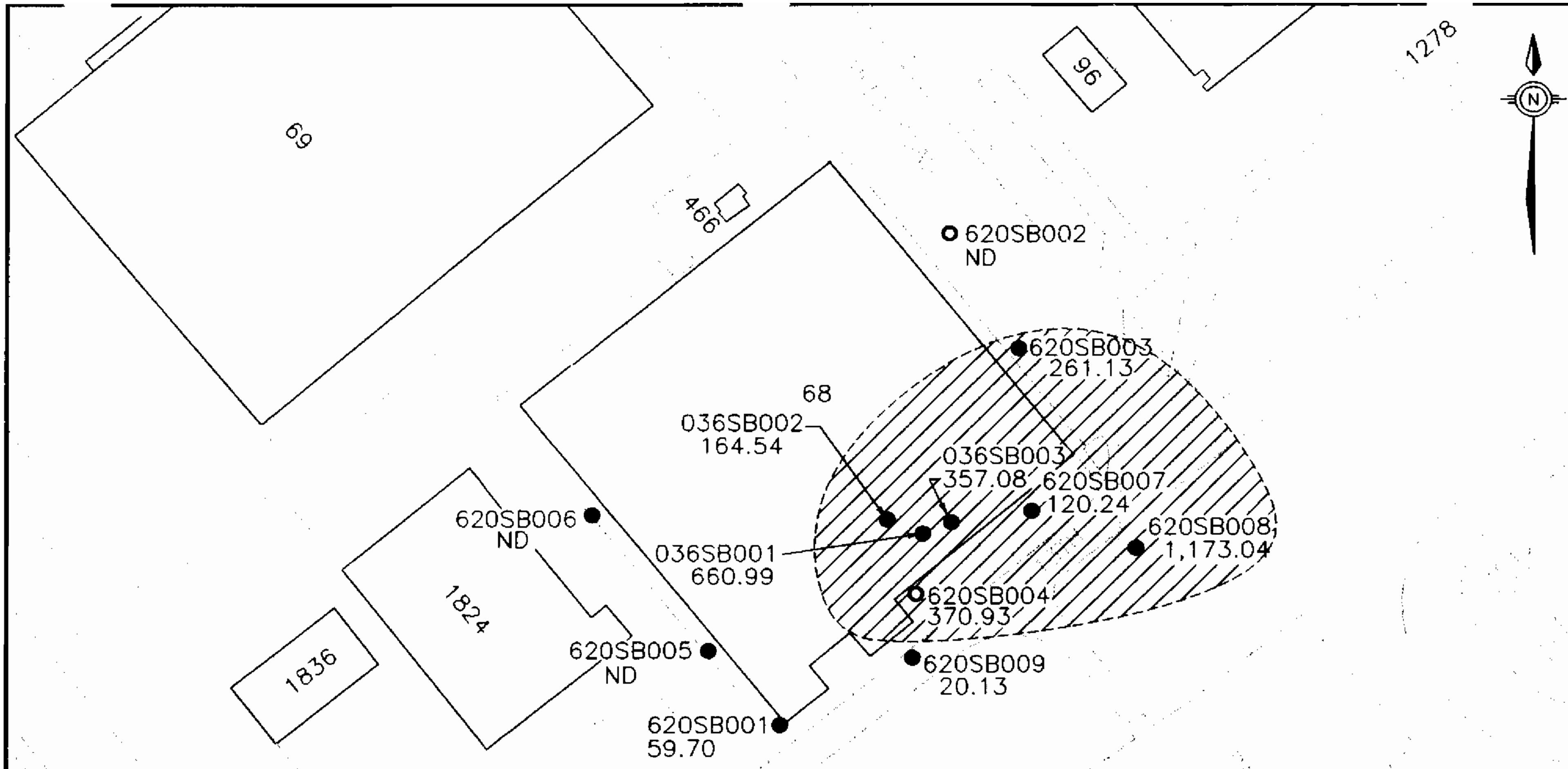
Organic compound analytical results for soil are summarized in Table 10.2.2. Inorganic analytical results for soil are summarized in Table 10.2.3. Table 10.2.4 presents a summary of all analytes detected in soil at SWMU 36 and AOC 620. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organic Compounds in Soil

Five VOCs were detected in surface soil samples; one of these was also detected in subsurface soil. All VOC concentrations were far below their respective RBCs and SSLs for surface and subsurface soil.

Semivolatile Organic Compounds in Soil

Twenty SVOCs were detected in site soil samples. Nineteen SVOCs were detected in surface soil samples. Only three, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene, exceeded their RBCs in surface soil samples. Thirteen SVOCs were detected in subsurface soil samples. One SVOC — 4-methylphenol — exceeded its SSL for subsurface soil. Figure 10.2-4 presents the surface soil total BEQ exceedances detected in surface soil. Figure 10.2-5 presents the 4-Methylphenol detections in subsurface soil.



LEGEND

- ● – SOIL BORING
- o – SOIL BORING/ SHALLOW MONITORING WELL
- ☐ – < 88 $\mu g/kg$
- ▨ – > 88 $\mu g/kg$
- ---- – APPROXIMATE EXTENT

NOTES:

- 88 $\mu g/kg$ = RBC FOR BEQs IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

100 0 100

SCALE FEET

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FIGURE 10.2–4
BEQs IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906BISS

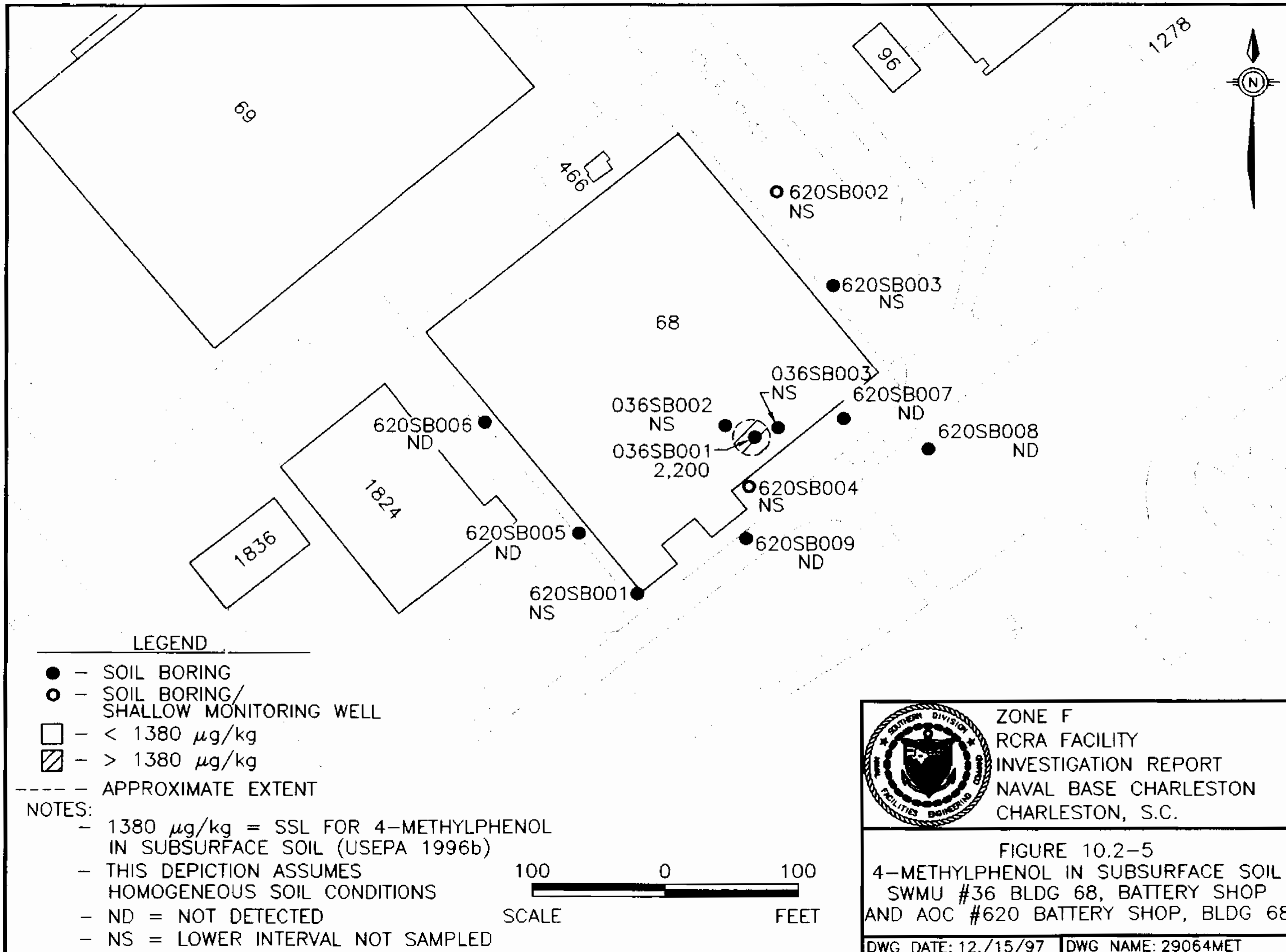

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FIGURE 10.2-5
4-METHYLPHENOL IN SUBSURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12./15/97 | DWG NAME: 29064MET

Table 10.2.2
Zone F
SWMU 36 and AOC 620
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 - 9 Samples plus 2 Duplicate Samples/Lower Interval - 3 Samples) (µg/kg)						
2-Butanone (MEK)	Upper	2/9	2 - 3	2.5	4700000	0
	Lower	2/3	10 - 10	10	7900	0
4-Methyl-2-Pentanone (MIBK)	Upper	1/9	1.0	1.0	630000	0
	Lower	0/3	ND	ND	12300	0
Acetone	Upper	1/9	42	42	780000	0
	Lower	0/3	ND	ND	16000[a]	0
Trichloroethene	Upper	1/9	2.0	2.0	58000	0
	Lower	0/3	ND	ND	60	0
Xylene (Total)	Upper	1/9	2.0	2.0	16000000	0
	Lower	0/3	ND	ND	142000	0
Semivolatile Organic Compounds (Upper Interval -12 Samples plus 2 Duplicate Sample/Lower Interval - 6 Samples) (µg/kg)						
BEQs[1]	Upper	9/12	20.1 - 1173	354	88.00	7
	Lower	0/0	NA	NA	NA	NA
2-Methylnaphthalene	Upper	1/12	78	78	310000	0
	Lower	0/6	ND	ND	126000	0
4-Methylphenol	Upper	0/12	ND	ND	39000	0
	Lower	1/6	2200	2200	1380	1
Acenaphthylene	Upper	2/12	59 - 140	99.5	310000	0
	Lower	0/6	ND	ND	293000	0

Table 10.2.2
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds (Upper Interval -12 Samples plus 2 Duplicate Sample/Lower Interval - 6 Samples) (μg/kg)						
Anthracene	Upper	4/12	43 - 170	91.5	2300000	0
	Lower	1/6	53	53	12000000[a]	0
Benzo(a)anthracene	Upper	9/12	58 - 450	187	880	0
	Lower	4/6	60 - 110	90	2000[b]	0
Benzo(a)pyrene	Upper	8/12	46.5 - 760	265	88	7
	Lower	4/6	62 - 140	106	8000	0
Benzo(b)fluoranthene	Upper	7/12	69 - 1200	341	880	1
	Lower	4/6	69 - 160	117	5000[b]	0
Benzo(g,h,i)perylene	Upper	8/12	43 - 550	207	230000	0
	Lower	3/6	65 - 140	108	4.66E+08	0
Benzo(k)fluoranthene	Upper	9/12	44.5 - 740	276	8800	0
	Lower	3/6	91 - 140	124	49000[b]	0
Benzoic acid	Upper	1/12	110	110	31000000	0
	Lower	1/6	60.0	60.0	400000[a,c]	0
Chrysene	Upper	9/12	58 - 640	242	88000	0
	Lower	4/6	66 - 140	114	160000[b]	0
Dibenz(a,h)anthracene	Upper	4/12	54 - 190	124	88	3
	Lower	0/6	ND	ND	2000[b]	0
Dibenzofuran	Upper	1/12	44	44	31000	0
	Lower	0/6	ND	ND	240000	0

Table 10.2.2
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds (Upper Interval -12 Samples plus 2 Duplicate Sample/Lower Interval - 6 Samples) (μg/kg)						
Fluoranthene	Upper	9/12	61 - 720	256	310000	0
	Lower	4/6	88 - 200	140	4300000[a]	0
Fluorene	Upper	2/12	44 - 52	48	310000	0
	Lower	0/6	ND	ND	560000[a]	0
Indeno(1,2,3-cd)pyrene	Upper	7/12	59 - 500	199	880	0
	Lower	2/6	81 - 120	101	14000[b]	0
Naphthalene	Upper	2/12	72 - 74	73	310000	0
	Lower	0/6	ND	ND	84000[a]	0
Phenanthrene	Upper	8/12	46 - 420	175	230000	0
	Lower	1/6	77	77	1380000	0
Pyrene	Upper	9/12	76 - 620	294	230000	0
	Lower	4/6	94 - 360	196	4200000[a]	0
bis(2-Ethylhexyl)phthalate(BEHP)	Upper	1/12	1300	1300	46000	0
	Lower	0/6	ND	ND	3600000	0
Pesticides and PCBs (Upper Interval - 8 Samples plus 2 Duplicate Sample/Lower Interval - 4 Samples) (μg/kg)						
4,4-DDD	Upper	3/8	3.2 - 34	17.4	2700	0
	Lower	1/4	24	24	16000[b]	0
4,4'-DDE	Upper	5/8	4.4 - 140	49	1900	0
	Lower	1/4	100	100	54000[b]	0

Table 10.2.2
Zone F
SWMU 36 and AOC 620
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
Pesticides and PCBs (Upper Interval - 8 Samples plus 2 Duplicate Sample/Lower Interval - 4 Samples) (μg/kg)						
4,4-DDT	Upper	4/8	6.4 - 150	80.6	1900	0
	Lower	1/4	75	75	32000[b]	0
Aroclor-1254	Upper	1/8	295	295	160	1
	Lower	0/4	ND	ND	1000	0
Aroclor-1260	Upper	3/8	97 - 430	256	320	1
	Lower	0/4	ND	ND	1000	0
Endrin	Upper	1/8	5.7	5.7	2300	0
	Lower	0/4	ND	ND	1000	0
Heptachlor	Upper	1/8	1.7	1.7	140	0
	Lower	0/4	ND	ND	23000	0
alpha-Chlordane	Upper	1/8	12	12	490	0
	Lower	0/4	ND	ND	10000	0
gamma-Chlordane	Upper	3/8	2.6 - 24	10.9	490	0
	Lower	1/4	3.6	3.6	10000	0
Dioxins (Upper Interval - 2 Duplicate Samples) (ng/kg)						
Dioxin (2,3,7,8-TCDD TEQs[1])	Upper	2/2	0.537 - 0.882	0.710	1000	0
	Lower	0/0	ND	ND	1900	0

Table 10.2.2
Zone F
SWMU 36 and AOC 620
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
Herbicides (Upper Interval - 2 Duplicate Samples) (μg/kg)						
Dinoseb	Upper	½	41	41	7800	0
	Lower	0/0	ND	ND	NL	NA

Notes:
[1] = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
[a] = Calculated values correspond to a noncancer hazard quotient of 1.
[b] = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
[c] = SSL for pH of 6.8.
[d] = Soil saturation concentration (C_{sat}).
* = 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.
ND = Not detected
NL = Not listed
NA = Not applicable
BEQ = Benzo(a)pyrene Equivalents
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram

Table 10.2.3
Zone F
SWMU 36 and AOC 620
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 - 12 Samples plus 2 Duplicate Samples/Lower Interval - 6 Samples) (mg/kg)						
Aluminum	Upper	12/12	34.1 - 21100	5520	7800	2
	Lower	6/6	5530 - 33000	17600	1000000	0
Antimony	Upper	6/12	0.530 - 2.70	1.53	3.1	0
	Lower	2/6	1.20 - 1.30	1.25	5	0
Arsenic	Upper	11/12	1.30 - 31.5	11.2	0.43	11
	Lower	6/6	0.510 - 19.9	12.6	29[b]	0
Barium	Upper	12/12	8.20 - 62.3	30.2	550	0
	Lower	6/6	8.50 - 43.5	27.2	1600[b]	0
Beryllium	Upper	9/12	0.160 - 1.000	0.436	0.15	9
	Lower	6/6	0.0600 - 1.30	0.752	63[b]	0
Cadmium	Upper	9/12	0.05 - 0.690	0.303	3.9	0
	Lower	1/6	0.170	0.170	8[b]	0
Calcium	Upper	12/12	261 - 126500	18800	NL	NA
	Lower	6/6	1170 - 9790	5400	NL	NA
Chromium	Upper	12/12	1.4 - 43.2	14.9	39	1
	Lower	6/6	8.10 - 141	46.2	38[b]	2
Cobalt	Upper	12/12	0.430 - 5.90	2.50	470	0
	Lower	6/6	1.90 - 7.90	4.62	2000	0
Copper	Upper	7/12	4.40 - 84.8	39.0	310	0
	Lower	5/6	1.20 - 43.7	20.0	920	0

Table 10.2.3
Zone F
SWMU 36 and AOC 620
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 - 12 Samples plus 2 Duplicate Samples/Lower Interval - 6 Samples) (mg/kg)						
Iron	Upper	12/12	197 - 23900	8410	2300	9
	Lower	6/6	921 - 28200	16600	NL	NA
Lead	Upper	12/12	9.80 - 2660	432	400[c]	2
	Lower	6/6	5.30 - 127	55.6	400[c]	0
Magnesium	Upper	12/12	17.0 - 2870	955	NL	NA
	Lower	6/6	246 - 4670	2220	NL	NA
Manganese	Upper	12/12	1.000 - 277	88.6	180	2
	Lower	6/6	9.90 - 445	173	1100	0
Mercury	Upper	10/12	0.0900 - 0.790	0.282	2.3	0
	Lower	6/6	0.170 - 0.520	0.340	2.0[b]	0
Nickel	Upper	11/12	0.700 - 14.1	5.52	160	0
	Lower	5/6	1.20 - 17.1	10.1	130[b]	0
Potassium	Upper	9/12	128 - 1590	599	NL	NA
	Lower	5/6	442 - 2310	1530	NL	NA
Selenium	Upper	6/12	0.370 - 0.910	0.613	39.0	0
	Lower	5/6	0.470 - 1.60	0.952	5[b]	0
Silver	Upper	2/12	0.250 - 0.330	0.290	39.0	0
	Lower	0/6	ND	ND	34[a,b]	0

Table 10.2.3
Zone F
SWMU 36 and AOC 620
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	Upper	8/12	167 - 967	350	NL	NA
	Lower	4/6	262 - 3470	1140	NL	NA
Inorganics (Upper Interval - 12 Samples plus 2 Duplicate Samples/Lower Interval - 6 Samples) (mg/kg)						
Thallium	Upper	1/12	0.540	0.540	0.630	0
	Lower	1/6	0.640	0.640	1.24	0
Vanadium	Upper	12/12	0.340 - 45.3	15.9	55	0
	Lower	6/6	1.70 - 82.0	42.7	6000[a]	0
Zinc	Upper	11/12	4.30 - 302	101	2300	0
	Lower	6/6	3.40 - 209	110	12000[a,b]	0

Notes:
a = Calculated values correspond to a noncancer hazard quotient of 1.
b = SSL for pH of 6.8.
c = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA 1994a).
* = 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.
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
2-Butanone (MEK)	036SB001	ND	4700000	NA	10.0	7900	NA
	620SB001	3.0			NT		
	620SB002	2.0			NT		
	620SB005	ND			10.0		
4-Methyl-2-Pentanone (MIBK)	036SB003	1.0	630000	NA	NT	12300	NA
Acetone	620SB001	42	780000	NA	NT	16000*	NA
Trichloroethene	620SB001	2.0	58000	NA	NT	60	NA
Xylene	036SB002	2.0	16000000	NA	NT	142000	NA
Semivolatile Organic Compounds (μg/kg)							
BEQ[1]	036SB001	**660.99**	88.0	NA	NA	NL	NA
	036SB002	**164.54**			NA		
	036SB003	**357.08**			NA		
	620SB001	59.703			NA		
	620SB003	**261.13**			NA		
	620SB004	**370.93**			NA		
	620SB007	**120.24**			NA		
	620SB008	**1173.04**			NA		
	620SB009	20.13			NA		
2-Methylnaphthalene	036SB001	78	310000	NA	ND	126000	NA
4-Methylphenol	036SB001	ND	39000	NA	**2200**	1380	NA

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds ($\mu g/kg$)							
Acenaphthylene	620SB003	59	310000	NA	NT	293000	NA
	620SB008	140			ND		
Anthracene	036SB001	98	2300000	NA	ND	12000000[a]	NA
	036SB003	55			NT		
	620SB003	43			NT		
	620SB008	170			53		
Benzo(a)anthracene	036SB001	360	880.0	NA	110	2000[b]	NA
	036SB002	110			NT		
	036SB003	230			NT		
	620SB001	58			NT		
	620SB003	140			NT		
	620SB004	150			NT		
	620SB005	ND			110		
	620SB007	74			60		
	620SB008	450			80		
	620SB009	110			ND		
Benzo(a)pyrene	036SB001	**400**	88.0	NA	140	8000	NA
	036SB002	**140**			NT		
	036SB003	**220**			NT		
	620SB001	46.5			NT		
	620SB003	**200**			NT		
	620SB004	**260**			NT		
	620SB005	ND			100		
	620SB007	**94**			62		
	620SB008	**760**			120		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds ($\mu g/kg$)							
Benzo(b)fluoranthene	036SB001	370	880	NA	120	5000[b]	NA
	620SB001	69			NT		
	620SB003	350			NT		
	620SB004	197			NT		
	620SB005	ND			120		
	620SB007	120			69		
	620SB008	1200			160		
	620SB009	84			ND		
Benzo(g,h,i)perylene	036SB001	330	230000.0	NA	140	4.66E+08	NA
	036SB002	130			NT		
	036SB003	220			NT		
	620SB001	43			NT		
	620SB003	95			NT		
	620SB004	210			NT		
	620SB005	ND			65		
	620SB007	74			ND		
	620SB008	550			120		
Benzo(k)fluoranthene	036SB001	350	8800.0	NA	140	49000[b]	NA
	036SB002	240			NT		
	036SB003	480			NT		
	620SB001	44.5			NT		
	620SB003	270			NT		
	620SB004	210			NT		
	620SB005	ND			91		
	620SB007	83			ND		
	620SB008	740			140		
	620SB009	63			ND		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds (μg/kg)							
Benzoic acid	620SB002	110	31000000	NA	NT	400000[a,c]	NA
	620SB008	ND			60		
Chrysene	036SB001	490	88000.0	NA	140	160000[b]	NA
	036SB002	140			NT		
	036SB003	280			NT		
	620SB001	58			NT		
	620SB003	230			NT		
	620SB004	130			NT		
	620SB005	ND			120		
	620SB007	110			66		
	620SB008	640			130		
	620SB009	100			ND		
Dibenz(a,h)anthracene	036SB001	**160**	88	NA	ND	2000[b]	NA
	036SB003	**90**			NT		
	620SB004	54			NT		
	620SB008	**190**			ND		
Dibenzofuran	036SB003	44	31000	NA	NT	240000	NA
Fluoranthene	036SB001	720	310000.0	NA	200	4300000[a]	NA
	036SB002	260			NT		
	036SB003	400			NT		
	620SB001	61			NT		
	620SB003	130			NT		
	620SB004	129			NT		
	620SB005	74			170		
	620SB007	120			88		
	620SB008	410			100		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds ($\mu g/kg$)							
Fluorene	036SB003	44	310000	NA	NT	560000[a]	NA
	620SB009	52			ND		
Indeno(1,2,3-cd)pyrene	036SB001	240	880	NA	120	14000[b]	NA
	036SB002	110			NT		
	036SB003	190			NT		
	620SB003	92			NT		
	620SB004	200			NT		
	620SB007	59			ND		
	620SB008	500			81		
Naphthalene	036SB001	72.0	310000	NA	ND	84000[a]	NA
	036SB003	74.0			NT		
Phenanthrene	036SB001	420	230000.0	NA	77	1380000	NA
	036SB002	140			NT		
	036SB003	290			NT		
	620SB003	46			NT		
	620SB004	82			NT		
	620SB007	50			ND		
	620SB008	120			ND		
	620SB009	250			ND		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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
Semivolatile Organic Compounds (μg/kg)							
Pyrene	036SB001	620	230000.0	NA	220	4200000[a]	NA
	036SB002	180			NT		
	036SB003	320			NT		
	620SB001	76			NT		
	620SB003	540			NT		
	620SB004	122.5			NT		
	620SB005	120			360		
	620SB007	110			94		
	620SB008	560			110		
bis(2-Ethylhexyl)phthalate (BEHP)	620SB007	1300	46000	NA	ND	3600000	NA
Pesticides and PCBs (μg/kg)							
4,4'-DDD	620SB001	3.2	2700	NA	NT	16000[b]	NA
	620SB003	34.0			NT		
	620SB007	15.0			ND		
	620SB008	ND			24.0		
4,4'-DDE	620SB001	4.4	1900.0	NA	NT	54000[b]	NA
	620SB003	47.0			NT		
	620SB004	44.5			NT		
	620SB007	140.0			ND		
	620SB008	9.1			100		
4,4'DDT	620SB003	46.0	1900	NA	NT	32000[b]	NA
	620SB004	120.0			NT		
	620SB007	150.0			ND		
	620SB008	6.4			75		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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
Pesticides and PCBs (μg/kg)							
Aroclor-1254	620SB004	**295**	160	NA	NT	1000	NA
Aroclor-1260	620SB001	97	320	NA	NT	1000	NA
	620SB003	240			NT		
	620SB004	**430**			NT		
Endrin	620SB003	5.7	2300	NA	NT	1000	NA
Heptachlor	620SB003	1.7	140	NA	NT	23000	NA
alpha-Chlordane	620SB007	12.0	490	NA	ND	10000	NA
gamma-Chlordane	620SB004	6.0	490	NA	NT	10000	NA
	620SB007	24.0			ND		
	620SB008	2.6			3.6		
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	620SB001	0.537	1000	NA	NA	1900	NA
	620SB004	0.8824			NA		
Herbicides (μg/kg)							
Dinoseb	620SB004	41	7800	NA	NT	NL	NA

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)	036SB001	768	7800.0	18500	33000	1000000	17100
	036SB002	1060			NT		
	036SB003	34.1			NT		
	620SB001	4105			NT		
	620SB002	2340			NT		
	620SB003	3950			NT		
	620SB004	6880			NT		
	620SB005	8420			16900		
	620SB006	5200			11500		
	620SB007	5959			32300		
	620SB008	21100			5530		
	620SB009	6430			6470		
Antimony (Sb)	036SB001	1.1	3.1	0.79	ND	5	NL
	036SB002	0.53			NT		
	620SB003	2.5			NT		
	620SB004	0.725			NT		
	620SB007	2.7			1.3		
	620SB008	1.6			1.2		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Arsenic (As)	036SB001	2.3	0.43	19.9	16.6	29[c]	18.2
	036SB002	1.3			NT		
	620SB001	7.6			NT		
	620SB002	2.3			NT		
	620SB003	13.1			NT		
	620SB004	15.05			NT		
	620SB005	15.2			19.9		
	620SB006	8.8			9.2		
	620SB007	**31.5**			11.9		
	620SB008	**22.6**			17.4		
	620SB009	2.9			0.51		
Barium (Ba)	036SB001	62.3	550.0	61.5	31.2	1600[c]	51.8
	036SB002	46.9			NT		
	036SB003	11.2			NT		
	620SB001	15.9			NT		
	620SB002	8.2			NT		
	620SB003	23.5			NT		
	620SB004	36.65			NT		
	620SB005	31.5			33.7		
	620SB006	16.5			28.1		
	620SB007	52.2			43.5		
	620SB008	45.6			18.1		
	620SB009	11.8			8.5		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Beryllium (Be)	036SB001	ND	0.15	1.05	1.2	63[c]	1.20
	620SB001	0.405			NT		
	620SB002	0.21			NT		
	620SB003	0.38			NT		
	620SB004	0.5			NT		
	620SB005	0.77			1.2		
	620SB006	0.17			0.44		
	620SB007	0.33			1.3		
	620SB008	1.0			0.31		
	620SB009	0.16			0.06		
Cadmium (Cd)	036SB001	0.07	3.9	0.26	ND	8[c]	0.09
	036SB003	0.05			NT		
	620SB001	0.305			NT		
	620SB002	0.08			NT		
	620SB003	0.69			NT		
	620SB004	0.49			NT		
	620SB007	0.50			ND		
	620SB008	0.39			0.17		
	620SB009	0.15			ND		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Calcium (Ca)	036SB001	261	NL	NL	9790	NL	NL
	036SB002	266			NT		
	036SB003	1650			NT		
	620SB001	126500			NT		
	620SB002	4400			NT		
	620SB003	51400			NT		
	620SB004	3480			NT		
	620SB005	8170			9330		
	620SB006	2580			3870		
	620SB007	17900			6400		
	620SB008	7480			1820		
	620SB009	2060			1170		
Chromium (Cr)	036SB001	2.4	39 VI	34.8	**57.9**	38[c] (total)	32.2
	036SB002	2.5	7800 III		NT		
	036SB003	1.4			NT		
	620SB001	10.65			NT		
	620SB002	4.6			NT		
	620SB003	20.3			NT		
	620SB004	21.3			NT		
	620SB005	18.3			33.3		
	620SB006	11.7			20.8		
	620SB007	34.1			**141.0**		
	620SB008	43.2			15.8		
	620SB009	8.9			8.1		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Cobalt (Co)	036SB001	0.43	470.0	15.1	7.1	2000	6.85
	036SB002	0.46			NT		
	036SB003	1.5			NT		
	620SB001	2.35			NT		
	620SB002	0.82			NT		
	620SB003	3.2			NT		
	620SB004	2.5			NT		
	620SB005	3.4			6.5		
	620SB006	0.78			2.3		
	620SB007	2.9			7.9		
	620SB008	5.7			2.0		
	620SB009	5.9			1.9		
Copper (Cu)	620SB001	20.8	310.0	48.2	NT	920	30.4
	620SB003	53.0			NT		
	620SB004	47.3			NT		
	620SB005	19.6			27.9		
	620SB006	ND			9.3		
	620SB007	84.8			43.7		
	620SB008	43.2			17.7		
	620SB009	4.4			1.2		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Iron (Fe)	036SB001	467	2300.0	NL	16700	NL	NL
	036SB002	976			NT		
	036SB003	197			NT		
	620SB001	**6590**			NT		
	620SB002	**2890**			NT		
	620SB003	**10600**			NT		
	620SB004	**11185**			NT		
	620SB005	**16200**			28200		
	620SB006	**11800**			16800		
	620SB007	**11900**			28200		
	620SB008	**23900**			8900		
	620SB009	**4220**			921		
Lead(Pb)	036SB001	**1600**	400.0[d]	180	127	400[d]	51.7
	036SB002	69.6			NT		
	036SB003	70.3			NT		
	620SB001	45.1			NT		
	620SB002	47.9			NT		
	620SB003	166			NT		
	620SB004	**2660**			NT		
	620SB005	78.9			58.3		
	620SB006	9.8			34		
	620SB007	287			57.3		
	620SB008	88.9			51.6		
	620SB009	61.9			5.3		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Magnesium (Mg)	036SB001	64.5	NL	NL	2410	NL	NL
	036SB002	35.5			NT		
	036SB003	17.0			NT		
	620SB001	2005			NT		
	620SB002	247			NT		
	620SB003	1090			NT		
	620SB004	803			NT		
	620SB005	2460			4670		
	620SB006	623			1750		
	620SB007	819			3550		
	620SB008	2870			719		
	620SB009	423			246		
Manganese (Mn)	036SB001	5.6	180.0	307	95.4	1100	469
	036SB002	5.8			NT		
	036SB003	1.0			NT		
	620SB001	159			NT		
	620SB002	18.5			NT		
	620SB003	95.3			NT		
	620SB004	115.5			NT		
	620SB005	239			445		
	620SB006	22.2			77.9		
	620SB007	93.2			260		
	620SB008	277			152		
	620SB009	31.4			9.9		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Mercury (Hg)	036SB001	0.17	2.3	0.62	0.39	2[c]	0.23
	036SB002	0.33			NT		
	036SB003	0.11			NT		
	620SB001	0.11			NT		
	620SB003	0.11			NT		
	620SB004	0.29			NT		
	620SB005	0.56			0.32		
	620SB006	ND			0.46		
	620SB007	0.79			0.52		
	620SB008	0.27			0.18		
	620SB009	0.09			0.17		
Nickel (Ni)	036SB001	0.7	160.0	12.6	17.1	130[c]	8.85
	036SB002	0.77			NT		
	036SB003	0.79			NT		
	620SB001	6.85			NT		
	620SB002	1.5			NT		
	620SB003	11.3			NT		
	620SB004	7.15			NT		
	620SB005	5.9			10.9		
	620SB007	9.1			16.2		
	620SB008	14.1			5.2		
	620SB009	2.6			1.2		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Potassium (K)	036SB001	ND	NL	NL	1930	NL	NL
	620SB001	391			NT		
	620SB002	128			NT		
	620SB003	379			NT		
	620SB004	444			NT		
	620SB005	1190			2310		
	620SB006	317			793		
	620SB007	693			2170		
	620SB008	1590			442		
	620SB009	257			ND		
Selenium (Se)	620SB001	0.37	39.0	1.15	NT	5[c]	1.24
	620SB004	0.72			NT		
	620SB005	ND			0.9		
	620SB006	0.63			1.2		
	620SB007	0.65			1.6		
	620SB008	0.91			0.47		
	620SB009	0.40			0.59		
Silver (Ag)	620SB004	0.25	39.0	1.85	NT	34[a,c]	ND
	620SB007	0.33			ND		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Sodium (Na)	620SB001	255	NL	NL	NT	NL	NL
	620SB002	167			NT		
	620SB003	272			NT		
	620SB004	204.5			NT		
	620SB005	967			3470		
	620SB007	336			470		
	620SB008	391			353		
	620SB009	207			262		
Thallium (Tl)	620SB008	0.54	0.63	NL	0.64	1.24	1.24
Vanadium (V)	036SB001	2.3	55.0	48.9	82	6000[a]	49.4
	036SB002	1.7			NT		
	036SB003	0.34			NT		
	620SB001	13.05			NT		
	620SB002	6.7			NT		
	620SB003	17.8			NT		
	620SB004	22.15			NT		
	620SB005	35.6			61		
	620SB006	13.9			29.3		
	620SB007	22.0			66.8		
	620SB008	45.3			15.5		
	620SB009	9.4			1.7		

Table 10.2.4
Zone F
SWMU 36 and AOC 620
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)							
Zinc (Zn)	036SB001	6.8	2300.0	198	192	12000[a,c]	84.2
	036SB002	6.5			NT		
	036SB003	4.3			NT		
	620SB001	73.55			NT		
	620SB002	10.5			NT		
	620SB003	302			NT		
	620SB004	171			NT		
	620SB005	108			116		
	620SB006	ND			43.6		
	620SB007	214			209		
	620SB008	192			95.9		
	620SB009	19.6			3.4		

Notes:

a = Calculated values correspond to a noncancer hazard quotient of 1.
b = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c = SSL for pH of 6.8.
d = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
e = Soil saturation concentration (C_{sat}).
* = 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.
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
mg/kg = Milligrams per kilogram
ng/kg = Nanograms 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 F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

Pesticides and PCBs in Soil

Seven pesticides and two PCBs were detected in soil samples. Only the two PCBs, Aroclor-1254 and Aroclor-1260, exceeded their respective RBCs for surface soil samples. Figures 10.2-6 and 10.2-7 show these two PCB exceedances detected in surface soil. All subsurface pesticide concentrations were below SSLs. Subsurface samples were not collected where the PCBs were detected in surface samples, due to obstruction or the high water table.

Other Organic Compounds in Soil

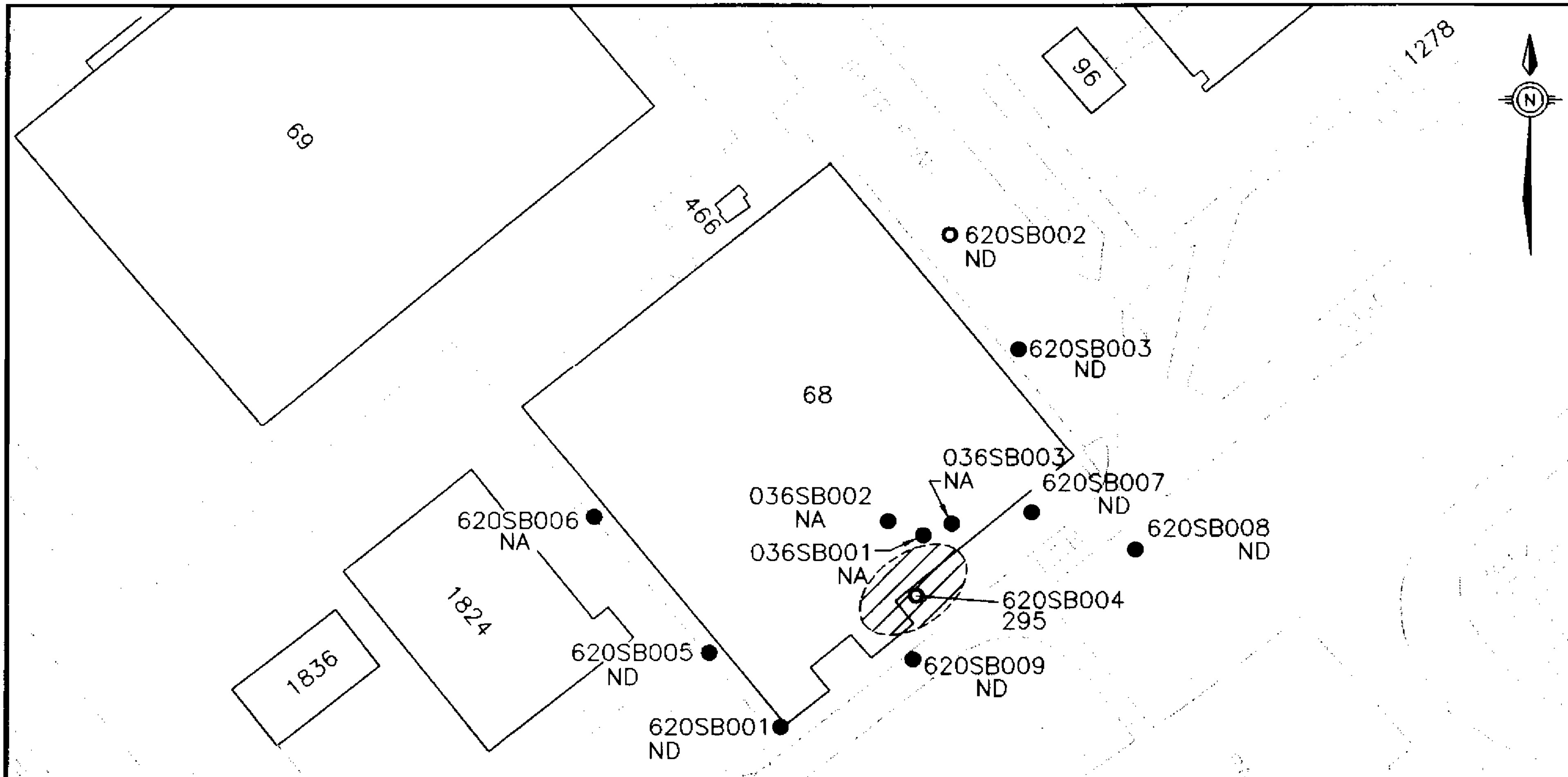
The herbicide dinoseb, and dioxin (2,3,7,8-TCDD TEQs), were detected in surface soil. All detected concentrations were below the respective RBCs for surface soil. Dioxins were not analyzed for in subsurface soil. Subsurface samples were not analyzed for herbicides. No subsurface soil samples were duplicated at this site.

Inorganic Elements in Soil

Twenty-three metals were detected in soil samples collected at SWMU 36 and AOC 620. Aluminum, arsenic, chromium, and lead concentrations were detected in surface soil samples above both their respective RBCs and background concentrations for Zone F surface soil. Iron concentrations were also detected in surface samples exceeding RBCs; no surface background is available for iron. Only chromium was detected in subsurface soil exceeding its SSLs. Figures 10.2-8 through 10.2-12 show individual metal exceedances in surface and subsurface soil.

10.2.4 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of two shallow monitoring wells within the SWMU 36 and AOC 620 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. During the field investigation, four shallow monitoring wells were actually installed at these sites, in two



LEGEND

- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- □ – < 160 μg/kg
- ▨ – > 160 μg/kg
- ---- – APPROXIMATE EXTENT

NOTES:

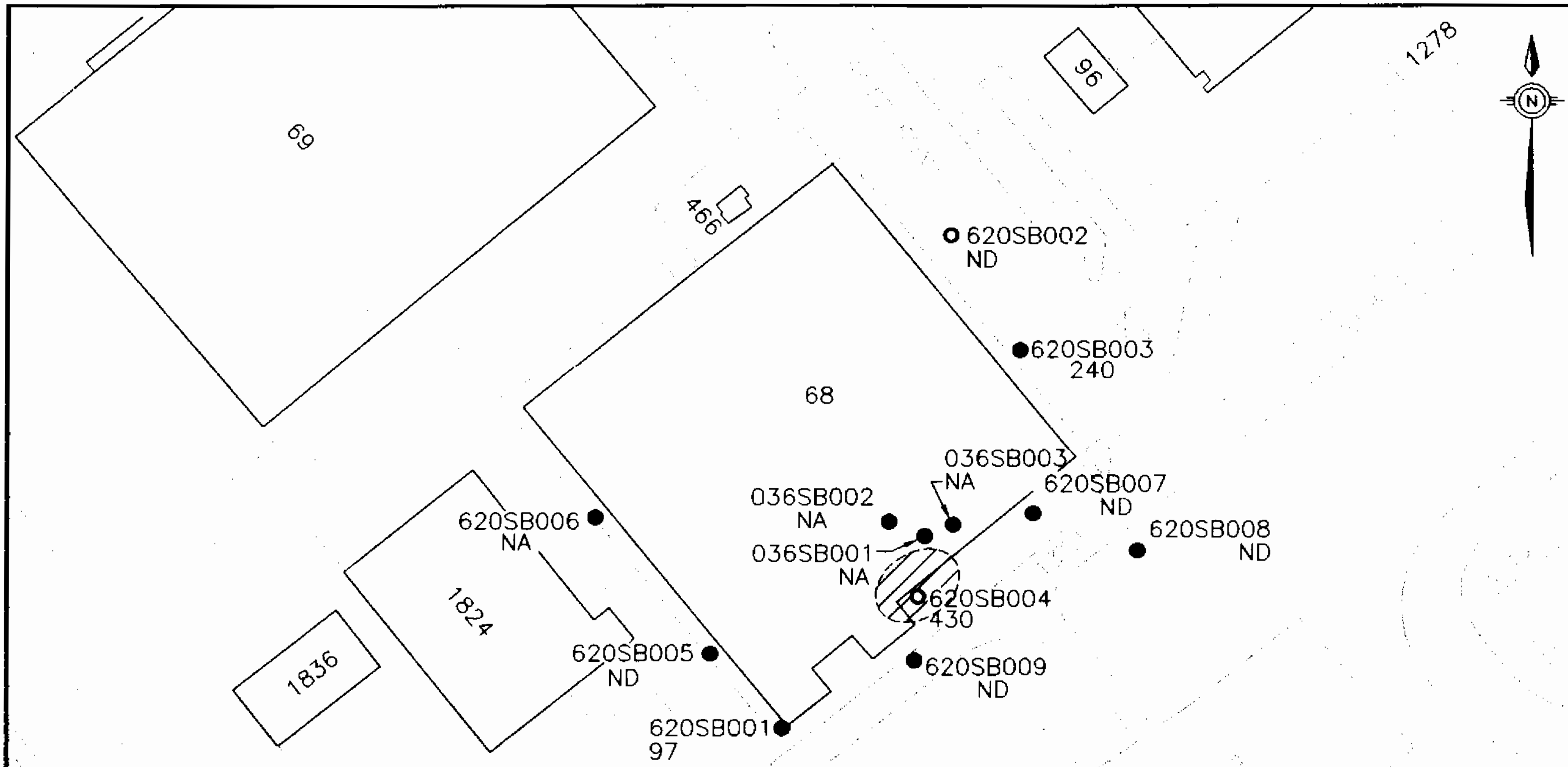
- 160 μg/kg = RBC FOR AROCLOR-1254 IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- NA = NOT ANALYZED FOR PCBs
- ND = NOT DETECTED

100 0 100
SCALE FEET

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

FIGURE 10.2-6
AROCLOR-1254 IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906ARCL



LEGEND

- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- ☐ – < 320 µg/kg
- ▨ – > 320 µg/kg
- ---- – APPROXIMATE EXTENT

NOTES:

- 320 µg/kg = RBC FOR AROCLOR–1260 IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- NA = NOT ANALYZED FOR PCBs
- ND = NOT DETECTED

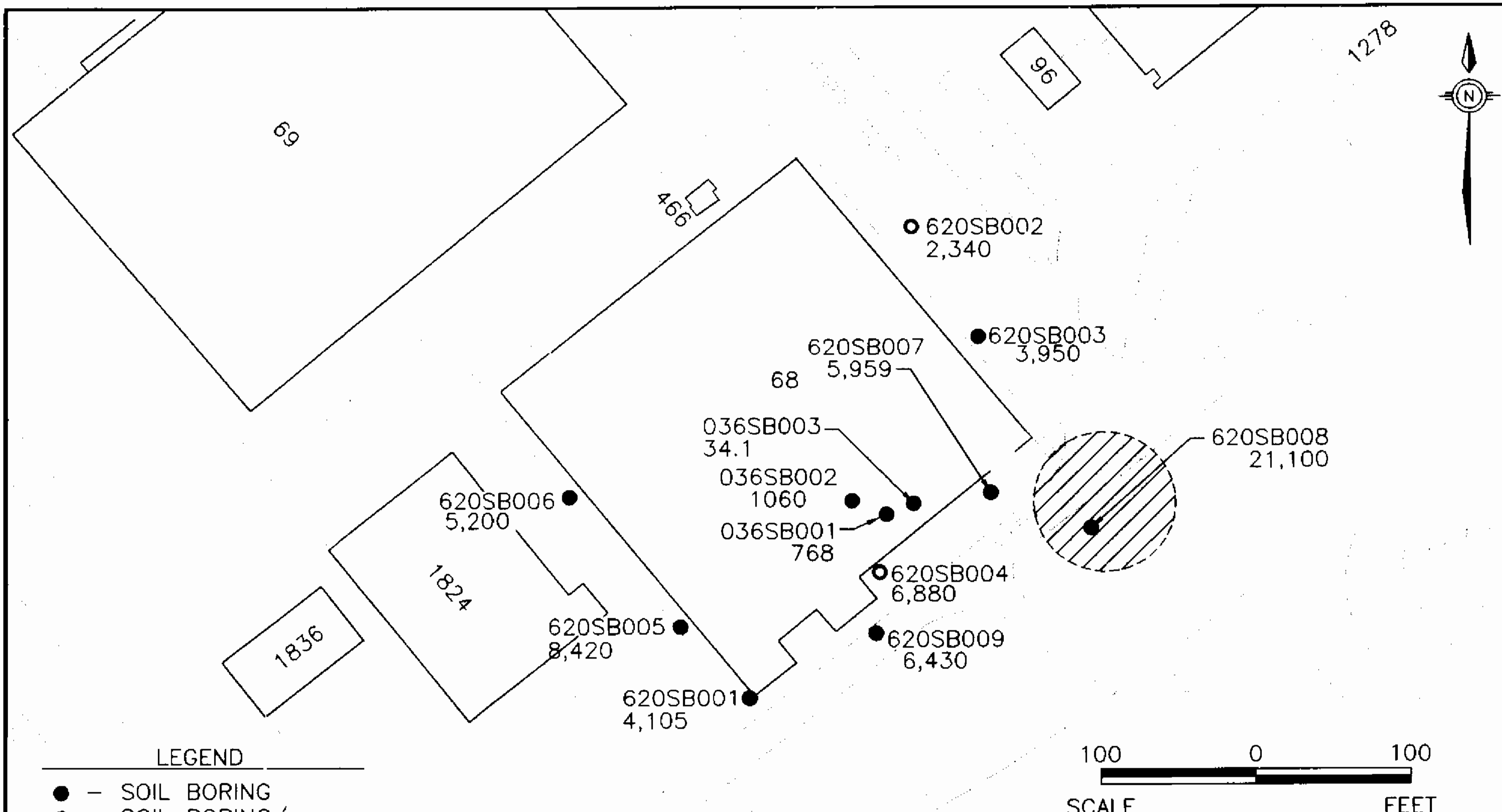
100 0 100

SCALE FEET

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

FIGURE 10.2–7
AROCLOR–1260 IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906A126



LEGEND

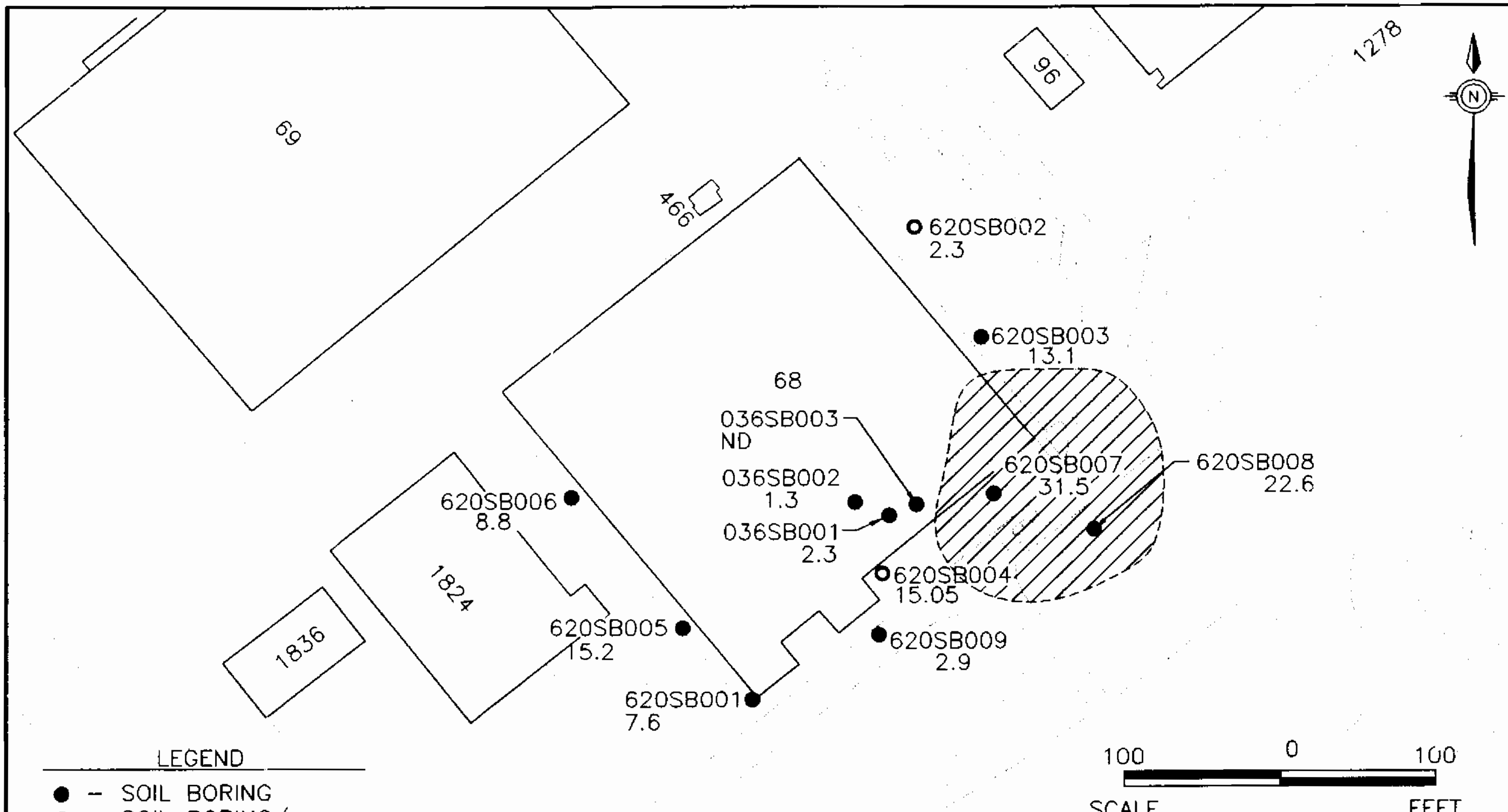
- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- □ – < 18,500 mg/kg
- ▨ – > 18,500 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 18,500 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR ALUMINUM IN SURFACE SOIL
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

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

FIGURE 10.2-8
ALUMINUM IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/05/97	DWG NAME: 2906AISS



LEGEND

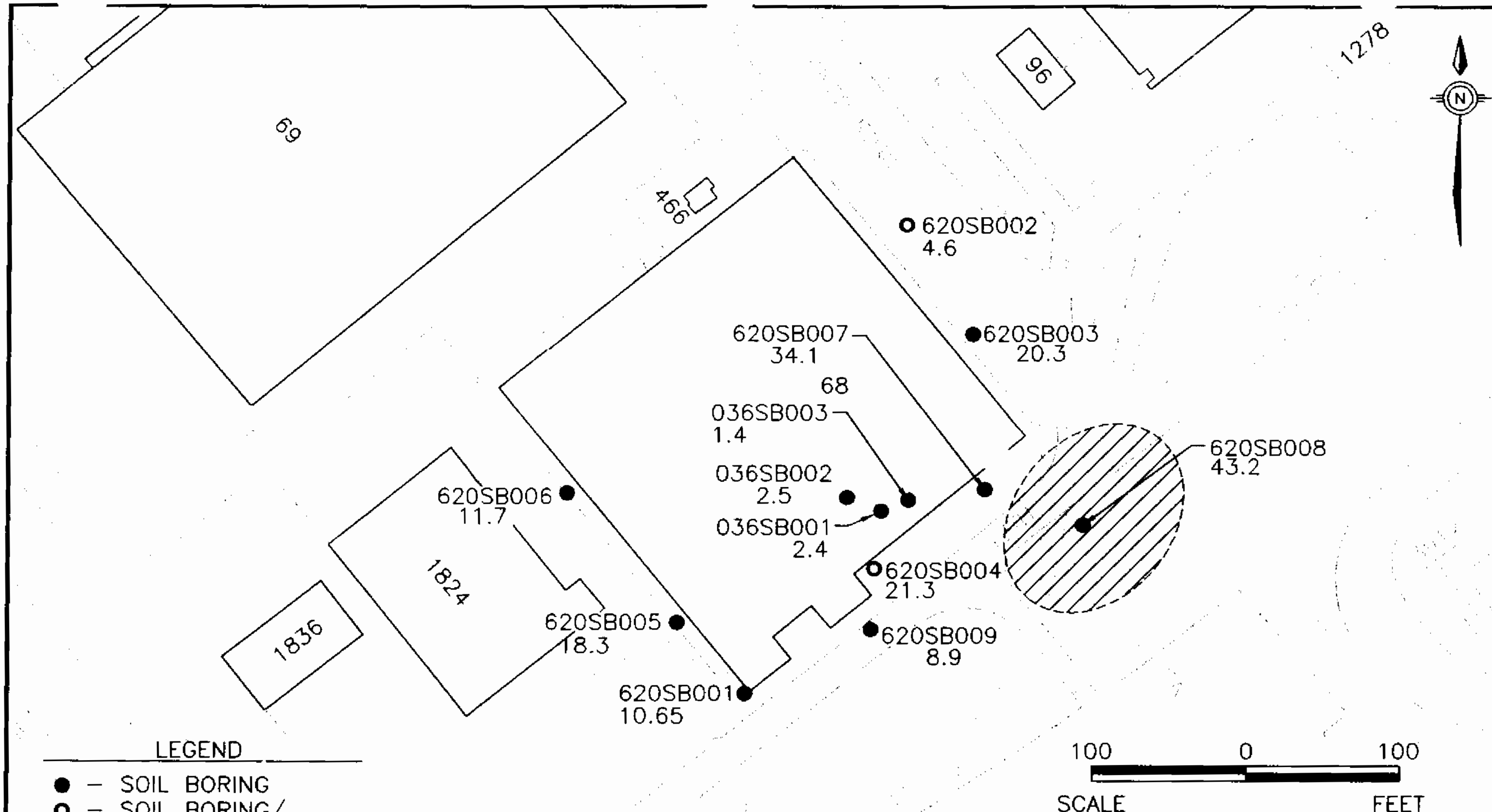
- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- □ – < 19.9 mg/kg
- ▨ – > 19.9 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 19.9 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN SURFACE SOIL
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

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

FIGURE 10.2–9
ARSENIC IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/05/97 | DWG NAME: 2906ASNI



LEGEND

● – SOIL BORING

○ – SOIL BORING/
SHALLOW MONITORING WELL

☐ – < 39 mg/kg

▨ – > 39 mg/kg

---- – APPROXIMATE EXTENT

NOTES:

– 39 mg/kg = RBC FOR CHROMIUM IN SURFACE SOIL (USEPA 1996b)

– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

– ND = NOT DETECTED

ZONE F
RCRA FACILITY
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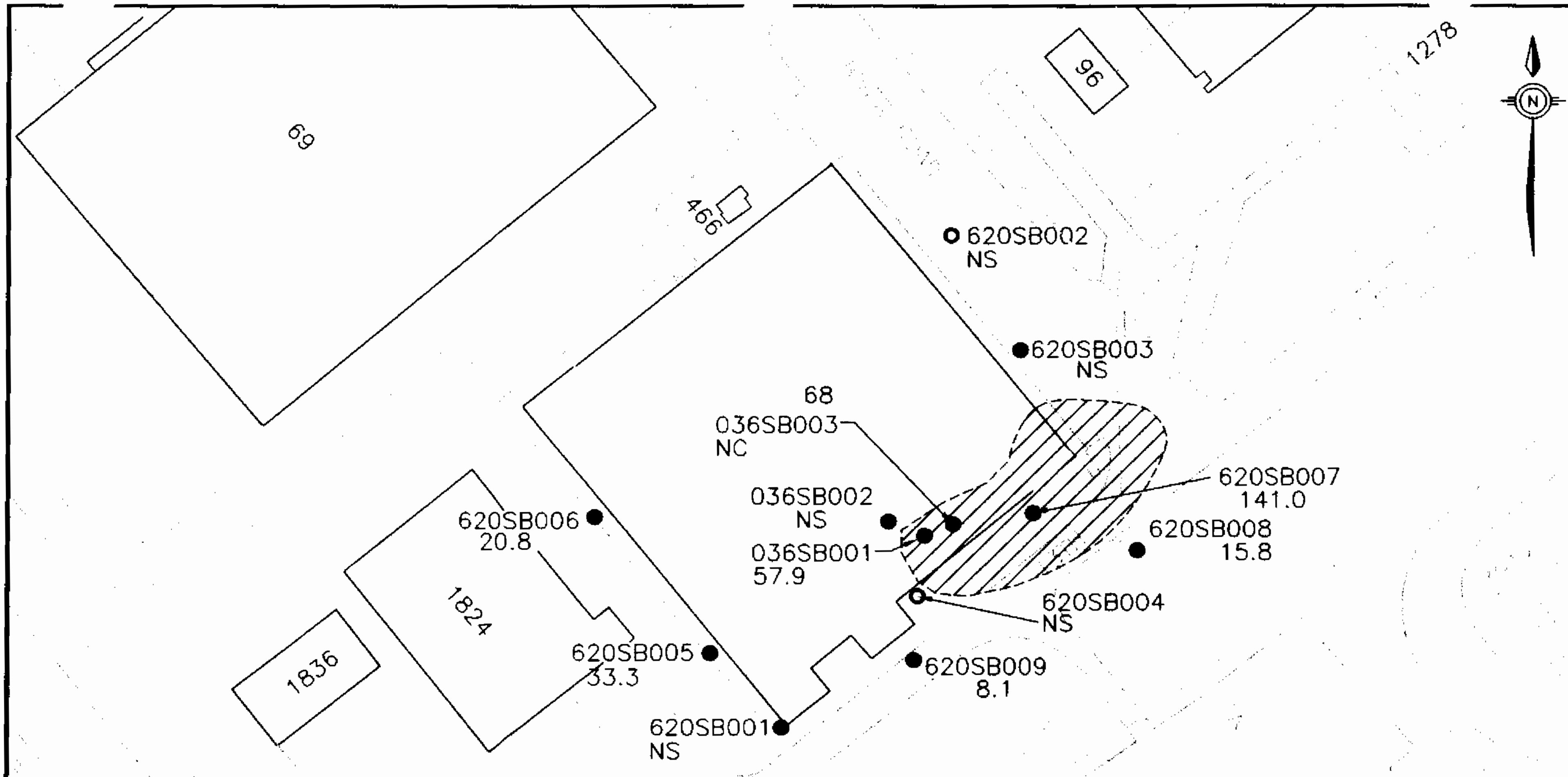
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.2–10
CHROMIUM IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97	DWG NAME: 2906CHRM



LEGEND

- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- ☐ – < 38 mg/kg
- ▨ – > 38 mg/kg
- ---- – APPROXIMATE EXTENT

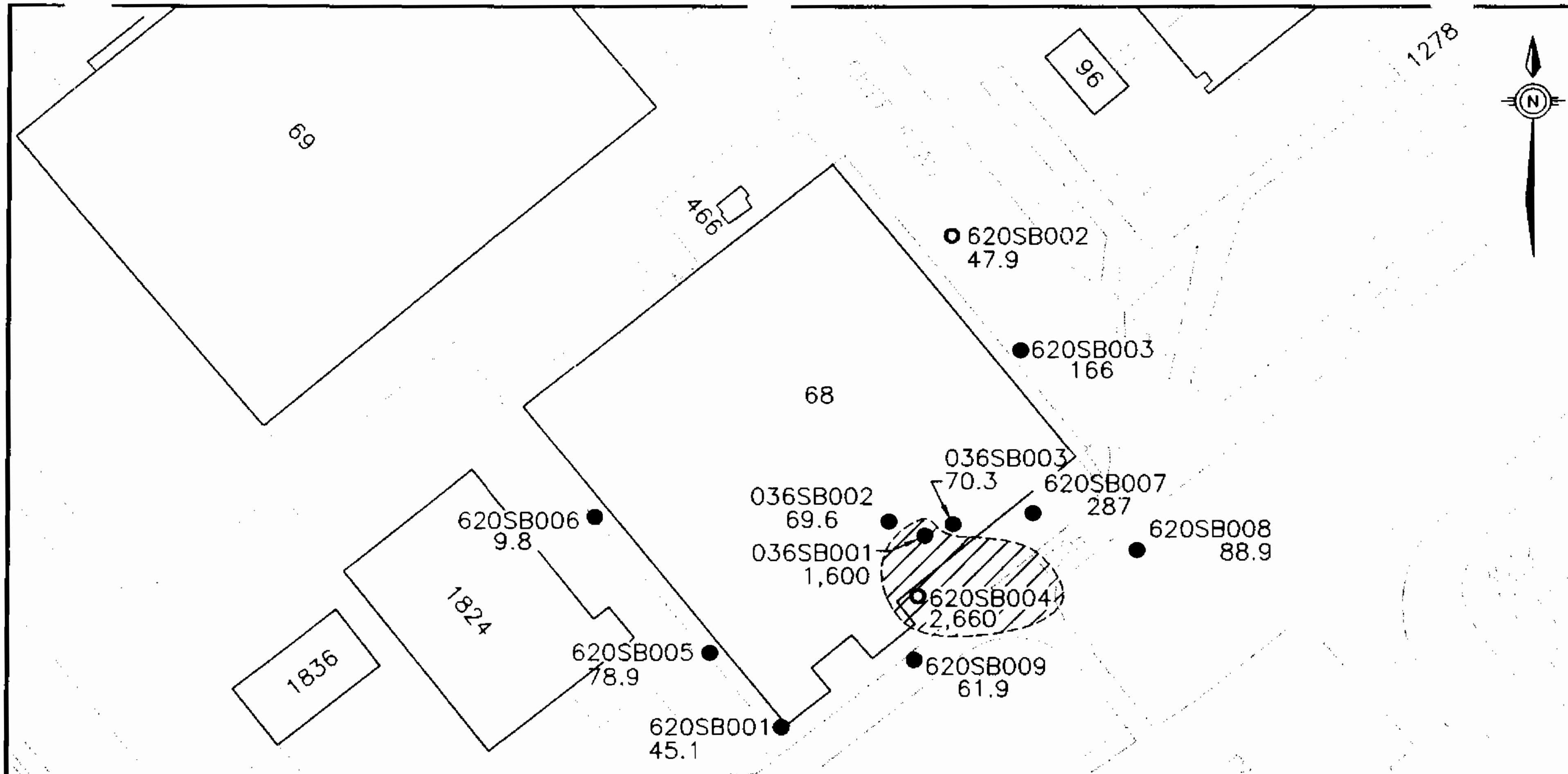
NOTES:

- 38 mg/kg = SSL FOR CHROMIUM IN SUBSURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NS = LOWER INTERVAL NOT SAMPLED

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

FIGURE 10.2-11
CHROMIUM IN SUBSURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906CHSS



LEGEND

- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- ☐ – < 400 mg/kg
- ▨ – > 400 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 400 mg/kg = INTERIM SOIL LEAD GUIDANCE IN SURFACE SOIL (USEPA 1994a)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

100 0 100

SCALE FEET

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

FIGURE 10.2–12
LEAD IN SURFACE SOIL
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906LEAD

phases (Figure 10.2-1). These wells were installed between approximately 12 and 14 ft bgs in the upper sand layer of the surficial aquifer. Two shallow wells were initially installed within the site area and sampled as specified in the approved final RFI work plan. Groundwater samples from these two wells were analyzed for metals, SVOAs, and VOAs at DQO Level III. Later, two additional wells were installed to define the potential downgradient impact to groundwater from metals contamination in soil at SWMU 36. Groundwater samples from the two succeeding wells were analyzed for metal constituents at DQO Level III, and pH. Table 10.2.5 summarizes the groundwater samples and analyses at these sites.

10.2.4.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater are summarized in Table 10.2.6. Inorganic analytical results for groundwater are summarized in Table 10.2.7. Table 10.2.8 presents a summary of all analytes detected in groundwater at AOC 620.

Wells 620001 and 620002 were installed for the first quarter sampling event. Wells 620003 and 620004 were installed to further evaluate site groundwater during second quarter sampling.

Table 10.2.5
SWMU 36 and AOC 620
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
620001	Shallow	62000101	11/08/96	Note 1	
620002	Shallow	62000201	11/04/96	Note 1	
620003	Shallow	620003A1	5/01/97	Note 2	Second-round well
620004	Shallow	620004A1	4/30/97	Note 2	Second-round well

Notes:
1 = SW-846 (metals, SVOAs, and VOAs) at DQO Level III
2 = SW-846 (metals) at DQO Level III; pH

Table 10.2.6
Zone F
SWMU 36 and AOC 620
Organic 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
Semivolatile Organic Compounds (2 Shallow Samples) (μg/L)							
Benzoic Acid	Shallow	2/2	2 - 3	2.5	15000	NL	0
Fluorene	Shallow	1/2	1.0	1.0	150	NL	0
pH (2 Shallow Samples)							
pH	Shallow	2/2	6.95 - 7.02	6.985	NL	NL	0

Notes:
NL = Not listed
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
μg/L = Micrograms per liter
Wells 620003 and 620004 were installed during the second-round and are included in calculations for this table
Data presented are from the initial sampling event only

Table 10.2.7
Zone F
SWMU 36 and AOC 620
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 (4 Shallow Samples) (μg/L)							
Aluminum	Shallow	3/4	62.3 - 173	123	3700	50	0
Arsenic	Shallow	3/4	5.3 - 9.6	7.3	0.045	50	3
Barium	Shallow	4/4	18.3 - 460	133	260	2000	1
Cadmium	Shallow	2/4	0.3 - 0.31	0.305	1.8	5	0
Calcium	Shallow	4/4	74000 - 129000	101000	NL	NL	NA
Chromium	Shallow	1/4	2.2	2.2	18	100	0
Cobalt	Shallow	1/4	1.5	1.5	220	NL	0
Copper	Shallow	1/4	2.5	2.5	150	1000	0
Iron	Shallow	4/4	1850 - 6880	4270	1100	300	4
Lead	Shallow	2/4	4.6 - 30.7	17.7	15	15	1
Magnesium	Shallow	4/4	6200 - 359000	101000	NL	NL	NA
Manganese	Shallow	4/4	208 - 749	464	84	50	0
Nickel	Shallow	1/4	3.7	3.7	73	100	0
Potassium	Shallow	4/4	7070 - 169000	51500	NL	NL	NA
Sodium	Shallow	4/4	40900 - 3460000	936000	NL	NL	NA

Table 10.2.7
Zone F
SWMU 36 and AOC 620
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 (4 Shallow Samples) (μg/L)							
Thallium	Shallow	3/4	2.8 - 11.0	6.33	0.29	2	2
Vanadium	Shallow	3/4	1.1 - 13.9	5.87	26	NL	0

Notes:
NL = Not listed
NA = Not applicable
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
μg/L = Micrograms per liter
Wells 620003 and 620004 were installed during the second-round and are included in calculations for this table
Data presented are from the initial sampling event only

Table 10.2.8
Zone F
SWMU 36 and AOC 620
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-Chloro-3-methylphenol	620003	NI	NT	1.0	NL	NL	NA
4-Methylphenol	620001	ND	2.0	ND	18	NL	NA
Acenaphthene	620003	NI	NT	2.0	220	NL	NA
Benzoic Acid	620001	2.0	1.0	5.0	15000	NL	NA
	620002	3.0	ND	5.0			
	620003	NI	NT	4.0			
	620004	NI	NT	4.0			
Diethylphthalate	620001	ND	ND	1.0	2900	NL	NA
	620002	ND	ND	2.0			
Fluorene	620001	1.0	ND	ND	150	NL	NA
Inorganics (μg/L)							
Aluminum (Al)	620001	133	69	99.5	3700	50	224
	620002	62.3	10.2	ND			
	620003	NI	ND	182			
	620004	NI	173	539			
Antimony (Sb)	620001	ND	3.3	ND	1.5	6	NL
	620002	ND	2.1	ND			
Arsenic (As)	620001	9.6	8.0	3.8	0.045	50	16.7
	620002	7.0	ND	4.9			
	620003	NI	ND	11.1			
	620004	NI	5.3	7.7			

Table 10.2.8
Zone F
SWMU 36 and AOC 620
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
Inorganics (µg/L)							
Barium (Ba)	620001	**460**	**525**	**701**	260	2000	94.3
	620002	18.3	31.2	42.3			
	620003	NI	32.9	67.2			
	620004	NI	21.0	55.5			
Beryllium (Be)	620001	ND	0.28	**0.85**	0.016	4	0.66
	620002	ND	0.39	ND			
	620004	NI	ND	0.3			
Cadmium (Cd)	620003	NI	0.30	ND	1.8	5	0.82
	620004	NI	0.31	ND			
Calcium (Ca)	620001	128000	126000	132000	NL	NL	NL
	620002	74900	147000	152000			
	620003	NI	129000	134000			
	620004	NI	74000	117000			
Chromium (Cr)	620001	2.2	4.9	7.2	18	100	2.05
	620002	ND	ND	1.2			
	620003	NI	ND	1.4			
	620004	NI	ND	3.7			
Cobalt (Co)	620001	ND	1.3	1.6	220	NL	10.9
	620004	NI	1.5	2.4			
Copper (Cu)	620001	ND	2.0	ND	150	1000	NL
	620003	NI	2.5	ND			

Table 10.2.8
Zone F
SWMU 36 and AOC 620
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
Inorganics (μg/L)							
Iron (Fe)	620001	**6440**	**15000**	**8780**	1100	300	NL
	620002	**1850**	134	**2830**			
	620003	NI	**6880**	**11700**			
	620004	NI	**1920**	**15300**			
Lead (Pb)	620001	4.6	ND	ND	15	15	NL
	620004	NI	**30.7**	ND			
Magnesium (Mg)	620001	359000	423000	388000	NL	NL	NL
	620002	6200	6450	7910			
	620003	NI	231000	18800			
	620004	NI	17400	338000			
Manganese (Mn)	620001	286	214	193	84	50	2010
	620002	208	157	208			
	620003	NI	749	604			
	620004	NI	613	477			
Nickel (Ni)	620001	ND	3.8	3.4	73	100	5.55
	620002	ND	ND	1.4			
	620004	NI	3.7	ND			
Potassium (K)	620001	169000	137000	162000	NL	NL	NL
	620002	7070	14200	14400			
	620003	NI	16800	19200			
	620004	NI	13000	140000			
Selenium (Se)	620002	ND	3.7	ND	18	50	NL
Silver (Ag)	620004	NI	ND	1.5	18	100	NL

Table 10.2.8
Zone F
SWMU 36 and AOC 620
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
Inorganics (µg/L)							
Sodium (Na)	620001	3460000	3550000	4630000	NL	NL	NL
	620002	40900	31100	25500			
	620003	NI	75900	71400			
	620004	NI	169000	3400000			
Thallium (Tl)	620001	11.0	ND	ND	0.29	2	5.58
	620002	2.8	ND	ND			
	620003	NI	5.2	ND			
Vanadium (V)	620001	13.9	7.1	8.2	26	NL	1.58
	620002	1.1	ND	ND			
	620004	NI	2.6	9.2			
Zinc (Zn)	620001	ND	ND	13.4	1100	5000	NL
pH							
pH	620003	NI	7.02	NT	NL	NL	NL
	620004	NI	6.95	NT			

Notes:
NL = Not listed
NA = Not applicable
NI = Not installed until April/May
NT = Not taken
µg/L = Micrograms per liter
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
Bolded concentrations exceed both the RBC and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background values for groundwater are based on two sampling rounds in two wells at each depth.
Wells 62003 and 62004 were installed during the second-round and are included in calculations for this table
Data presented are from the initial sampling event only

Organics Detected in Groundwater Samples

The only organics detected in groundwater were SVOCs. Two SVOCs, Benzoic acid and fluorene, were detected during the first quarter sampling event. Four additional SVOCs, 4-chloro-3-Methylphenol, 4-Methylphenol, and acenaphthene, and diethylphthalate, were detected during later sampling events. All detected SVOC concentrations were below their respective tap water RBCs.

Inorganic Elements in Groundwater

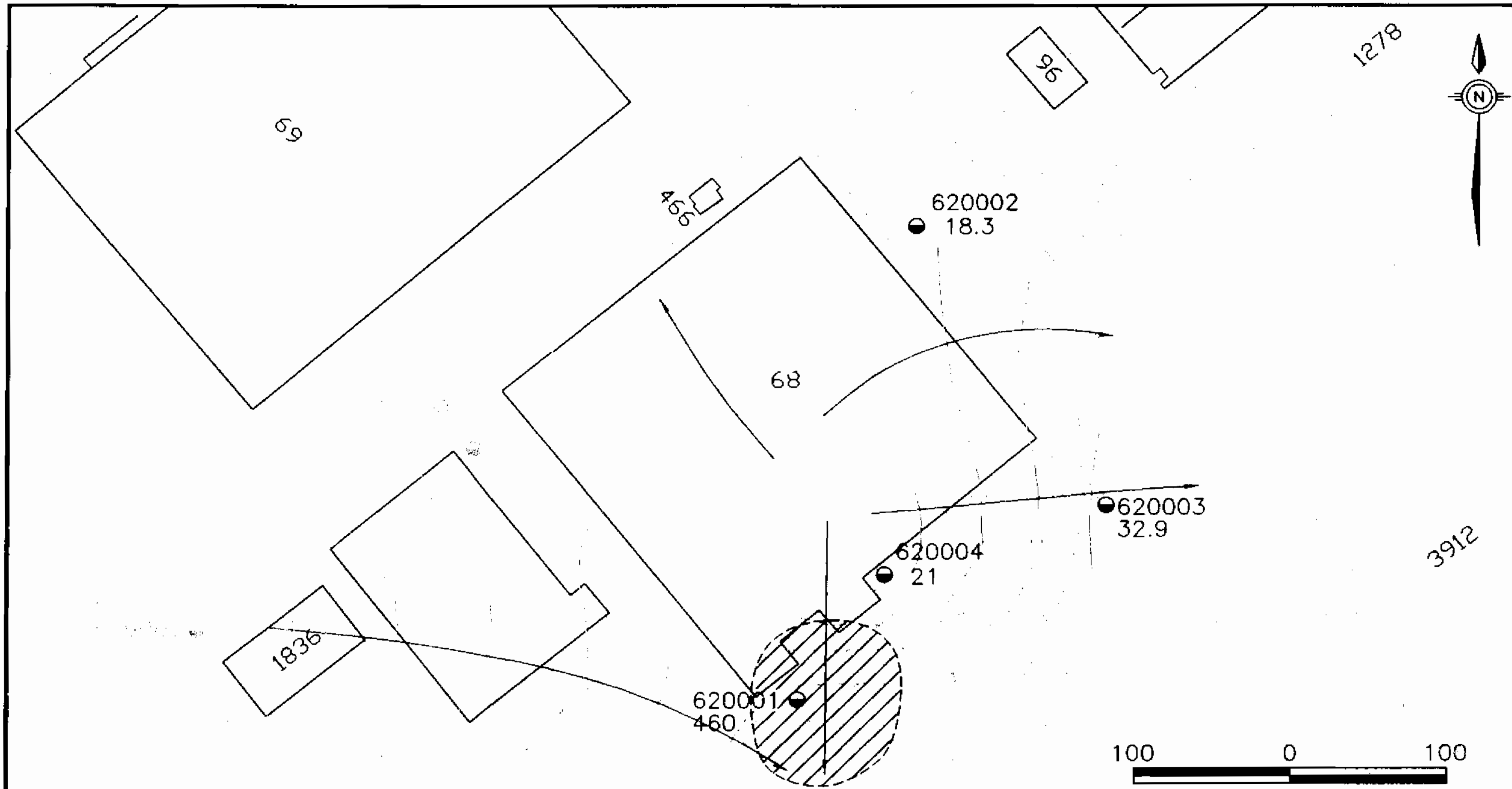
Seventeen metals were detected in AOC 620 groundwater samples. During first quarter sampling, barium and thallium exceeded both their respective tap water RBCs and shallow groundwater background concentrations. Lead and iron exceeded their respective RBCs, but no background concentrations are available for these metals in Zone F groundwater. Figures 10.2-13 through 10.2-15 show the distribution of barium, lead, and thallium in shallow groundwater at the site.

10.2.5 Fate and Transport Assessment for Combined SWMU 36 and AOC 620

Environmental media sampled as part of the combined SWMU 36 and AOC 620 investigation include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated include soil-to-groundwater, groundwater-to-surface water, and emission of volatiles from surface soil to air.

10.2.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.2.9 compares maximum detected organic constituent 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 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).



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 1 FOOT
- < 260 μg/L
- > 260 μg/L
- APPROXIMATE EXTENT

NOTES:
- 260 μg/L = TAP RBC FOR BARIUM (USEPA 1996b)
- RESULTS IN μg/L

ZONE F
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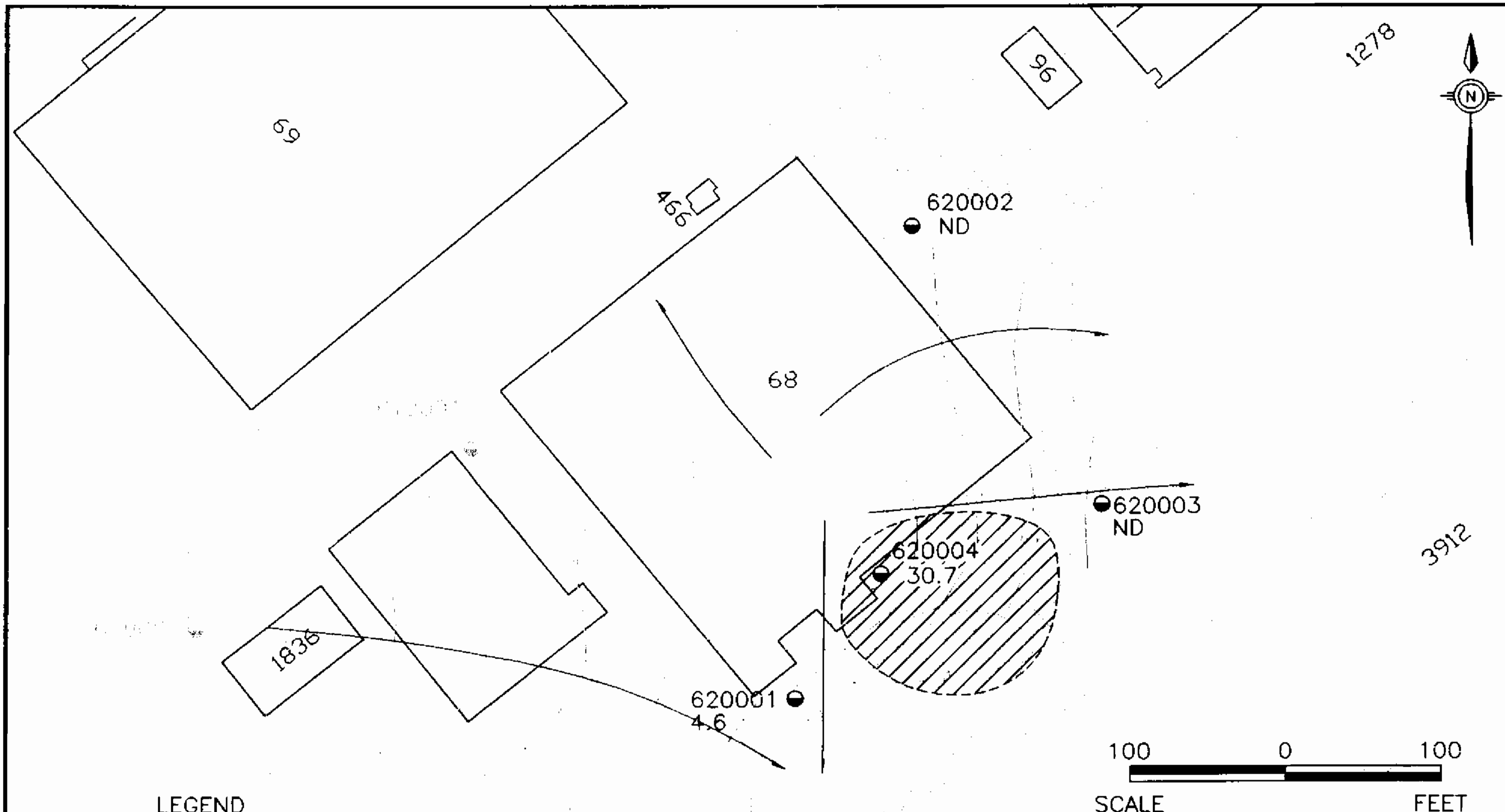
CHARLESTON, S.C.

FIGURE 10.2–13
BARIUM IN SHALLOW GROUNDWATER
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/10/97 | DWG NAME: 2906BRUM



LEGEND

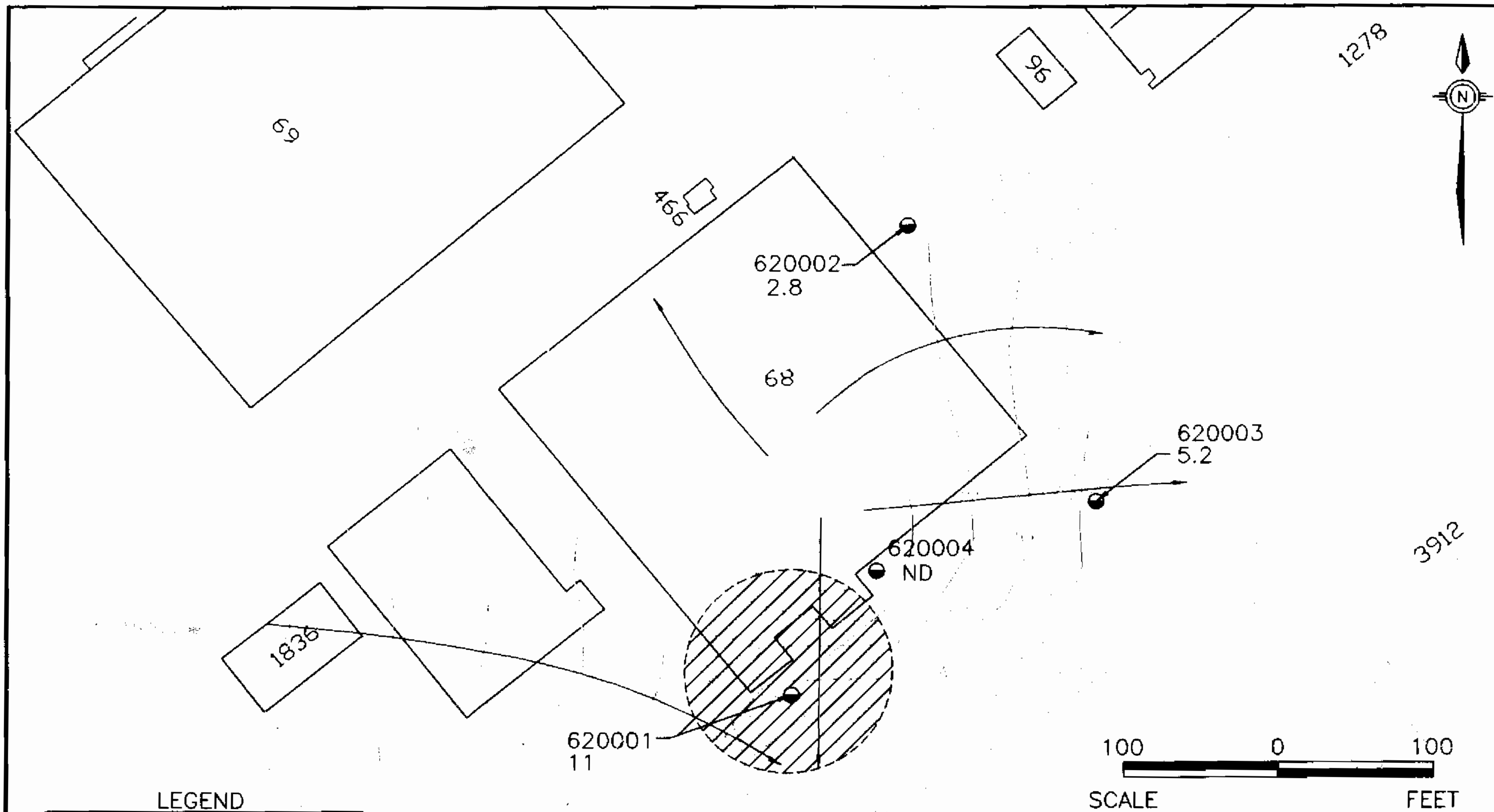
- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 1 FOOT
- < 15 $\mu g/L$
- > 15 $\mu g/L$
- APPROXIMATE EXTENT

NOTES:
- 15 $\mu g/L$ = TAP RBC FOR LEAD (USEPA 1996b)
- RESULTS IN $\mu g/L$

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

FIGURE 10.2–14
LEAD IN SHALLOW GROUNDWATER
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906LISG



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 1 FOOT
- < 5.58 $\mu g/L$
- > 5.58 $\mu g/L$
- APPROXIMATE EXTENT

NOTES:
- 5.58 $\mu g/L$ = BACKGROUND CONCENTRATION FOR THALLIUM IN ZONE F
- RESULTS IN $\mu g/L$
- ND = NOT DETECTED

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

FIGURE 10.2–15
THALLIUM IN SHALLOW GROUNDWATER
SWMU #36 BLDG 68, BATTERY SHOP
AND AOC #620 BATTERY SHOP, BLDG 68

DWG DATE: 12/15/97 | DWG NAME: 2906TISG

Table 10.2.9
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: SWMU 36 and AOC 620
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac 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												
Acetone	42	ND	ND	NA	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	3	10	ND	NA	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
4-Methyl-2-Pentanone (MIBK)	1	ND	ND	NA	12300	2900	NA	UG/KG	UG/L	NO	NO	NO
Trichloroethene	2	ND	ND	NA	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
Xylene (total)	2	ND	ND	NA	142000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthylene	140	ND	ND	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	170	53	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	110	60	3	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	550	140	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	450	110	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	760	140	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	1200	160	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	740	140	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	640	140	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	190	ND	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	500	120	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	44	ND	ND	NA	240000	150	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	1300	ND	ND	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	720	200	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	52	ND	1	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	78	ND	ND	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	2200	ND	NA	1380	180	NA	UG/KG	UG/L	YES	NO	NO
Naphthalene	74	ND	ND	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	420	77	ND	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	620	360	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1254	295	ND	NA	NA	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO
Aroclor-1260	430	ND	NA	NA	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO
alpha-Chlordane	12	ND	NA	NA	10000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	24	3.6	NA	NA	10000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	34	24	NA	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	140	100	NA	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	150	75	NA	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Endrin	5.7	ND	NA	NA	1000	11	0.0023	UG/KG	UG/L	NO	NO	NO
Heptachlor	1.7	ND	NA	NA	23000	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Herbicides												
Dinoseb	41	NA	NA	NA	NA	37	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.882	NA	NA	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	21100	33000	173	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	2.7	1.3	ND	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	31.5	19.9	9.6	NA	29	16.7	36	MG/KG	UG/L	YES	NO	NO
Barium	62.3	43.5	460	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1	1.3	ND	NA	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.69	0.17	0.31	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	43.2	141	2.2	NA	38	180	50	MG/KG	UG/L	YES	NO	NO
Cobalt	5.9	7.9	1.5	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	84.8	43.7	2.5	NA	920	1500	2.9	MG/KG	UG/L	NO	NO	NO

Table 10.2.9
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: SWMU 36 and AOC 620
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac 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
Cyanide	ND	NA	NA	NA	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	2660	127	30.7	NA	400	15	8.5	MG/KG	UG/L	YES	YES	YES
Manganese	277	445	749	NA	1100	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.79	0.52	ND	NA	2	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	14.1	17.1	3.7	NA	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	0.91	1.6	ND	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.33	ND	ND	NA	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Thallium	0.54	0.64	11	NA	1.24	2.9	21.3	MG/KG	UG/L	NO	YES	NO
Vanadium	45.3	82	13.9	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	302	209	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, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 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 reference value.

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
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

One organic — 4-Methylphenol — was detected above its SSL in subsurface soil at one location. Activities at this site would not preclude the presence of this compound, and its distribution may reflect increased mobilization through the soil column associated with a solvent release, or residual soil contamination associated with a smear zone at the soil-groundwater interface. The absence of this compound in downgradient groundwater indicates, however, that if it is leaching its lateral persistence is insignificant at this site. Three inorganics — arsenic, chromium, and lead — were detected above applicable SSLs in surface soil, while only chromium was above its SSL in subsurface soil (notably, the lead screening value is health-risk based, not leachability based; this is an important consideration in that a number of factors affect inorganic leachability. As a result, lead may be present below the risk-based level yet still pose a threat to groundwater). Arsenic and lead both exhibit attenuation as a function of depth, a pattern consistent with a surficial source. Chromium exhibits enrichment with depth at location 620SB007, a factor which suggests either a subsurface source or enhanced mobilization associated with a release. Overall, inorganic exceedances are limited to the interior area of Building 68, and the area immediately to the southeast of this building. The nature of the contamination is consistent with past site activities, and releases involving battery rebuilding and associated acid solutions. Chromium was only slightly above detection in site groundwater; the migration pathway may therefore have merit but the soil does not contain enough residual mass to pose a threat to groundwater. The presence of lead in groundwater also indicates that the migration pathway is valid, but not described well at this site via use of the health-based screening value.

10.2.5.2 Groundwater-to-Surface Water Cross-Media Transport

Table 10.2.9 also 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.

No organic species were detected in groundwater above applicable screening levels. Three inorganic species — barium, lead, and thallium — were detected in shallow groundwater at concentrations exceeding their respective RBC value. Lead was also present above saltwater screening criteria. Thallium was detected in site soil, but at levels below its SSL. This suggests that thallium is leachable at the site at levels below its generic SSL, or that it represents an ambient occurrence. However, assuming it is sourced at the site, and barring thallium enrichment at another downgradient source, it can be expected that thallium will attenuate simply by mechanical dispersion in a short travel distance from the site. The presence of lead is consistent with leaching from site soil; the highest lead in groundwater and soil are collected. The occurrence of lead at significant concentrations is limited to the area near location 620004. While migration of lead at deleterious levels in groundwater is plausible, the migration to receptors is invalid. The surficial groundwater is not used for potable purposes, nor is it planned to be in the future. Therefore, the groundwater migration pathway to human receptors is invalid due to non-use of the resource. The nearest surface water receptor to this site is the Cooper River, approximately 675 feet to the east. Groundwater flow near the area of high lead does have a component of flow to the east. Given the potential for lead to attenuate through adsorption and dispersion, and the zone-specific attributes of the aquifer media (porosity, gradient, mineralogy, and TOC) it is unlikely that lead concentrations that adversely affect ecological receptors would persist to the discharge point. Additionally, discharge at the River would experience significant dilution, attenuating concentrations even further. While the data suggest that the groundwater to surface water migration pathway has merit, they also suggests that the consequent impact, if any, is expected to be insignificant.

10.2.5.3 Soil-to-Air Cross-Media Transport

Table 10.2.10 lists the VOCs detected in surface soil samples collected at SWMU 36 and AOC 620, along with corresponding soil-to-air volatilization screening levels. Two VOCs— MEK and MIBK — were detected in site soil. These SSL values were estimated. However, even assuming that these concentrations pose a potential threat to receptors, the surface soil at the site is largely paved. This invalidates the migration pathway.

10.2.5.4 Fate and Transport Summary

One organic and three inorganic constituent were detected in site soil at concentrations exceeding screening levels. In subsurface soil, these constituents were limited to one organic and one inorganic. Occurrence of contaminants is limited to the Building 68 area and immediately southeast of it. The nature and distribution of contaminants is consistent with past activities at the site. The organic exceedance in soil is not repeated in groundwater, the occurrence of three inorganic exceedances in groundwater is notable. Chromium, which exhibited enrichment at depth, was only slightly above detection in site groundwater. Lead, which experienced significant attenuation with depth and was below health-based SSL in soil, was detected at significant levels in groundwater. The data suggests that chromium transfer to groundwater is insignificant, while lead transfer is significant and not adequately addressed through the use of the screening value. The occurrences of high lead in soil and groundwater are coincident, thereby establishing a clear transfer link. For groundwater, lead and thallium both exceeded applicable RBC values, while only lead exceeded saltwater screening criteria. The low concentration of thallium can be expected to attenuate naturally simply through dispersion over short travel distances. While the same can be expected for lead, attenuation distances may be greater due to higher initial concentrations. The health risk-based pathway for groundwater is invalid due to non-use of the resource. The surface water discharge migration pathway has some merit, however, the distance from the site to the discharge point, the tendency for lead to attenuate, and the dilutional effect

Table 10.2.10
Soil-to-Air Volatilization Screening Analysis
NAVBASE Charleston, Zone F: SWMU 36 and AOC 620
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil-to-Air SSL*	Units	Exceeds SSL
Acetone	42	100000000	UG/KG	NO
2-Butanone (MEK)	3	10000	UG/KG	NO
4-Methyl-2-pentanone (MIBK)	1	10000	UG/KG	NO
Trichloroethene	2	5000	UG/KG	NO
Xylene (total)	2	410000	UG/KG	NO

* - 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.
Values for 2-butanone estimated.

NA - Not available

upon discharge precludes considering this pathway significant. The soil-to-air pathway is inhibited by the presence of pavement overlying surface soil, and is considered insignificant for this site.

10.2.6 Human Health Risk Assessment for SWMU 36 and AOC 620

10.2.6.1 Site Background and Investigative Approach

SWMU 36 is the site of two releases of sulfuric acid down floor drains with subsequent discharge to the soil beneath Building 68. AOC 620 comprises all activities within Building 68 that were related to the battery shop formerly located in the building. For purposes of this risk assessment, the data from these two site were combined. The following text refers to these sites as combined SWMU 36.

During the RFI, a total of 12 soil samples were collected from the upper interval to identify potential impacts resulting from the activities listed above. Subsurface soil samples were collected where feasible. Surface soil data were used to quantitatively assess soil pathways in the HHRA. Four monitoring wells were installed in the shallow aquifer. The two original wells were sampled for VOAs, SVOAs, and metals. The two second-round wells were analyzed for metals. Data from the first quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.2.3 and 10.2.4 provide summaries of the sampling effort for combined SWMU 36 soil and groundwater.

10.2.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.2.11, the focus of this HHRA is on the following COPCs: Aroclor-1254, Aroclor-1260, BEQs, aluminum, arsenic, chromium (assumed to be hexavalent), and lead. Beryllium and manganese were detected at maximum concentrations exceeding their RBCs, however, their maximum concentrations did not exceed their background concentrations.

Table 10.2.11
Chemicals Present in Site Samples
SWMU 36 and AOC 620 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Reference	Units	Number Exceeding RBC	Number Exceeding Ref.
PCBs													
Aroclor-1254	*	1	8	295	295	295	75	110	160	NA	UG/KG	1	
Aroclor-1260	*	3	8	97	430	256	55	110	320	NA	UG/KG	1	
Carcinogenic PAHs													
B(a)P Equiv.	*	9	12	20.13	1173	354	878.18	1247.9	88	NA	UG/KG	7	
Benzo(a)anthracene		9	12	58	450	187	380	540	880	NA	UG/KG		
Benzo(b)fluoranthene	*	7	12	69	1200	341	380	540	880	NA	UG/KG	1	
Chrysene		9	12	58	640	242	380	540	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	4	12	54	190	124	370	540	88	NA	UG/KG	3	
Indeno(1,2,3-cd)pyrene		7	12	59	500	199	380	540	880	NA	UG/KG		
Benzo(k)fluoranthene		9	12	44.5	740	276	380	540	8800	NA	UG/KG		
Benzo(a)pyrene	*	8	12	46.5	760	265	380	540	88	NA	UG/KG	7	
TCDD Equivalents													
Dioxin Equiv.		2	2	0.54	0.88	0.71	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		2	2	28.5	45.6	37.1	NA	NA	NA	NA	NG/KG		
123678-HxCDD		1	2	1.18	1.18	1.18	0.731	0.731	NA	NA	NG/KG		
123789-HxCDD		1	2	0.50	0.50	0.50	0.761	0.761	NA	NA	NG/KG		
OCDD		2	2	252	258	255	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)	*	12	12	34.1	21100	5520	NA	NA	7800	18500	MG/KG	2	1
Antimony (Sb)		6	12	0.53	2.7	1.53	0.35	0.49	3.1	0.79	MG/KG		
Arsenic (As)	*	11	12	1.3	31.5	11.2	0.4	0.4	0.43	19.9	MG/KG	11	3
Barium (Ba)		12	12	8.2	62.3	30.2	NA	NA	550	61.5	MG/KG		
Beryllium (Be)		9	12	0.16	1	0.44	0.07	0.12	0.15	1.05	MG/KG	9	
Cadmium (Cd)		9	12	0.05	0.69	0.30	0.05	0.07	3.9	0.26	MG/KG		
Calcium (Ca)	N	12	12	261	126500	18846	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	12	12	1.4	43.2	14.9	NA	NA	39	34.8	MG/KG	1	1
Cobalt (Co)		12	12	0.43	5.9	2.50	NA	NA	470	15.1	MG/KG		
Copper (Cu)		7	12	4.4	84.8	39.0	0.49	4.8	310	48.2	MG/KG		
Iron (Fe)	N	12	12	197	23900	8410	NA	NA	NA	NA	MG/KG		
Lead (Pb)	*	12	12	9.8	2660	432	NA	NA	400	180	MG/KG	2	3
Magnesium (Mg)	N	12	12	17	2870	955	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		12	12	1	277	88.6	NA	NA	180	307	MG/KG	2	
Mercury (Hg)		10	12	0.09	0.79	0.28	0.04	0.04	2.3	0.62	MG/KG		
Nickel (Ni)		11	12	0.7	14.1	5.52	1	1	160	12.6	MG/KG		
Potassium (K)	N	9	12	128	1590	599	244	316	NA	NA	MG/KG		
Selenium (Se)		6	12	0.37	0.91	0.61	0.34	0.49	39	1.15	MG/KG		
Silver (Ag)		2	12	0.25	0.33	0.29	0.21	0.31	39	1.85	MG/KG		
Sodium (Na)	N	8	12	167	967	350	195	250	NA	NA	MG/KG		
Thallium (Tl)		1	12	0.54	0.54	0.54	0.38	0.56	0.63	NA	MG/KG		
Vanadium (V)		12	12	0.34	45.3	15.9	NA	NA	55	48.9	MG/KG		
Zinc (Zn)		11	12	4.3	302	101	8.1	8.1	2300	198	MG/KG		
Pesticides													
alpha-Chlordane		1	8	12	12	12.0	1.5	2.1	470	NA	UG/KG		
gamma-Chlordane		3	8	2.6	24	10.9	1.5	6.3	470	NA	UG/KG		
4,4'-DDD		3	8	3.2	34	17.4	2.9	4.1	2700	NA	UG/KG		
4,4'-DDE		5	8	4.4	140	49.0	2.9	4.1	1900	NA	UG/KG		
4,4'-DDT		4	8	6.4	150	80.6	2.9	6.5	1900	NA	UG/KG		
Dinoseb		1	2	41	41	41.0	44	44	7800	NA	UG/KG		
Endrin		1	8	5.7	5.7	5.70	2.9	4.1	2300	NA	UG/KG		
Heptachlor		1	8	1.7	1.7	1.70	1.5	2.1	140	NA	UG/KG		

Table 10.2.11
Chemicals Present in Site Samples
SWMU 36 and AOC 620 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		reening Concentratio RBC	Reference	Units	Number Exceeding RBC	Ref.
Semivolatile Organics												
Acenaphthylene	2	12	59	140	99.5	380	540	310000	NA	UG/KG		
Anthracene	4	12	43	170	91.5	380	540	2300000	NA	UG/KG		
Benzo(g,h,i)perylene	8	12	43	550	207	380	540	310000	NA	UG/KG		
Benzoic acid	1	12	110	110	110	1800	2600	3.1E+07	NA	UG/KG		
bis(2-Ethylhexyl)phthalate	1	12	1300	1300	1300	370	1400	46000	NA	UG/KG		
Dibenzofuran	1	12	44	44	44.0	370	540	31000	NA	UG/KG		
Fluoranthene	9	12	61	720	256	380	420	310000	NA	UG/KG		
Fluorene	2	12	44	52	48.0	370	540	310000	NA	UG/KG		
2-Methylnaphthalene	1	12	78	78	78.0	370	540	310000	NA	UG/KG		
Naphthalene	2	12	72	74	73.0	370	540	310000	NA	UG/KG		
Phenanthrene	8	12	46	420	175	380	540	310000	NA	UG/KG		
Pyrene	9	12	76	620	294	380	420	230000	NA	UG/KG		
Volatile Organics												
Acetone	1	9	42	42	42.0	13	140	780000	NA	UG/KG		
2-Butanone	2	9	2	3	2.5	11	20	4700000	NA	UG/KG		
4-Methyl-2-Pentanone	1	9	1	1	1.0	11	16	630000	NA	UG/KG		
Trichloroethene	1	9	2	2	2.0	6	8	58000	NA	UG/KG		
Xylene (Total)	1	9	2	2	2.0	6	8	1.6E+07	NA	UG/KG		

NOTES:

*	Identified as a COPC
N	Essential nutrient
SQL	Sample quantitation limit
MG/KG	milligram per kilogram
UG/KG	microgram per kilgram
NG/KG	nanogram per kilogram
NA	Not applicable

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.

Groundwater

As shown in Table 10.2.12, barium, lead, and thallium were identified as COPCs in shallow groundwater for combined SWMU 36. The Zone F groundwater background value for thallium was exceeded in one sample. Arsenic and manganese were detected in first quarter groundwater samples at maximum concentrations exceeding their tap water RBCs, however, their maximum concentrations did not exceed their background concentrations. There were inadequate groundwater background data to validate Wilcoxon rank sum test analyses, and as a result, this corollary background comparison was not performed.

10.2.6.3 Exposure Assessment

Exposure Setting

Combined SWMU 36 is located in an industrialized setting, approximately 675 feet west of the water front along the Cooper River. The site is surrounded by buildings, roads, railroad right-of-ways, and paved storage/parking areas. These surface coverings would prevent direct contact with soil and would inhibit migration of potential contaminants to groundwater or air. 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. Additional potentially exposed populations are hypothetical future site residents. 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 assumes continuous exposure to surface soil conditions.

Table 10.2.12
Chemicals Present in Site Samples - Groundwater
SWMU 36 and AOC 620
NAVBASE - Charleston
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													
Aluminum (Al)		3	4	62.3	173	123	4	4	3700	224	UG/L		
Arsenic (As)		3	4	5.3	9.6	7.3	1.05	1.05	0.045	16.7	UG/L	3	
Barium (Ba)	*	4	4	18.3	460	133	NA	NA	260	94.3	UG/L	1	1
Cadmium (Cd)		2	4	0.3	0.31	0.31	0.25	0.25	1.8	0.82	UG/L		
Calcium (Ca)	N	4	4	74000	129000	101475	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	4	2.2	2.2	2.2	0.4	0.5	18	2.05	UG/L		1
Cobalt (Co)		1	4	1.5	1.5	1.5	0.4	0.45	220	10.9	UG/L		
Copper (Cu)		1	4	2.5	2.5	2.5	0.3	2.35	150	NA	UG/L		
Iron (Fe)	N	4	4	1850	6880	4273	NA	NA	NA	NA	UG/L		
Lead (Pb)	*	2	4	4.6	30.7	17.7	0.45	0.85	15	NA	UG/L	1	4
Magnesium (Mg)	N	4	4	6200	359000	101425	NA	NA	NA	NA	UG/L		
Manganese (Mn)		4	4	208	749	464	NA	NA	84	2010	UG/L	4	
Nickel (Ni)		1	4	3.7	3.7	3.7	0.35	0.95	73	5.55	UG/L		
Potassium (K)	N	4	4	7070	169000	51468	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	4	4	40900	3460000	936450	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	3	4	2.8	11	6.3	2.5	2.5	0.29	5.58	UG/L	3	1
Vanadium (V)		3	4	1.1	13.9	5.9	0.55	0.55	26	1.58	UG/L		2
Semivolatile Organics													
Benzoic acid		2	2	2	3	2.5	NA	NA	15000	NA	UG/L		
Fluorene		1	2	1	1	1.0	5	5	150	NA	UG/L		

* - Identified as a COPC
N - Essential Nutrient
SQL - Sample quantitation limit
UG/L - micrograms per liter
NA - Not applicable

Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (the entire area is either paved or covered with buildings). Therefore, future worker assessment is considered to be conservatively representative of current site users. 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 are the same as those for the future site worker with respect to soil. Uniform exposure was assumed for all soil sample locations. The groundwater pathway for the hypothetical future site residents is incidental ingestion of groundwater. No VOCs were reported in first-quarter groundwater samples at combined SWMU 36, therefore the inhalation of volatiles pathway was not addressed for this site. Table 10.2.13 presents the justification for exposure pathways assessed in this HHRA.

Table 10.2.13
Exposure Pathways Summary — Combined SWMU 36
NAVBASE — Zone F
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	Little surface soil is exposed at combined SWMU 36, inhibiting fugitive dust generation. Therefore, 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 combined SWMU 36.

Table 10.2.13
Exposure Pathways Summary — Combined SWMU 36
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	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 combined SWMU 36.
	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 combined SWMU 36, inhibiting fugitive dust generation. Therefore, 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 nonresidential water at combined SWMU 36; however, this pathway was included as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not 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.

Table 10.2.13
Exposure Pathways Summary — Combined SWMU 36
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	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

Except for Aroclor-1254 and Aroclor-1260, 95% UCLs were calculated for soil COPCs. These UCLs are presented on Table 10.2.14 and were used as EPCs to estimate exposure to site surface soil. Less than ten surface soil samples were analyzed for Aroclor-1254 and Aroclor-1260, and as a result, maximum detected concentrations were used as exposure point concentrations (EPCs), as discussed in Section 7 of this RFI. Since groundwater COPCs cannot be associated with a specific plume, their maximum concentrations were used as their EPCs.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.2.15 and 10.2.16, respectively.

Groundwater

The CDIs for groundwater ingestion are presented in Table 10.2.17.

Table 10.2.14
Summary of Statistical Analysis
Surface Soil COPCs; SWMU 36 and AOC 620
Naval Base Charleston, Zone F
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
PCBs								
Aroclor-1254	8	NA	NA	NA	NA	0.30	0.30	Max
Aroclor-1260	8	NA	NA	NA	NA	0.43	0.43	Max
Semivolatile Organics								
Benzo(a)pyrene equivalents	12	5.551	1.141	3.182	1.5	1.2	1.2	Max
Inorganics								
Aluminum (Al)	12	7.946	1.654	4.220	90979	21100	21100	Max
Arsenic (As)	12	1.680	1.451	3.797	81	31.5	32	Max
Chromium (Cr)	12	2.245	1.108	3.120	49	43.2	43	Max
Lead (Pb)	12	4.789	1.553	4.008	2621	2660	2621	95% 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 10.2.15
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
PCBs							
Aroclor 1254	1	0.30	4.0E-07	3.8E-06	4.6E-07	1.4E-07	5.2E-08
Aroclor 1260	1	0.43	5.9E-07	5.5E-06	6.7E-07	2.1E-07	7.5E-08
Semivolatile Organics							
Benzo(a)pyrene equivalents	1	1.2	1.6E-06	1.5E-05	1.8E-06	5.7E-07	2.0E-07
Inorganics							
Aluminum (Al)	1	21100	2.9E-02	2.7E-01	3.3E-02	1.0E-02	3.7E-03
Arsenic (As)	1	32	4.3E-05	4.0E-04	4.9E-05	1.5E-05	5.5E-06
Chromium (Cr)	1	43	5.9E-05	5.5E-04	6.8E-05	2.1E-05	7.5E-06
Lead (Pb)	1	2621	3.6E-03	3.4E-02	4.1E-03	1.3E-03	4.6E-04

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 10.2.16
Chronic Daily Intakes
Dermal Contact with Surface Soil
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
PCBs								
Aroclor 1254	1	0.30	0.01	1.7E-07	5.5E-07	1.0E-07	1.2E-07	4.2E-08
Aroclor 1260	1	0.43	0.01	2.4E-07	8.0E-07	1.5E-07	1.7E-07	6.2E-08
Semivolatile Organics								
Benzo(a)pyrene equivalents	1	1.2	0.01	6.6E-07	2.2E-06	4.1E-07	4.7E-07	1.7E-07
Inorganics								
Aluminum (Al)	1	21100	0.001	1.2E-03	3.9E-03	7.4E-04	8.5E-04	3.0E-04
Arsenic (As)	1	32	0.001	1.8E-06	5.8E-06	1.1E-06	1.3E-06	4.5E-07
Chromium (Cr)	1	43	0.001	2.4E-06	8.0E-06	1.5E-06	1.7E-06	6.2E-07
Lead (Pb)	1	2621	0.001	1.5E-04	4.9E-04	9.2E-05	1.1E-04	3.8E-05

NOTES:

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
- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.2.17
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
SWMU 36 and AOC 620
Naval Base Charleston Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics						
Barium	0.46	1.26E-02	2.94E-02	6.93E-03	4.50E-03	2.21E-03
Thallium	0.011	3.01E-04	7.03E-04	1.66E-04	1.08E-04	5.29E-05

NOTES:

lwa	lifetime weighted average
CDI	Chronic Daily Intake
H-CDI	Non-carcinogenic hazard based Chronic Daily Intake
C-CDI	Carcinogenic risk based Chronic Daily Intake

10.2.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.2.18 presents toxicological information specific to each COPC identified at combined SWMU 36. 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.

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation and indicates aluminum could affect the uptake of other chemicals. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen, et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based secondary MCL (SMCL) for drinking water is 50 to 200 μg/L.

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 RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. 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

Table 10.2.18
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 36 and AOC 620
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	*Non-Carcinogenic Toxicity Data* 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	*Carcinogenic Toxicity Data* Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
Aluminum	1	d	NA	NA	NA	NA		NA	NA	NA	NA		NA		NA	NA
Arsenic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
Benzo(a)pyrene equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	6.1	e	B2	mutagen
Barium	0.07	a	M	increased blood pressure	NA	0.000143	b	NA	NA	NA	NA		NA		D	NA
Chromium III	1	a	L	NA	100/10	5.71E-07	e	NA	NA	NA	NA		NA	a	D	NA
Chromium VI	0.005	a	L	NA	500	NA		NA	NA	NA	NA		42	a	A	lung
Lead	NA		NA	NA	NA	NA		NA	NA	NA	NA		NA		B2	various
PCB Aroclor-1254 (soil)	2E-05	a	M	various	NA	NA		NA	NA	NA	2	a	NA		B2	hepatocellular carcinoma
PCB Aroclor-1260 (soil)	NA		NA	NA	NA	NA		NA	NA	NA	2	a	NA		B2	hepatocellular carcinoma
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)
c = HEAST alternative method
d = EPA NCEA - Cincinnati (provisional)
e = Withdrawn from IRIS/HEAST
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

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 1.5 mg/kg-day^{-1} SF. As listed in IRIS the basis for the classification is sufficient evidence from 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. 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.

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. Brazil nuts contain 3 to 4 mg per gram nuts. The fatal absorbed dose of barium is approximately 1,000 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 RfDo and RfDi 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".

Chromium exists in two stable, natural forms: trivalent (III) and hexavalent (VI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS, 1995). Oral RfD values for both forms of chromium are 1.0 and 5E-03 mg/kg-day. For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a SFo of 42 mg/kg/day^{-1} has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS, the classification is base on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

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 RfDo for thallium is 0.00008 mg/kg-day (Klaassen, et al., 1986; Dreisbach, et al., 1987).

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 7.3 mg/kg-day^{-1}. TEF, 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 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 (see Additional Comments for Oral Exposure). 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. The classification reflects 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 presented as the risk per mg/kg-day. The unit risk is the 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.

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. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclors-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen, et al, 1986) (Dreisbach, et al, 1987). USEPA classified PCB Aroclors as group B2 probable human carcinogens, primarily based on animal data. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. The cancer potency of PCB mixtures is determined using a tiered approach. The high risk and persistence tier uses an upper-bound slope factor of 2.0 mg/kg-day^{-1} and is appropriate for food chain exposures, sediment and soil ingestion, dust or aerosol inhalation, and dermal exposure. The low risk and persistence tier uses an upper-bound slope factor of 0.4 mg/kg-day^{-1} and is appropriate for ingestion of water soluble congeners and inhalation of evaporated congeners. The lowest risk and persistence tier uses an upper-bound slope factor of 0.07 mg/kg-day^{-1} and is appropriate for PCB congener mixtures with congeners having more than four chlorines comprising less than 1/2% of the mixture.

10.2.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (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 10.2.19 and 10.2.20 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 ingestion ILCR (based on the adult and child lifetime weighted average) for combined SWMU 36 surface soils is 9E-05. The dermal pathway ILCR is 2E-05. Arsenic and BEQs were the primary contributors to the ingestion and dermal pathways, accounting for close to 80% of the cumulative risk, while Aroclor-1260 was a secondary contributor.

The computed hazard indices for the adult resident was 0.2 for the soil ingestion pathway and 0.05 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 2 and 0.2, respectively. The primary contributor to HI projections is arsenic, accounting for close to 70% of the cumulative HI, with Aroclor-1254, aluminum, and chromium as secondary contributors.

Hypothetical Site Workers

Site worker ILCRs are 1E-05 and 6E-06 for the ingestion and dermal contact pathways, respectively. Arsenic and BEQs were the primary contributors for each pathway. Hazard indices for the ingestion and dermal pathways were projected to be 0.07 and 0.04, respectively, for the hypothetical future site worker scenario.

Table 10.2.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
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
PCBs							
Aroclor 1254	2E-05	2	0.020	0.19	9.2E-07	0.0072	1.0E-07
Aroclor 1260	NA	2	ND	ND	1.3E-06	ND	1.5E-07
Semivolatile Organics							
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	1.3E-05	ND	1.5E-06
Inorganics							
Aluminum (Al)	1	NA	0.029	0.27	ND	0.010	ND
Arsenic (As)	0.0003	1.5	0.14	1.3	7.4E-05	0.051	8.3E-06
Chromium (Cr)	0.005	NA	0.012	0.11	ND	0.0042	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
SUM Hazard Index/ILCR			0.2	2	9E-05	0.07	1E-05

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 10.2.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
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	Current Worker Adult Hazard Quotient	Current Worker Adult ILCR
PCBs								
Aroclor 1254	0.5	1E-05	4	0.017	0.055	4.1E-07	0.012	1.7E-07
Aroclor 1260	0.5	NA	4	ND	ND	6.0E-07	ND	2.5E-07
Semivolatile Organics								
Benzo(a)pyrene equivalent	0.5	NA	14.6	ND	ND	6.0E-06	ND	2.5E-06
Inorganics								
Aluminum (Al)	0.2	0.2	NA	0.0059	0.020	ND	0.0042	ND
Arsenic (As)	0.2	6E-05	7.5	0.029	0.097	8.3E-06	0.021	3.4E-06
Chromium (Cr)	0.2	0.001	NA	0.0024	0.0080	ND	0.0017	ND
Lead (Pb)	0.2	NA	NA	ND	ND	ND	ND	ND
SUM Hazard Index/ILCR				0.05	0.2	2E-05	0.04	6E-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)

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under a residential scenario 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 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 10.2.21 presents the risk and hazard for the ingestion pathway. Since no VOCs were identified as COPCs in groundwater at combined SWMU 36, the inhalation pathway was not addressed at this site.

Hypothetical Site Residents

The hazard indices for the adult and child resident are 9 and 4, respectively. Thallium is the primary contributor to HI projections, accounting for approximately 95% of the cumulative HI. Barium was a secondary contributor to HI projections.

Hypothetical Site Workers

The shallow groundwater hazard index for the ingestion exposure pathway is 1. Thallium is the primary contributor to HI projections for the future site worker scenario.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for combined SWMU 36 or other areas of Zone F. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

Table 10.2.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
SWMU 36 and AOC 620
Naval Base Charleston Zone F
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	0.07	NA	0.18	0.42	ND	0.064	ND
Thallium	8E-05	NA	3.8	8.8	ND	1.3	ND
SUM Hazard Index/ILCR			4	9	ND	1	ND

NOTES:

NA Not available
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Lead Toxicity

Background

Currently, USEPA has not established an oral SF or reference dose for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood levels as low as 10 μg/L.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Uptake/Biokinetics Model (Version 0.99d) (Lead Model) to predict mean blood lead levels in children based on exposure to impacted environmental media. The model was used to assess the potential health effects of elevated lead levels reported in surface soil and groundwater at combined SWMU 36.

Future Residential Scenario

The Lead Model default concentrations are used for exposure to air (0.1 Pb g/m^3) and maternal blood lead level (2.5 Pb per μg/dl). In the case of combined SWMU 36 surface soil, an area of elevated lead concentrations was identified as boring location 620SB004 and the five additional sampling locations surrounding this point (locations 036SB001, 036SB002, 036SB003, 620SB003, and 620SB007). The total area encompassed by these locations is approximately one-half acre. The mean surface soil lead concentration at these sample points (809 mg/kg) was used as the input for soil and house dust. The maximum groundwater concentration of lead (30.7μg/L) was detected in the sample collected from monitoring well 620004 and was used as the input for drinking water. The Lead Model was run for a child ages 0-7 years using the inputs listed above. Table 10.2.22 summarizes the Lead Model results under these exposure conditions.

Table 10.2.22
Lead Model Results - Residential Scenario
SWMU 36 and AOC 620
NAVBASE - Charleston, Zone F
Charleston, South Carolina

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT
DRINKING WATER Conc: 30.70 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	809.0	809.0
1-2	809.0	809.0
2-3	809.0	809.0
3-4	809.0	809.0
4-5	809.0	809.0
5-6	809.0	809.0
6-7	809.0	809.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

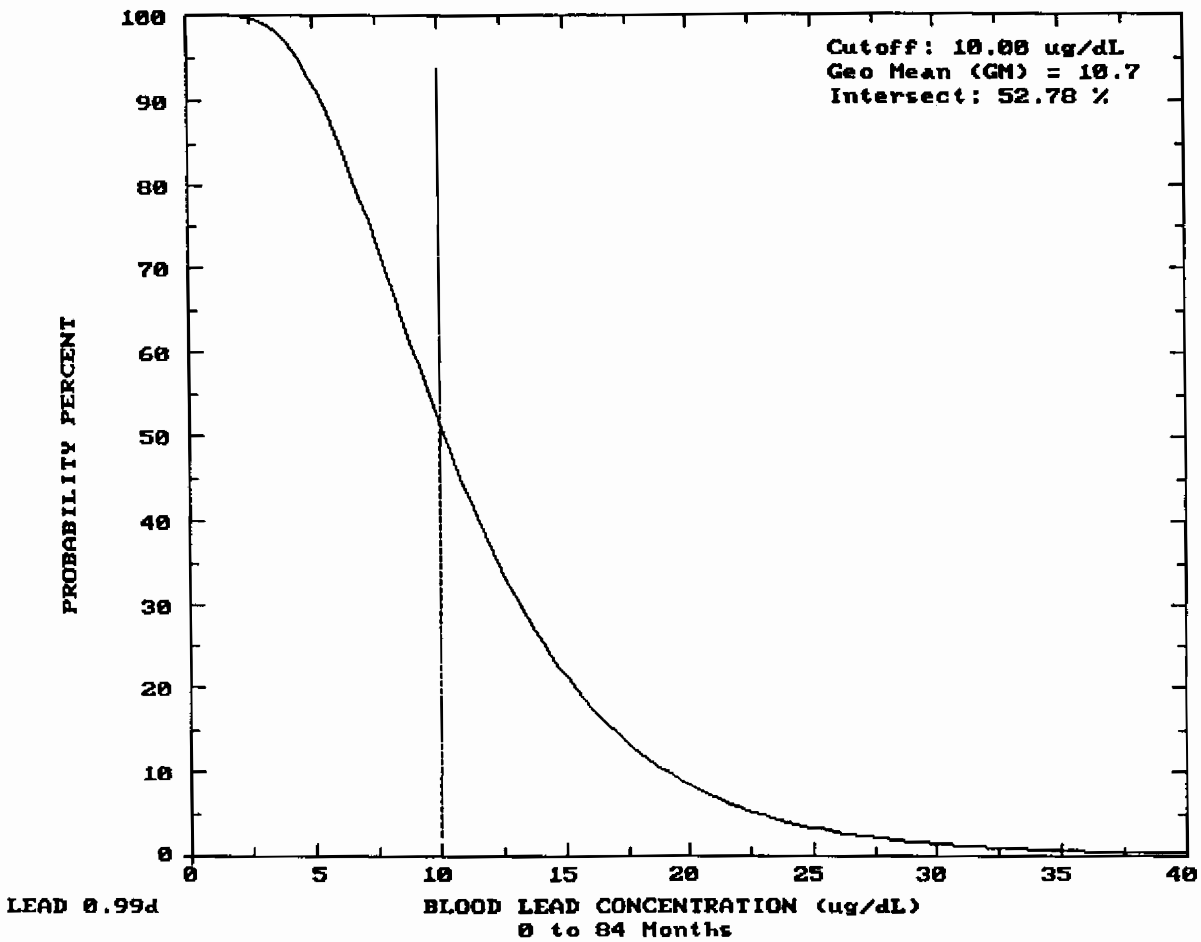
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	10.9	20.76	16.17	2.17	2.41	0.00	0.02
1-2:	13.0	32.32	24.42	2.15	5.72	0.00	0.03
2-3:	12.4	33.94	25.23	2.50	6.15	0.00	0.06
3-4:	12.0	35.05	26.04	2.48	6.47	0.00	0.07
4-5:	10.4	30.22	20.49	2.54	7.13	0.00	0.07
5-6:	9.1	29.42	18.88	2.74	7.70	0.00	0.09
6-7:	8.3	29.17	18.08	3.07	7.94	0.00	0.09

Figure 10.2-16 shows the probability percentage of blood lead levels for a child 0 to 7 years old. Based on this model output using the mean soil lead concentration in the "worst case half-acre" and maximum groundwater results, the geometric mean blood concentrations is estimated to be 10.7 μg/dl, and the probability of blood lead concentration exceeding 10 μg/dl is 52.78%. USEPA generally considers that media concentrations resulting in probability percentage estimates of 5% or less sufficiently protect potential child receptors. As a result, surface soil and/or groundwater lead would require corrective action under this hypothetical exposure scenario.

Future Commercial/Industrial Scenario

In coordination with USEPA Region IV's Office of Health Assessment, a conservative exposure scenario was developed to assess the significance of lead concentrations reported in soil and groundwater samples collected at combined SWMU 36 under an future industrial scenario. This scenario involves a child (age 5 to 6) who gains access to the most heavily contaminated area for one day and is maximally exposed. Additionally, the same child ingests one liter of water drawn from monitoring well 620004. The scenario was based on the proposed future use of this area. Base reuse plans indicate that the area will maintain its current industrial use. The exposure frequency was based on the child accompanying a parent to work at a nearby building on a one-time basis and wandering into the area of contaminated soil. This exposure scenario also assumes that the buildings potable water supply is drawn from the maximally contaminated portion of the shallow aquifer.

Exposure to site soil and groundwater was addressed as an additional exposure relative to typical exposures encountered at the child's place of residence. This additional exposure was presented as an alternate source within the constructs of the Lead Model. The only modification made to standard default assumptions in the lead model was raising the drinking water lead concentration to the treatment technique action level (TTAL) of 15 μg/L. This change was made to provide a conservative estimate of daily intake from sources unrelated to combined SWMU 36.



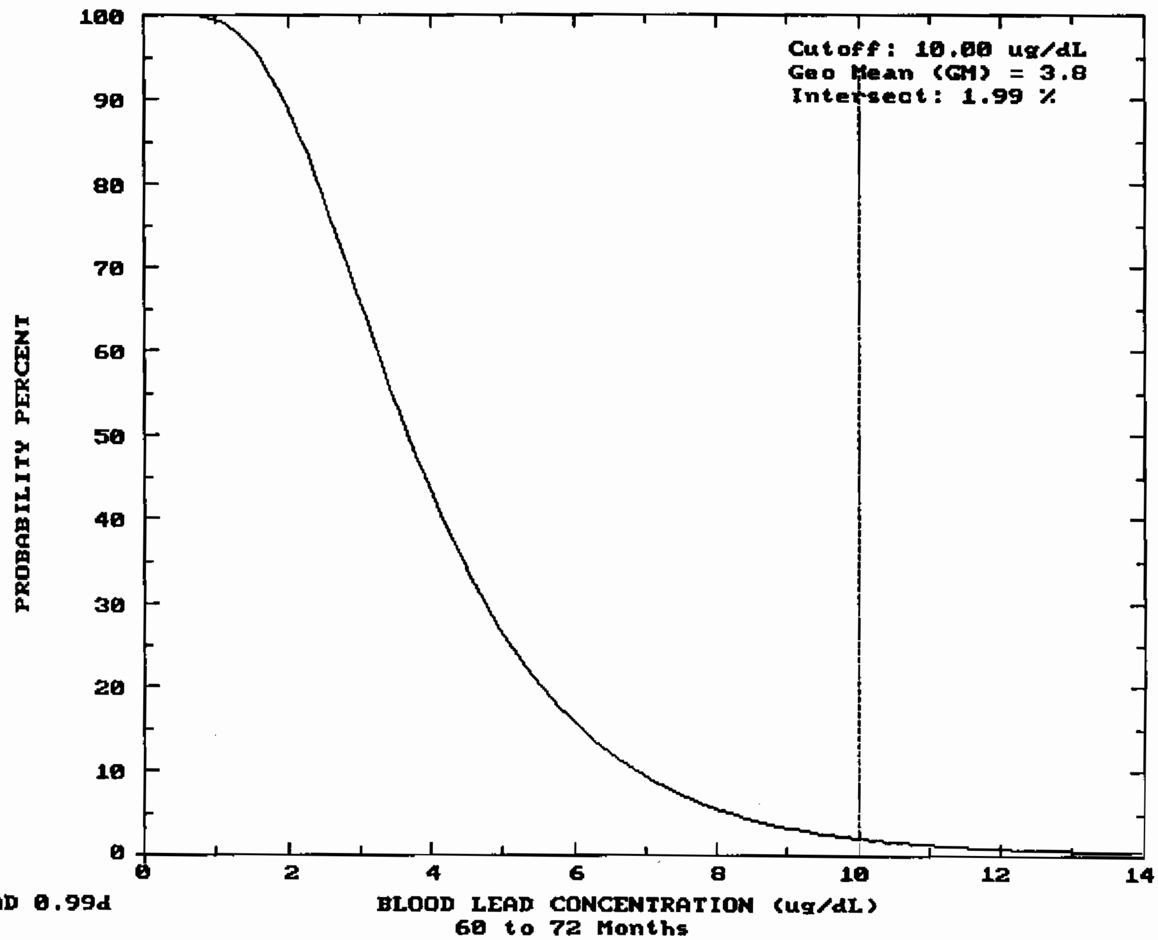
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.2.16
PROBABILITY DISTRIBUTION OF BLOOD LEAD LEVELS FOR CHILD 0-7 YEARS RESIDENTIAL SCENARIO - SWMU 36 AND AOC 620

The assumption was made that this child would ingest 0.1 grams of soil from the most heavily contaminated area and one liter of contaminated groundwater. In the case of combined SWMU 36 surface soil, the lead "hot spot" is represented by borings 036SB001, 036SB002, 036SB003, 620SB003, 620SB004, and 620SB007. The total area encompassed by these locations is approximately one-half acre, and the mean surface soil lead concentration is 809 mg/kg. Additionally, the child would ingest one liter of water from the most heavily contaminated portion of the aquifer (30.7 μg/L). Within the Lead Model, an alternate source was entered to account for exposure to site soil and groundwater as previously discussed. The bioavailability of lead ingested from the alternate source was equal to that of lead ingested through water consumption from the standard residential default source. The annual alternate source exposure was estimated to be 0.3 μg lead/day. Table 10.2.23 summarizes the Lead Model results under these exposure conditions.

Figure 10.2-17 shows the probability percentage of blood lead levels for a child 5 to 6 years old. Based on this model output, the geometric mean blood level is estimated to be 3.8 μg/dl, and the probability of blood lead levels in excess of 10 μg/dl is 1.99%. USEPA generally considers media concentrations that result in probability percentage estimates of 5% or less sufficiently protective of potential child receptors. As a result, neither surface soil nor groundwater lead at combined SWMU 36 would require specific action under this hypothetical future exposure scenario. However, the concentration of lead reported for two surface soil samples (620SB001 and 620SB004) exceeded the its adult screening level (1,300 mg/kg).

Current exposure to child receptors is highly unlikely at combined SWMU 36 due to the industrialized nature of the area. Current exposure to site workers is limited to soil pathways only since groundwater is not currently used to provide potable or process water. Direct contact to lead contaminated soil is currently prevented for much of combined SWMU 36 due to surface coverings such as building and pavement.



ZONE F
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NAVAL BASE CHARLESTON

FIGURE 10.2.17
PROBABILITY DISTRIBUTION OF BLOOD LEAD LEVELS FOR CHILD 5-6 YEARS COMM./INDUST. SCENARIO - SWMU 36 AND AOC 620

Table 10.2.23
Lead Model Results - Commercial/Industrial Scenario
SWMU 36 and AOC 620
NAVBASE - Charleston, Zone F
Charleston, South Carolina

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT
DRINKING WATER Conc: 15.00 ug Pb/L WATER Consumption: DEFAULT

SOIL & DUST - Soil: constant conc. Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

Alternative Source Intake: varied by year as follows:
0-1: 0.00 ug Pb/day
1-2: 0.00 ug Pb/day
2-3: 0.00 ug Pb/day
3-4: 0.00 ug Pb/day
4-5: 0.00 ug Pb/day
5-6: 0.30 ug Pb/day
6-7: 0.00 ug Pb/day

MATERNAL CONTRIBUTION: Infant Model Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	4.6	8.52	4.63	2.51	1.36	0.00	0.02
1-2:	5.4	13.16	7.21	2.57	3.34	0.00	0.03
2-3:	5.1	13.81	7.30	2.93	3.52	0.00	0.06
3-4:	4.9	13.97	7.41	2.85	3.64	0.00	0.07
4-5:	4.3	12.34	5.61	2.81	3.86	0.00	0.07
5-6:	3.8	12.40	5.09	2.99	4.10	0.14	0.09
6-7:	3.5	12.42	4.83	3.31	4.19	0.00	0.09

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 in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.2.24 presents the COCs identified for combined SWMU 36 surface soil and shallow groundwater.

Surface Soils

Future Site Residents

Arsenic, Aroclor-1260, and BEQs were identified as the soil pathway COCs based on their contribution to cumulative ILCR projections. Aluminum, arsenic, Aroclor-1254, and chromium (assumed to be hexavalent) were identified as soil pathway COCs based on their contribution to cumulative HI projections. Chromium was identified as a COC based on the assumption that it exists in the hexavalent state. This is a highly conservative assumption as chromium in the trivalent state is generally predominant. This issue is further discussed in the uncertainty section. Lead was also identified as a soil COC based on the output of the lead model with respect to the hypothetical child resident.

Table 10.2.24
Summary of Risk and Hazard-based COCs
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental	**PCBs**						
	Ingestion	Aroclor 1254	0.020	0.19	9.2E-07	0.0072	1.0E-07	1
		Aroclor 1260	ND	ND	1.3E-06	ND	1.5E-07	2
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	1.3E-05	ND	1.5E-06	2 4
		Inorganics						
		Aluminum (Al)	0.029	0.27	ND	0.010	ND	1
		Arsenic (As)	0.14	1.3	7.4E-05	0.051	8.3E-06	1 2 4
		Chromium (Cr)	0.012	0.11	ND	0.0042	ND	1
		Lead (Pb)	ND	ND	ND	ND	ND	
	Dermal	**PCBs**						
		Aroclor 1254	0.017	0.055	4.1E-07	0.012	1.7E-07	
		Aroclor 1260	ND	ND	6.0E-07	ND	2.5E-07	
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	6.0E-06	ND	2.5E-06	2 4
		Inorganics						
		Aluminum (Al)	0.0059	0.020	ND	0.0042	ND	
		Arsenic (As)	0.029	0.097	8.3E-06	0.021	3.4E-06	2 4
		Chromium (Cr)	0.0024	0.0080	ND	0.0017	ND	
		Lead (Pb)	ND	ND	ND	ND	ND	
Surface Soil Pathway Sum			0.3	2	1E-04	0.1	2E-05	
Groundwater	Ingestion	**Inorganics**						
		Barium (Ba)	0.18	0.42	ND	0.064	ND	1
		Thallium (Tl)	3.8	8.8	ND	1.3	ND	1 3
Groundwater Pathway Sum			4	9	ND	1	ND	
Sum of All Pathways			4	11	1E-04	1.5	2E-05	

Notes:

ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1 Chemical is a COC by virtue of projected child residence noncarcinogenic 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 noncarcinogenic hazard.
4 Chemical is a COC by virtue of projected site worker ILCR.

Future Site Workers

Arsenic and BEQs were identified as the 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 identified above. Aluminum was detected above its residential RBC in only two of 12 surface soil samples. Arsenic was detected above its residential RBC in 11 of 12 surface soil samples; however, it was only detected in two samples above its background concentration. Chromium was detected above its residential RBC for the hexavalent species in only one of 12 surface soil samples; its mean detected concentration (14.9 mg/kg) was below the RBC for its hexavalent species (39 mg/kg). BEQs were detected above the residential RBC in seven of 12 surface soil samples. Elevated BEQs were identified in surface soil sample 620SB008, otherwise concentrations were lower for the rest of the site. Elevated concentrations of Aroclor-1254 and Aroclor-1260 were reported in surface soil sample 620SB004. Aroclor-1254 was not detected in any other surface soil sample and Aroclor-1260 was detected in two additional surface soil samples (620SB001 and 620SB003).

First Quarter Groundwater

Barium was detected at a concentration exceeding its tap water RBC in only one of four first quarter groundwater samples. Thallium exceeded its tap water RBC in all three of the first quarter groundwater samples in which it was detected. Thallium exceeded its background value in one first-quarter groundwater sample.

10.2.6.6 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 this area of Zone F. If this area were used as a residential site, the buildings 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 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 combined SWMU 36 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone F. This system is slated to remain in operation under the current base reuse plan. As a result, groundwater is not 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

Either a 95% UCL or a maximum detected soil constituent concentration was used as the EPC for COPCs identified for this site. Use of 95% UCLs and maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely for the true mean

COPC concentrations exceed these point estimates. Since it was impossible to define a barium plume with only one monitoring well, groundwater hazard was calculated using the maximum concentration of barium as the EPC. This is a conservative assumption since the barium concentrations in groundwater samples collected from the other three monitoring wells were much lower. Since there were only four groundwater sample points for thallium, the maximum thallium concentration was used as its EPC as well. This is also a conservative approach since thallium was not detected in any second quarter groundwater sample. Use of maximum concentrations as EPCs provides an overestimation of hazard since the average groundwater concentration over time is likely to be much lower than the maximum first quarter concentration.

Frequency of Detection and Spatial Distribution

Aluminum (12 of 12), arsenic (11 of 12), and chromium (12 of 12) were detected frequently in surface soil samples. However, concentrations of these COCs exceeding background were only reported in surface soil samples 620SB008 (aluminum, arsenic, and chromium), and 620SB007 (arsenic only). Aroclor-1254 was only detected in one surface soil sample above its residential RBC and Aroclor-1260 was only detected above its residential RBC in one surface soil sample. Aroclor-1260 was only detected in two other surface soil samples at concentrations well below it residential RBC. BEQ compounds were detected above risk-based concentrations in 7 of 12 surface soil samples; however, background levels of BEQs at NAVBASE have also exceeded risk-based concentrations. Additionally, many of the soil sample locations were situated near or underneath asphalt, which may explain the presence of this group of constituents.

Thallium was detected in three first quarter groundwater samples at concentrations exceeding its tap water RBC and was not detected in any second quarter groundwater samples. Thallium was reported in samples collected from Zone F background wells at concentrations ranging from 4.8 to 6.6 μg/L. Thallium concentrations reported for first quarter groundwater samples ranged from 2.8 to 11 μg/L. These findings suggest that the occurrence of thallium in the surficial aquifer is common in Zone F. Barium was detected in first and second quarter groundwater sample collected from 620001 at a concentration above its tap water RBC but was not reported at concentrations exceeding its RBC in the remaining three wells (through the second quarter sampling event).

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.

Soil

A conservative screening process was used to identify COPCs for combined SWMU 36. 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). Chromium was carried through the risk assessment using the toxicity parameters for the hexavalent species, which would tend to overestimate hazard projections if in fact the trivalent species is predominant for combined SWMU 36 soil. Two surface soil samples were analyzed for hexavalent chromium both of which reported nondetects for hexavalent chromium. This would suggest that most of the chromium exists as trivalent chromium. Beryllium and manganese were eliminated from consideration in the HHRA based on comparison of their maximum detected concentrations to their background concentrations, even though their maximum concentrations exceeded their RBCs. Wilcoxon rank sum test analysis confirmed that site concentrations of these elements were consistent with background concentrations.

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). Arsenic and manganese were eliminated from consideration in the HHRA since their maximum concentrations did not exceed their background concentrations. No Wilcoxon rank sum test analyses was performed since their were too few background groundwater samples to provide meaningful results.

Groundwater is not currently used as a potable water source at combined SWMU 36, 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.

10.2.6.7 Risk Summary

The risk and hazard posed by contaminants at combined SWMU 36 were assessed for the future site worker and the future site resident under RME assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed. The groundwater pathway was based on ingestion of shallow groundwater represented by first quarter groundwater data. Table 10.2.25 presents the risk summary for each soil pathway/receptor group evaluated for combined SWMU 36.

Table 10.2.25
Summary of Risk and Hazard
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.2	2	9E-05	0.07	1E-05
	Dermal Contact	0.05	0.2	2E-05	0.04	6E-06
Sum of Soil Pathways		0.3	2	1E-04	0.1	2E-05
Groundwater	Ingestion	4	9	ND	1.4	ND
Sum of Groundwater Pathways		4	9	ND	1.4	ND
Sum of All Pathways		4	11	1E-04	1.5	2E-05

NOTES:

ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

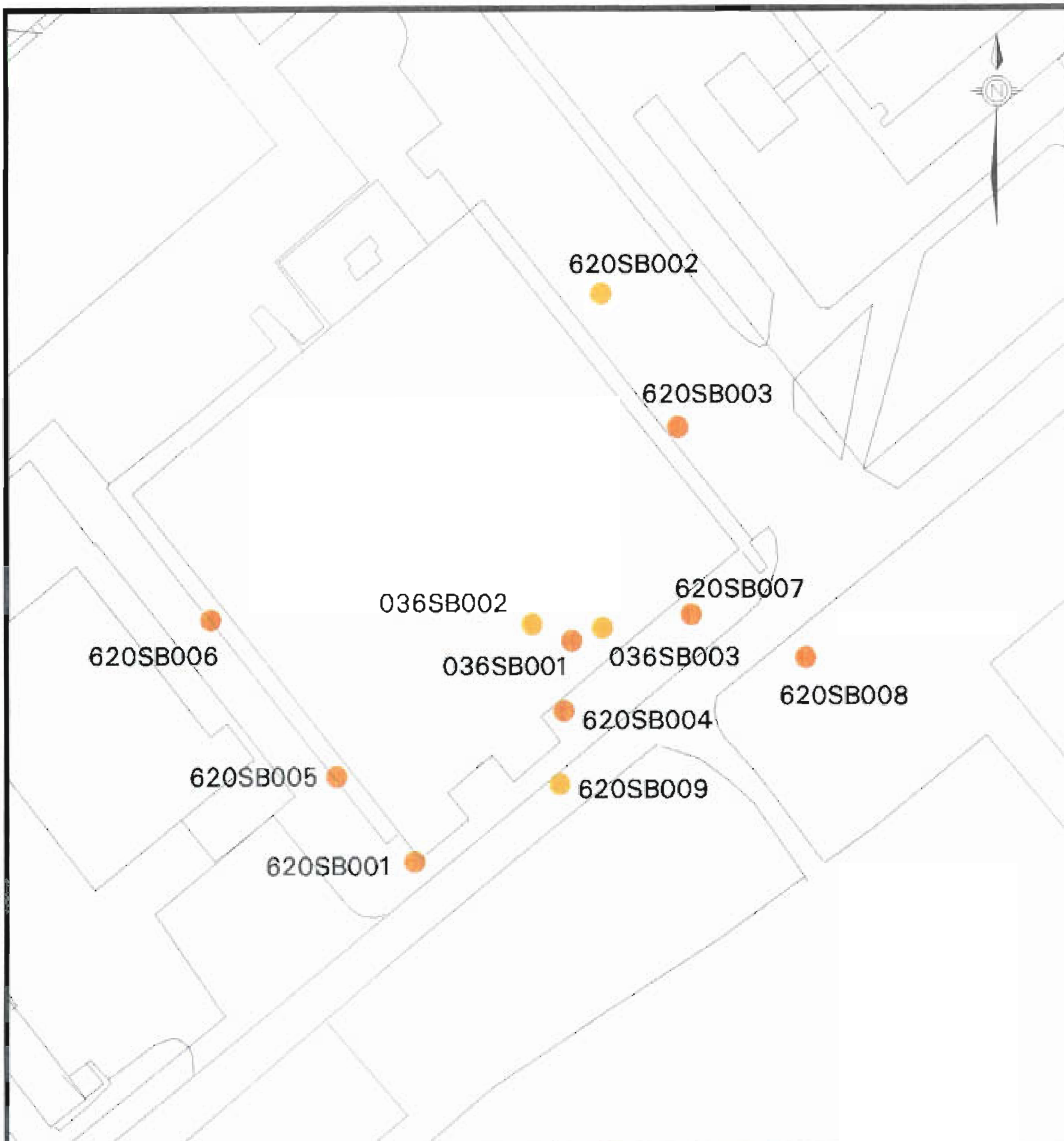
Soil — Residential Scenario

Residential soil pathway COCs identified for combined SWMU 36 include Aroclor-1254, Aroclor-1260, aluminum, arsenic, BEQs, and chromium. Figures 10.2-18 and 10.2-19 illustrate point risk and hazard indices for combined SWMU 36 surface soil under a future residential scenario. Table 10.2.26 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.

Arsenic and BEQs, both of which were identified as COCs in the formal risk assessment, are the predominant contributors to risk estimates above 1E-06 at all surface soil sample locations. Aroclor-1254 and Aroclor-1260, also identified as COCs, were secondary contributors to risk projections at sample locations 620SB003 and 620SB004. Risk estimates ranged from 6E-06 (036SB002, 036SB003, and 620SB002) to 8E-05 (620SB007). Hazard indices exceed unity at three sample locations, 620SB004, 620SB007, and 620SB008, driven mostly by arsenic.

Soil — Site Worker Scenario

Site Worker soil pathway COCs identified for combined SWMU 36 include arsenic and BEQs. Figure 10.2-20 illustrates point risk estimates for combined SWMU 36 surface soil under a future industrial (site worker) scenario. Table 10.2.27 summarizes the risk and hazard contribution of each COPC at each sample location. Industrial risks ranged from 8E-07 (620SB002) to 1E-05 (620SB007 and 620SB008) due to the reported concentrations of arsenic and BEQs. Hazard indices for the site worker scenario do not exceed unity at any sample location.

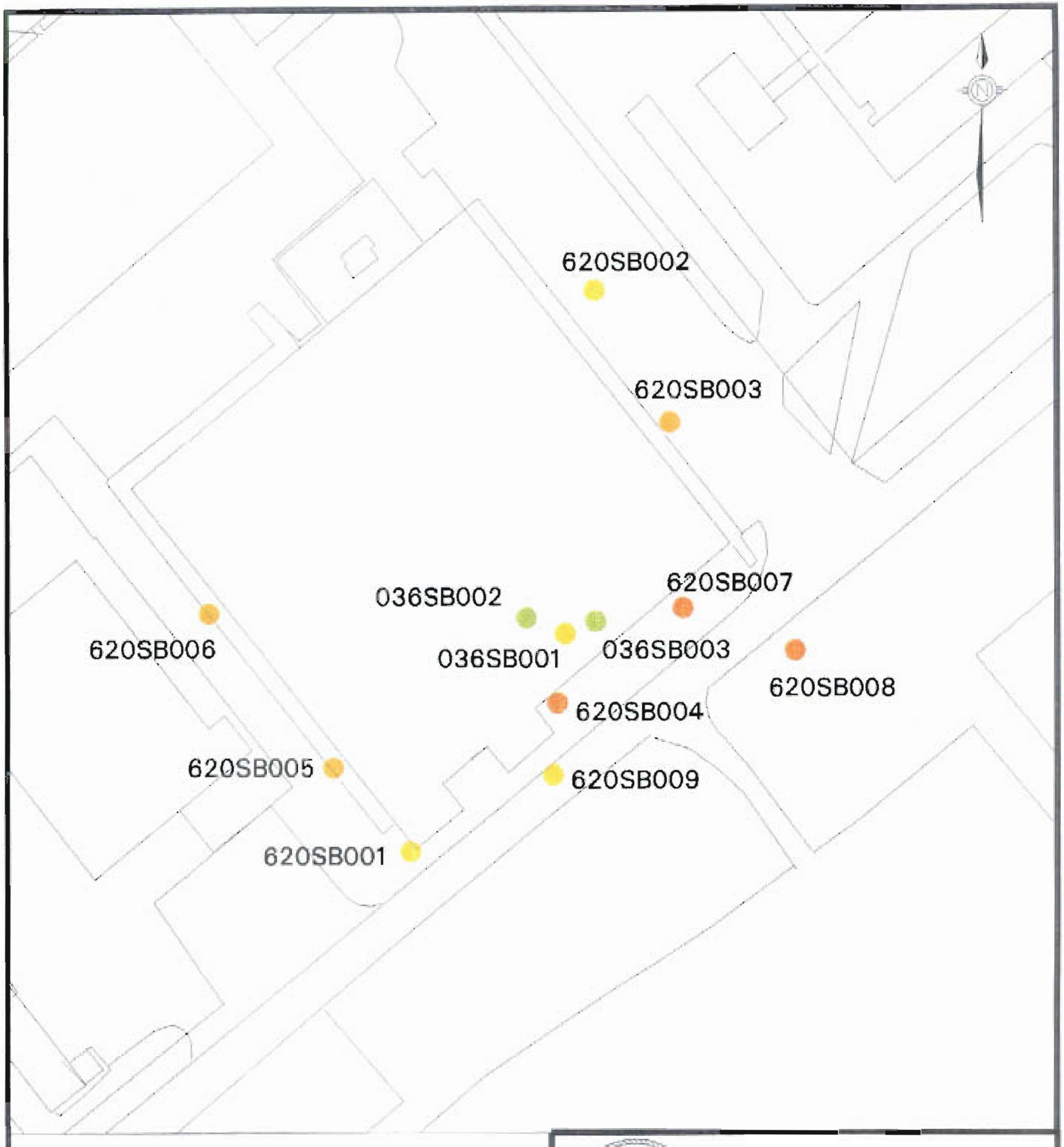


LEGEND
NO COPCs DETECTED
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4

0 feet 150

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

FIGURE 10.2.18
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 36, AOC 620



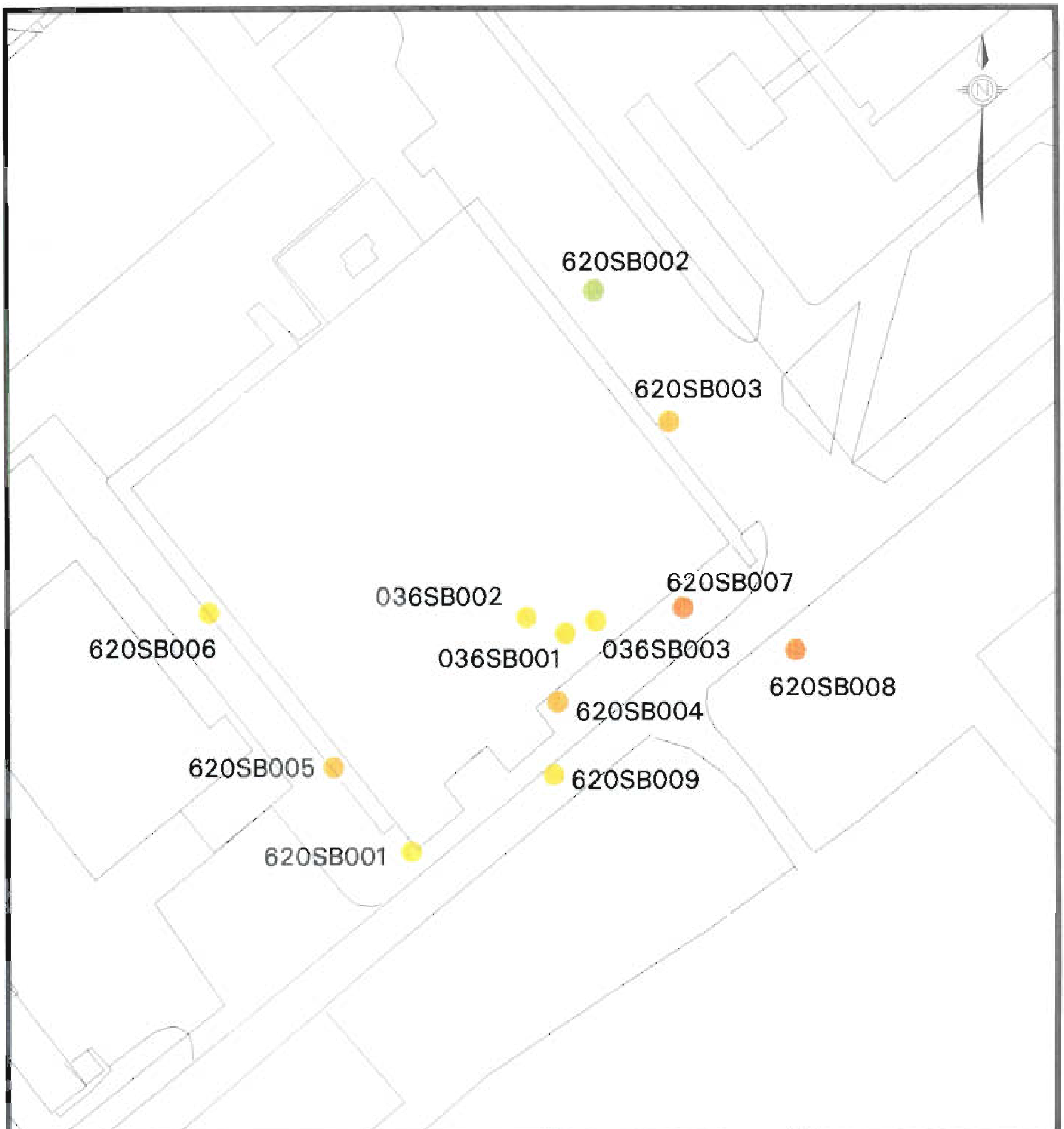
LEGEND

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

0 feet 150

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

FIGURE 10.2.19
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 36, AOC 620



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 150

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

FIGURE 10.2.20
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
SWMU 36, AOC 620

Table 10.2.26
Point Estimates of Risk and Hazard - Soil Pathways
Residential Scenario
SWMU 36 and AOC 620
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
036	001	Aluminum (Al)	768	MG/KG	0.0105	8.61	NA	
036	001	Arsenic (As)	2.3	MG/KG	0.1051	86.00	6.0076	35.44
036	001	B(a)P Equiv.	660.99	UG/KG	NA		10.9462	64.56
036	001	Chromium (Cr)	2.4	MG/KG	0.0066	5.38	NA	
036	001	Lead (Pb)	1600	MG/KG	NA		NA	
		Total			0.1222		16.9538	
036	002	Aluminum (Al)	1060	MG/KG	0.0145	17.99	NA	
036	002	Arsenic (As)	1.3	MG/KG	0.0594	73.53	3.3956	55.48
036	002	B(a)P Equiv.	164.54	UG/KG	NA		2.7248	44.52
036	002	Chromium (Cr)	2.5	MG/KG	0.0069	8.48	NA	
036	002	Lead (Pb)	69.6	MG/KG	NA		NA	
		Total			0.0808		6.1204	
036	003	Aluminum (Al)	34.1	MG/KG	0.0005	10.86	NA	
036	003	Arsenic (As)	ND	MG/KG	NA		NA	
036	003	B(a)P Equiv.	357.08	UG/KG	NA		5.9134	100.00
036	003	Chromium (Cr)	1.4	MG/KG	0.0038	89.14	NA	
036	003	Lead (Pb)	70.3	MG/KG	NA		NA	
		Total			0.0043		5.9134	
620	001	Aluminum (Al)	4105	MG/KG	0.0563	13.00	NA	
620	001	Aroclor-1254	ND	UG/KG	NA		NA	
620	001	Aroclor-1260	97	UG/KG	NA		0.4401	2.07
620	001	Arsenic (As)	7.6	MG/KG	0.3474	80.25	19.8512	93.29
620	001	B(a)P Equiv.	59.703	UG/KG	NA		0.9887	4.65
620	001	Chromium (Cr)	10.65	MG/KG	0.0292	6.75	NA	
620	001	Lead (Pb)	45.1	MG/KG	NA		NA	
		Total			0.4329		21.2800	
620	002	Aluminum (Al)	2340	MG/KG	0.0321	21.42	NA	
620	002	Aroclor-1254	ND	UG/KG	NA		NA	
620	002	Aroclor-1260	ND	UG/KG	NA		NA	
620	002	Arsenic (As)	2.3	MG/KG	0.1051	70.16	6.0076	100.00
620	002	B(a)P Equiv.	ND	UG/KG	NA		NA	
620	002	Chromium (Cr)	4.6	MG/KG	0.0126	8.42	NA	
620	002	Lead (Pb)	47.9	MG/KG	NA		NA	
		Total			0.1498		6.0076	
620	003	Aluminum (Al)	3950	MG/KG	0.0542	7.64	NA	
620	003	Aroclor-1254	ND	UG/KG	NA		NA	
620	003	Aroclor-1260	240	UG/KG	NA		1.0889	2.75
620	003	Arsenic (As)	13.1	MG/KG	0.5988	84.50	34.2172	86.34
620	003	B(a)P Equiv.	261.13	UG/KG	NA		4.3244	10.91
620	003	Chromium (Cr)	20.3	MG/KG	0.0557	7.86	NA	
620	003	Lead (Pb)	166	MG/KG	NA		NA	
		Total			0.7086		39.6305	
620	004	Aluminum (Al)	6880	MG/KG	0.0943	8.70	NA	
620	004	Aroclor-1254	295	UG/KG	0.2433	22.44	1.3384	2.75
620	004	Aroclor-1260	430	UG/KG	NA		1.9509	4.00
620	004	Arsenic (As)	15.05	MG/KG	0.6879	63.46	39.3106	80.65
620	004	B(a)P Equiv.	370.93	UG/KG	NA		6.1427	12.60
620	004	Chromium (Cr)	21.3	MG/KG	0.0584	5.39	NA	
620	004	Lead (Pb)	2660	MG/KG	NA		NA	
		Total			1.0839		48.7427	
620	005	Aluminum (Al)	8420	MG/KG	0.1155	13.42	NA	
620	005	Aroclor-1254	ND	UG/KG	NA		NA	
620	005	Aroclor-1260	ND	UG/KG	NA		NA	
620	005	Arsenic (As)	15.2	MG/KG	0.6948	80.75	39.7024	100.00
620	005	B(a)P Equiv.	ND	UG/KG	NA		NA	

620	005	Chromium (Cr)	18.3	MG/KG	0.0502	5.83	NA	
620	005	Lead (Pb)	78.9	MG/KG	NA		NA	
		Total			0.8604		39.7024	
620	006	Aluminum (Al)	5200	MG/KG	0.0713	14.10	NA	
620	006	Arsenic (As)	8.8	MG/KG	0.4022	79.55	22.9856	100.00
620	006	B(a)P Equiv.	ND	UG/KG	NA		NA	
620	006	Chromium (Cr)	11.7	MG/KG	0.0321	6.35	NA	
620	006	Lead (Pb)	9.8	MG/KG	NA		NA	
		Total			0.5056		22.9856	
620	007	Aluminum (Al)	5950	MG/KG	0.0816	5.05	NA	
620	007	Aroclor-1254	ND	UG/KG	NA		NA	
620	007	Aroclor-1260	ND	UG/KG	NA		NA	
620	007	Arsenic (As)	31.5	MG/KG	1.4398	89.16	82.2780	97.64
620	007	B(a)P Equiv.	120.24	UG/KG	NA		1.9912	2.36
620	007	Chromium (Cr)	34.1	MG/KG	0.0935	5.79	NA	
620	007	Lead (Pb)	287	MG/KG	NA		NA	
		Total			1.6149		84.2692	
620	008	Aluminum (Al)	21100	MG/KG	0.2893	20.08	NA	
620	008	Aroclor-1254	ND	UG/KG	NA		NA	
620	008	Aroclor-1260	ND	UG/KG	NA		NA	
620	008	Arsenic (As)	22.6	MG/KG	1.0330	71.70	59.0312	75.24
620	008	B(a)P Equiv.	1173.04	UG/KG	NA		19.4259	24.76
620	008	Chromium (Cr)	43.2	MG/KG	0.1185	8.22	NA	
620	008	Lead (Pb)	88.9	MG/KG	NA		NA	
		Total			1.4408		78.4571	
620	009	Aroclor-1260	ND	UG/KG	NA		NA	
620	009	Arsenic (As)	2.9	MG/KG	0.1326	84.45	7.5748	95.78
620	009	B(a)P Equiv.	20.13	UG/KG	NA		0.3334	4.22
620	009	Chromium (Cr)	8.9	MG/KG	0.0244	15.55	NA	
620	009	Lead (Pb)	61.9	MG/KG	NA		NA	
		Total			0.1570		7.9082	

Table 10.2.27
Point Estimates of Risk and Hazard - Soil Pathways
Industrial Scenario
SWMU 36 and AOC 620
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
036	001	Arsenic (As)	2.3	MG/KG	0.0053	100.00	0.8499	27.63
036	001	B(a)P Equiv.	660.99	UG/KG	NA		2.2256	72.37
036	001	Lead (Pb)	1600	MG/KG	NA		NA	
		Total			0.0053		3.0755	
036	002	Arsenic (As)	1.3	MG/KG	0.0030	100.00	0.4804	46.44
036	002	B(a)P Equiv.	164.54	UG/KG	NA		0.5540	53.56
036	002	Lead (Pb)	69.6	MG/KG	NA		NA	
		Total			0.0030		1.0344	
036	003	Arsenic (As)	0	MG/KG	NA		NA	
036	003	B(a)P Equiv.	357.08	UG/KG	NA		1.2023	100.00
036	003	Lead (Pb)	70.3	MG/KG	NA		NA	
		Total			NA		1.2023	
620	001	Arsenic (As)	7.6	MG/KG	0.0175	100.00	2.8083	93.32
620	001	B(a)P Equiv.	59.703	UG/KG	NA		0.2010	6.68
620	001	Lead (Pb)	45.1	MG/KG	NA		NA	
		Total			0.0175		3.0093	
620	002	Arsenic (As)	2.3	MG/KG	0.0053	100.00	0.8499	100.00
620	002	B(a)P Equiv.	0	UG/KG	NA		NA	
620	002	Lead (Pb)	47.9	MG/KG	NA		NA	
		Total			0.0053		0.8499	
620	003	Arsenic (As)	13.1	MG/KG	0.0301	100.00	4.8405	84.63
620	003	B(a)P Equiv.	261.13	UG/KG	NA		0.8793	15.37
620	003	Lead (Pb)	166	MG/KG	NA		NA	
		Total			0.0301		5.7198	
620	004	Arsenic (As)	15.05	MG/KG	0.0346	100.00	5.5611	81.66
620	004	B(a)P Equiv.	370.93	UG/KG	NA		1.2490	18.34
620	004	Lead (Pb)	2660	MG/KG	NA		NA	
		Total			0.0346		6.8101	
620	005	Arsenic (As)	15.2	MG/KG	0.0349	100.00	5.6165	100.00
620	005	B(a)P Equiv.	0	UG/KG	NA		NA	
620	005	Lead (Pb)	78.9	MG/KG	NA		NA	
		Total			0.0349		5.6165	
620	006	Arsenic (As)	8.8	MG/KG	0.0202	100.00	3.2517	100.00
620	006	B(a)P Equiv.	0	UG/KG	NA		NA	
620	006	Lead (Pb)	9.8	MG/KG	NA		NA	
		Total			0.0202		3.2517	
620	007	Arsenic (As)	31.5	MG/KG	0.0724	100.00	11.6395	96.64
620	007	B(a)P Equiv.	120.24	UG/KG	NA		0.4049	3.36
620	007	Lead (Pb)	287	MG/KG	NA		NA	
		Total			0.0724		12.0443	
620	008	Arsenic (As)	22.6	MG/KG	0.0520	100.00	8.3509	67.89
620	008	B(a)P Equiv.	1173.04	UG/KG	NA		3.9498	32.11
620	008	Lead (Pb)	88.9	MG/KG	NA		NA	
		Total			0.0520		12.3006	
620	009	Arsenic (As)	2.9	MG/KG	0.0067	100.00	1.0716	94.05
620	009	B(a)P Equiv.	20.13	UG/KG	NA		0.0678	5.95
620	009	Lead (Pb)	61.9	MG/KG	NA		NA	
		Total			0.0067		1.1394	

Groundwater — Residential Scenario

As shown in Figure 10.2-21 and Table 10.2.28, thallium concentrations in groundwater equate with a rounded hazard indices ranging from 2 to 9. Thallium was not detected in any second quarter groundwater sample.

10.2.6.8 Remedial Goal Options

Soil

Risk-based RGOs were based on the lifetime weighted average site resident or site worker as presented in Table 10.2.29 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.

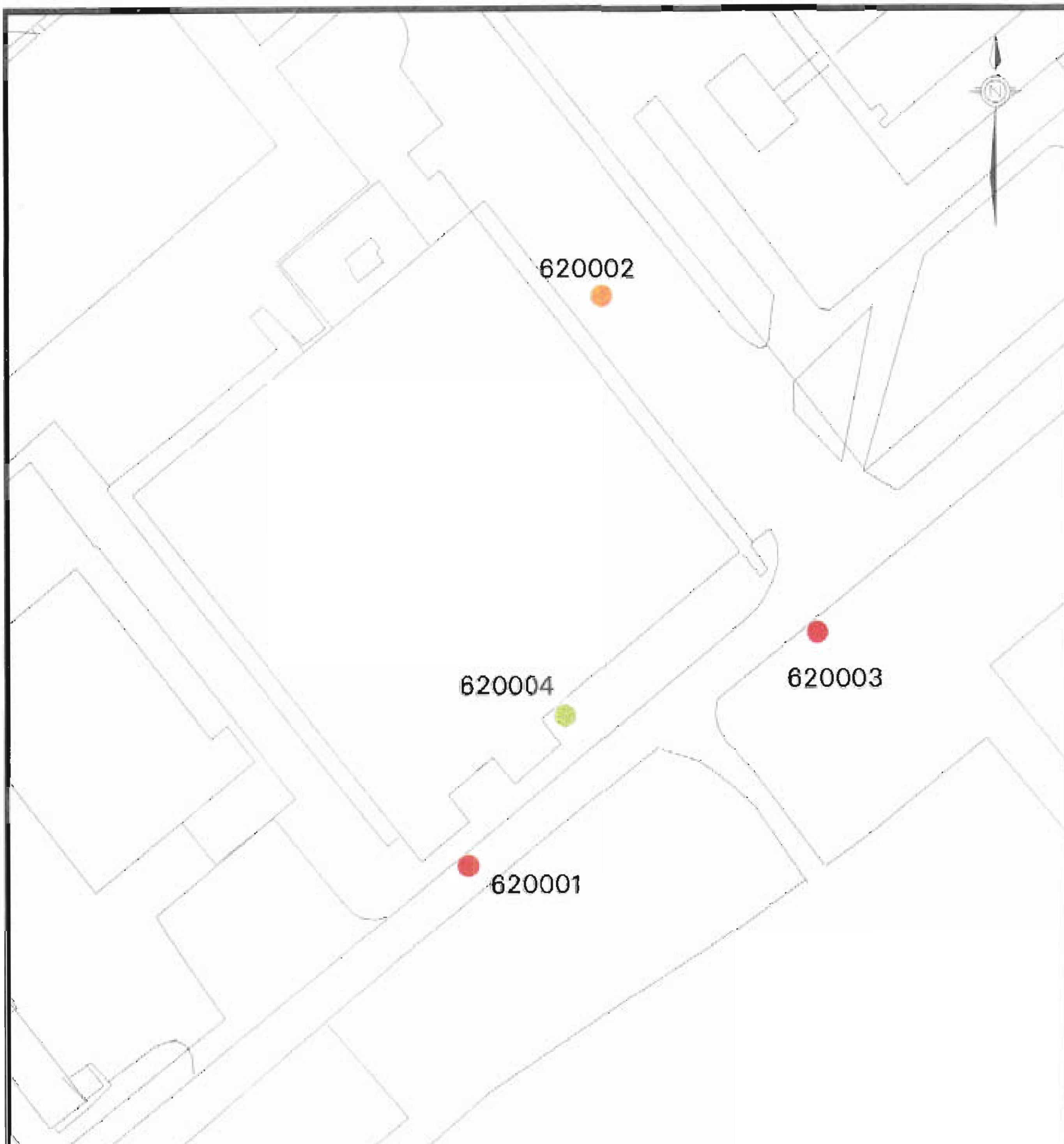
Groundwater

Groundwater risk and hazard based RGOs for the site resident scenario are shown in Table 10.2.30.

10.2.7 Corrective Measures Considerations

For SWMU 36 and AOC 620, the upper and lower soil intervals and shallow groundwater were investigated. Two groundwater monitoring wells were installed in the shallow aquifer. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is mostly paved with asphalt of concrete.

BEQs, Aroclor-1254, Aroclor-1260, aluminum, arsenic, chromium, and lead were identified as COCs in the upper soil interval. The soil pathway cumulative residential exposure risk is 1E-04



LEGEND

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

0 feet 150

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FIGURE 10.2.21
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
SWMU 36, AOC 620

Table 10.2.28
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 36 and AOC 620
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
620	001	Barium (Ba)	460	UG/L	0.4201	4.78	NA	
620	001	Thallium (Tl)	11	UG/L	8.7900	100.00	NA	
		Total			9.2100		NA	
620	002	Barium (Ba)	18.3	UG/L	0.0167	0.74	NA	
620	002	Thallium (Tl)	2.8	UG/L	2.2374	99.26	NA	
		Total			2.2542		NA	
620	003	Barium (Ba)	32.9	UG/L	0.0300	0.72	NA	
620	003	Thallium (Tl)	5.2	UG/L	4.1553	99.28	NA	
		Total			4.1853		NA	
620	004	Barium (Ba)	21	UG/L	0.0192	100.00	NA	
620	004	Thallium (Tl)	ND	UG/L	NA		NA	
		Total			0.0192		NA	

Table 10.2.29
Remedial Goal Options for Soil
SWMU 36 and AOC 620
Naval Base Charleston, Zone F
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
Inorganics										
Aroclor 1254	2	2E-05	0.30	3.6	1.2	0.12	0.22	2.2	22	NA
Aroclor 1260	2	NA	0.43	NA	NA	NA	0.22	2.2	22	NA
Semivolatile Organics										
Benzo(a)pyrene equivalents	7.3	NA	1.2	ND	ND	ND	0.06	0.6	6	NA
Inorganics										
Aluminum (Al)	NA	1	21100	218781	72927	7293	ND	ND	ND	18500
Arsenic (As)	1.5	0.0003	31.5	66	22	2.2	0.38	3.8	38	19.9
Chromium (Cr)	NA	0.005	43.2	1094	365	36	ND	ND	ND	34.8

Worker-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
Inorganics										
Arsenic (As)	1.5	0.0003	31.5	1305	435	43	2.7	27	271	19.9
Semivolatile Organics										
Benzo(a)pyrene equivalents	7.3	NA	1.2	NA	NA	NA	0.30	3.0	30	NA

NOTES:

EPC Exposure point concentration

NA Not applicable

- Remedial goal options were based on the residential or site worker lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.2.30
Residential-Based Remedial Goal Options Groundwater
SWMU 36 and AOC 620
Naval Base Charleston Zone F
Charleston, South Carolina

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	MCL mg/l	Background Concentration mg/l
Inorganics											
Barium	NA	0.07	0.460	0.11	1.1	3.3	NA	NA	NA	2	0.0943
Thallium	NA	8E-05	0.011	0.00013	0.0013	0.0038	NA	NA	NA	0.002	0.00558

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

and the cumulative HI is 2 (resident child). The cumulative residential exposure risk is at USEPA's acceptable lowest risk level of 1E-04. The HI of 2 is not within USEPA's acceptable range of between 1 and 0.1.

Lead was detected in all 12 surface soil samples collected at SWMU 36 and AOC 620. Soil concentrations ranged from 9.8 to 2,660 mg/kg with an average of 432 mg/kg. Only two of 12 samples exceeded the residential cleanup level of 400 mg/kg, 036SB001 and 620SB004.

Residential risk-based remedial goals for surface soil for arsenic, BEQs, Aroclor-1254, and Aroclor-1260 were 0.38, 0.06, 0.22, and 0.22 mg/kg, respectively, based on a target risk of 1E-06. Hazard-based remedial goals for surface soil for aluminum and chromium are 72,927 and 365 mg/kg, respectively, based on a target HI of 1. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.2.31.

Table 10.2.31
Potential Corrective Measures for SWMU 36 and AOC 620

Medium	Compounds of Concern	Potential Corrective Measures
Soil	Aluminum, arsenic, chromium, lead, BEQs, Aroclor-1254, and Aroclor-1260	a) No action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment f) Ex-situ, chemical and physical treatment
Shallow Groundwater	Barium and thallium	a) No action b) Intrinsic remediation and monitoring c) In-situ, chemical and physical treatment d) Ex-situ, chemical and physical treatment

Two COCs, barium and thallium, were identified in the shallow groundwater for AOC 620. Barium and thallium have a calculated HI of 9 associated with the present concentration which is above USEPA's acceptable HI of 1. The hazard-based RGO for thallium is 1.3E-03 and barium is 1.1 mg/l, based on a target of HI of 1.

Potential corrective measures for the shallow groundwater and respective COCs are in Table 10.2.31. Corrective measures for SWMU 36 and AOC 620 are detailed in Section 9.

10.1 SWMU 4, Pesticide Storage Building; AOC 619, Former Oil Storage Yard

These sites were combined into one investigation due to their close proximity and their potential for similar COPCs. SWMU 4 (a RFI site) is a building used to store various insecticides and rodenticides since 1980. The building has a formulation and mixing room, and equipment wash area, and sink and floor drains connected to the base sanitary sewer system. Pesticide storage at the facility was discontinued after 1985, and afterward the building was used for miscellaneous storage only. Materials released, stored or disposed of at the facility included various pesticides. AOC 619 (a CSI site) is a former oil storage yard used from 1955 to 1982 to store waste oil, possibly in an open pit. The possibility of an open pit storage area, along with the observation of stressed vegetation in the area were noted as increasing the potential for contamination at this site. Materials released, stored, or disposed of at this site included petroleum products.

10.1.1 Site Geology and Hydrogeology

Figure 10.1-1 depicts the soil boring, sediment sampling, and groundwater monitoring well locations within the SWMU 4 and AOC 619 area. The stratigraphy at SWMU 4 and AOC 619, based on three monitoring well borings, consists of organic sandy clay overlying silty and clayey sand. The organic sandy clay extends to an approximate depth which varies between eight and 12 ft bgs. The sandy clay exhibits a grain size distribution of 68% sand, 21% silt, and 11% clay. The silty and clayey sand, in which monitoring wells 619001 and 619002 are completed, exhibits a grain size distribution of 81% sand, 4% silt and 15% clay. The total depth reached by the borings at this site was 13.0 ft bgs. Boring logs are contained in Appendix A. Figures 10.1-2 and 10.1-3 are geologic cross sections across SWMU 4 and AOCs 619 and 620.

Figure 10.1-4 depicts the shallow groundwater potentiometric surface and inferred flow direction at low tide. Figure 10.1-5 depicts the shallow groundwater potentiometric surface and inferred

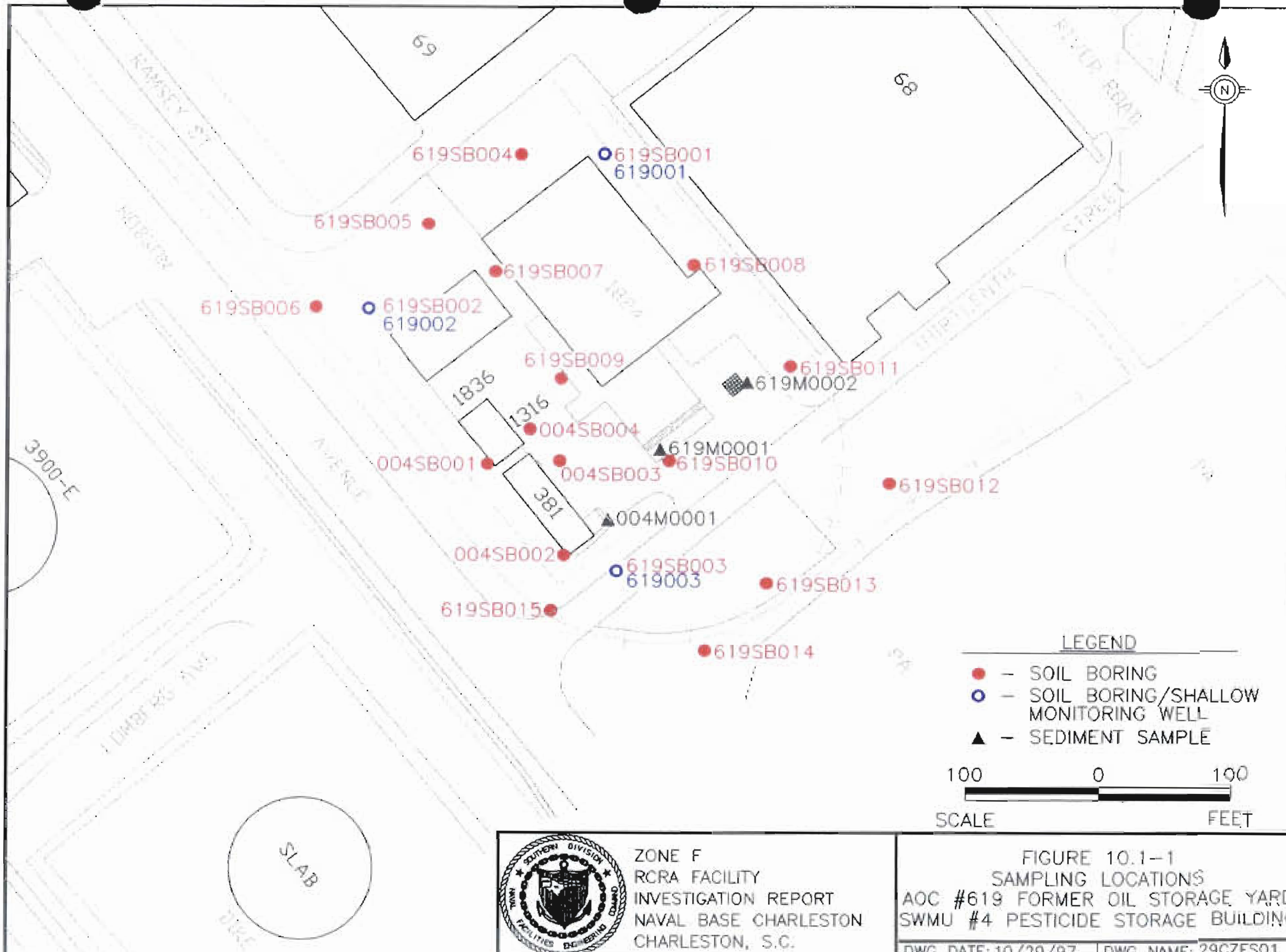

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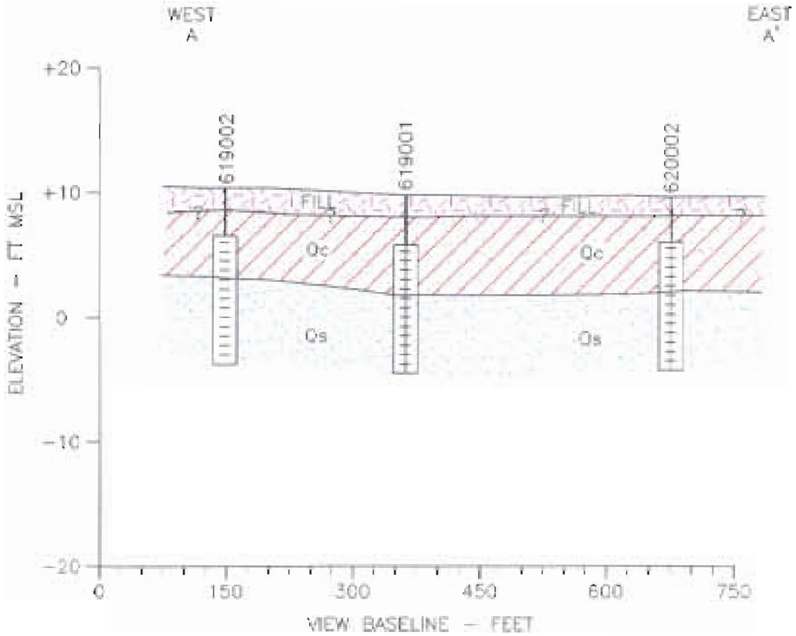
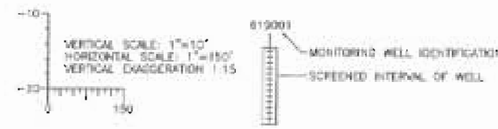
FIGURE 10.1-1
SAMPLING LOCATIONS
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

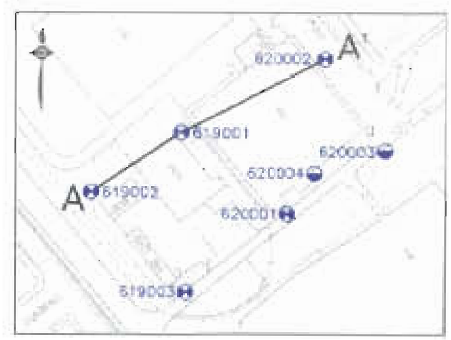
DWG DATE: 10/29/97	DWG NAME: 29CZFS01



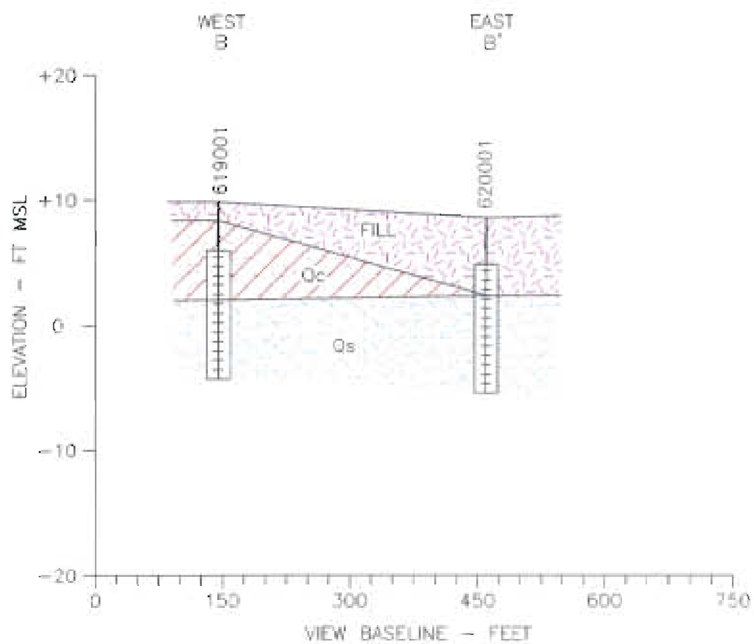
LEGEND

FILL	Undifferentiated mixture of medium to high plasticity clays, fine sand, silt, gravel and ROC. Varies greatly with location.
Qc	QUATERNARY CLAYEY SAND AND SILTY SAND—brown, orange-brown, gray, green, and tan, very fine to fine sand often with trace medium grains, varying amounts of silt and inorganic gray clay, often interbedded with soft gray, medium plasticity clay laminae; sand occasionally unconsolidated and loose. AQUIFER
Qs	QUATERNARY SAND—undifferentiated olive-brown, gray, and orange sand; primarily very fine to fine and moderately to well-sorted but typically increases in grain size with depth (from fine to medium with some coarse); clean to silty sand. AQUIFER.



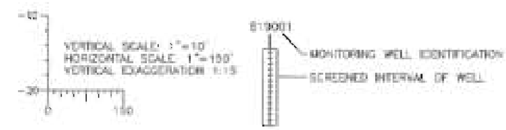


ZONE F RCRA FACILITY INVESTIGATION REPORT NAVAL BASE CHARLESTON CHARLESTON, S.C.	FIGURE 10.1-2 SWMU 4, AOC 619 AND 620 LITHOLOGIC CROSS SECTION A-A'
	DWG DATE: 11/07/97 DWG NAME: 2905CAA2



LEGEND

FILL	Undifferentiated mixture of medium to high plasticity clays, fine sand, silt, gravel and ROC. Varies greatly with location.
Qc	QUATERNARY CLAYEY SAND AND SILTY SAND--brown, orange-brown, gray, green, and tan, very fine to fine sand often with trace medium grains, varying amounts of silt and inorganic gray clay; often interbedded with soft gray, medium plasticity clay laminae; sand occasionally unconsolidated and loose. AQUIFER
Qs	QUATERNARY SAND--undifferentiated olive-brown, gray, and orange sand; primarily very fine to fine and moderately to well-sorted but typically increases in grain size with depth (from fine to medium with some coarse); clean to silty sand. AQUIFER.



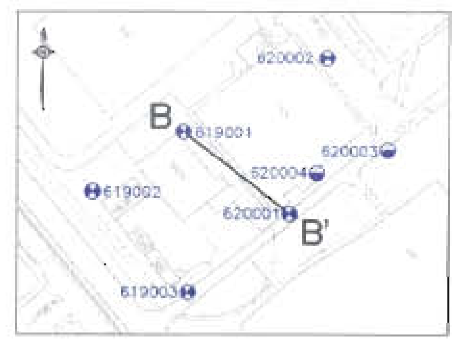


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FIGURE 10.1-3
SWMU 4, AOC 619 AND 620
LITHOLOGIC CROSS SECTION B-B'

DWG DATE: 11/07/97 | DWG NAME: 2906C882

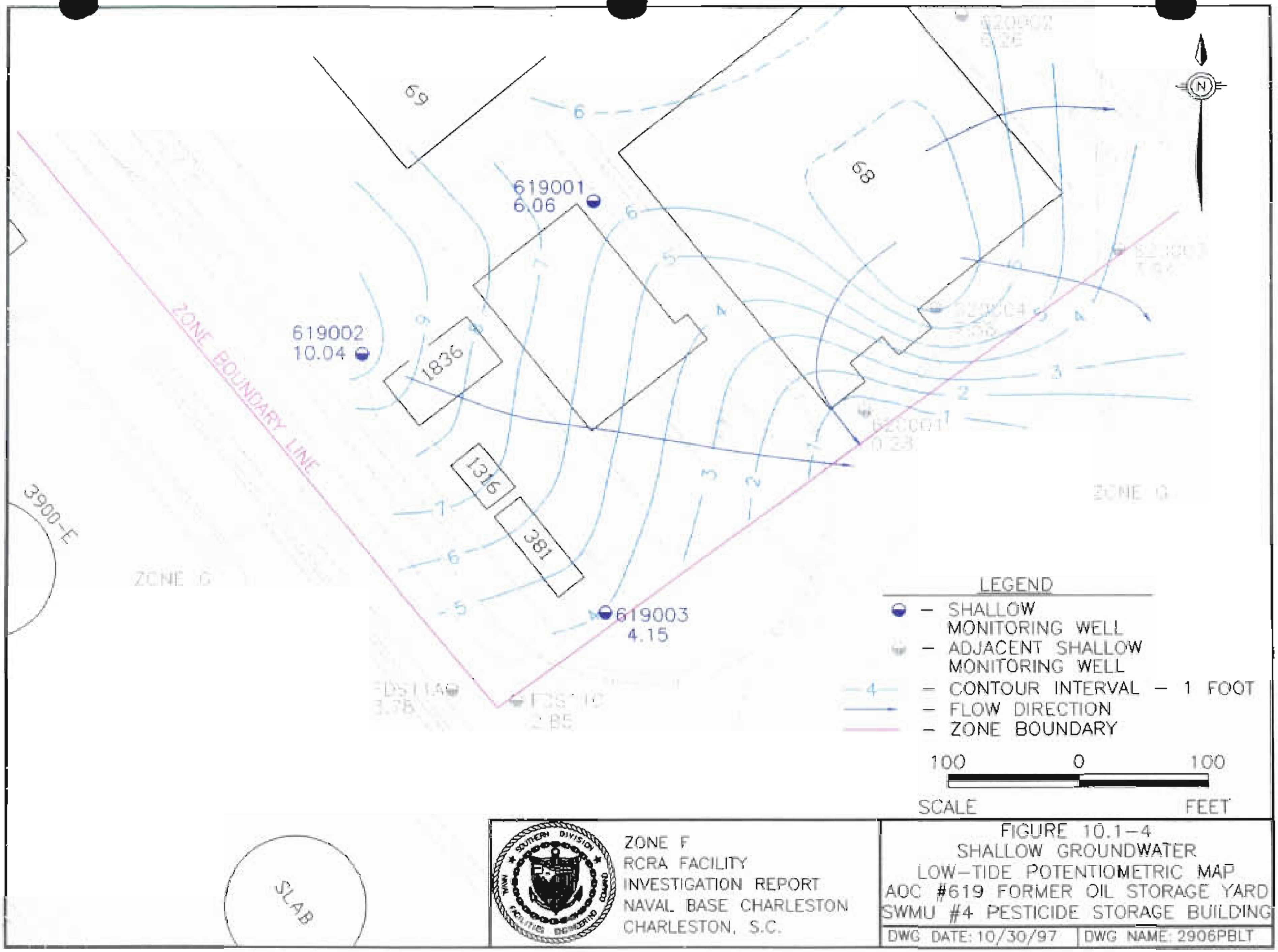

FIGURE 10.1-4
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

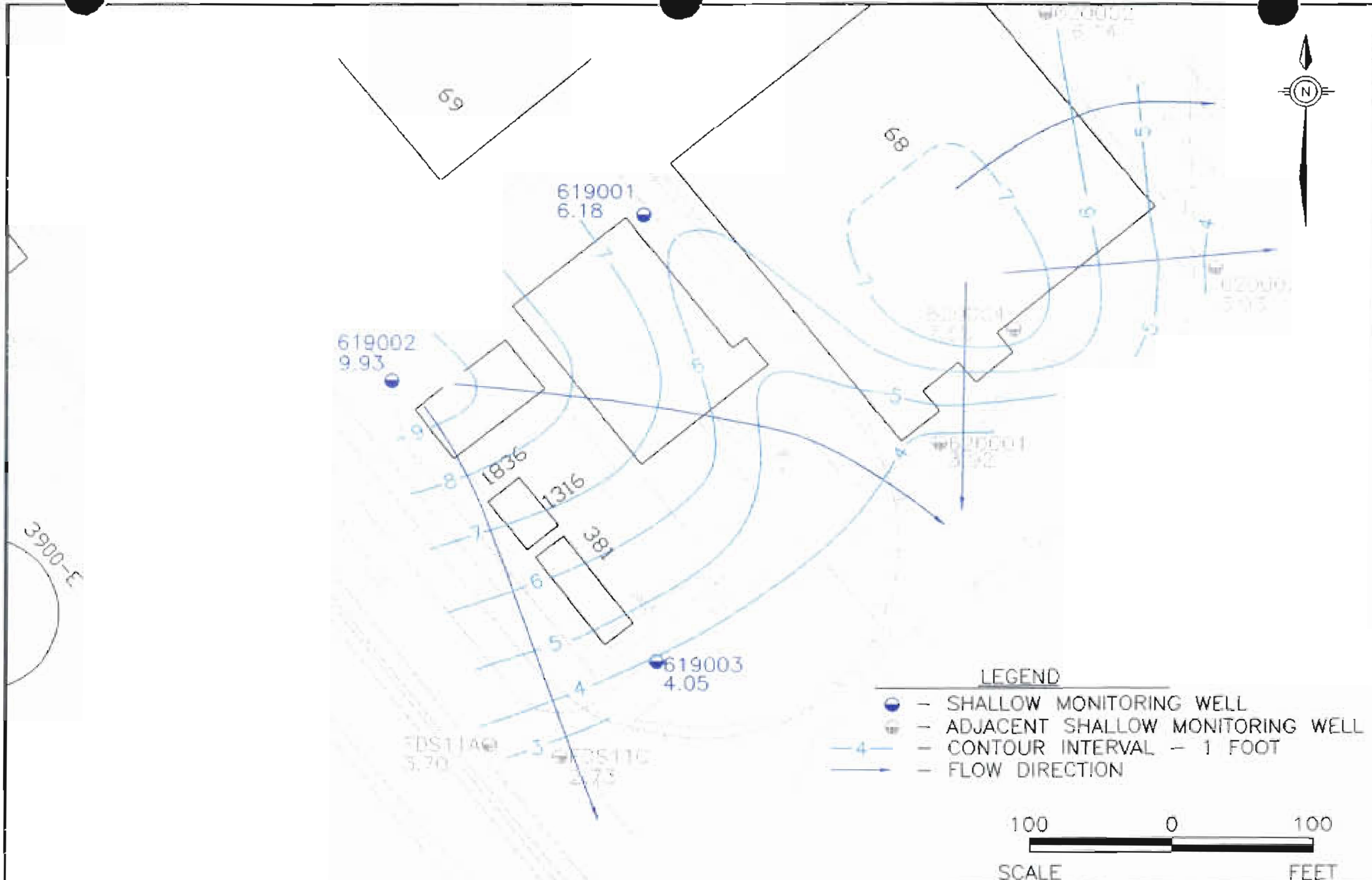

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FIGURE 10.1–5
SHALLOW GROUNDWATER
HIGH–TIDE POTENTIOMETRIC MAP
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

DWG DATE: 10/30/97 | DWG NAME: 2906PBHT

flow direction at high tide. Very minor differences in the static water levels and the overall flow pattern at the SWMU 4 and AOC 619 area were observed between high and low tide. The mean hydraulic conductivity calculated from slug testing, was 2.05E-03 ft/day. The horizontal hydraulic gradient, based on Figure 10.1-4 is 2.5E-02 ft/ft. The horizontal flow velocity was calculated at 5.1E-03 ft/day in the shallow deposits at SWMU 4 and AOC 619.

10.1.2 Field Investigation Approach

The objective of the field investigation at SWMU 4 and AOC 619 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, sediment and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hollow stem auger drilling procedures used for shallow well installation; the hand-auger procedures used for soil sampling; sediment and 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 F.

10.1.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing 19 soil borings within the combined SWMU 4/AOC 619 area to assess the presence of any soil contamination at these two sites. Upper and lower interval soil samples were proposed from each boring. Nineteen soil borings were advanced during the field investigation. Thirteen borings included both soil sampling intervals, while six included the upper interval only. Where not collected, the lower interval sample was deleted due to either an obstruction in the borehole, or because of a shallow water table.

The approved final RFI work plan specified site soil samples be analyzed for metals, pesticide/PCBs, VOAs, and SVOAs. All soil samples were analyzed at DQO Level III. Soil samples from SWMU 4 were analyzed for metals, pesticide/PCBs, VOAs, SVOAs, OP pesticides, and herbicides. Soil samples from AOC 619 were analyzed for metals, pesticide/PCBs, VOAs, and SVOAs. An exception was 619SB003, which was located within SWMU 4. Samples from 619SB003 (both intervals) were analyzed for pesticide/PCB, and OP pesticide constituents only. Additionally, several samples at AOC 619 were also analyzed for cyanides. Also, three upper interval duplicate soil samples from SWMU 4/AOC 619 were collected for Appendix IX analyses at DQO Level IV. Table 10.1.1 summarizes the combined SWMU 4 and AOC 619 soil samples and analyses.

10.1.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.1.2. Inorganic analytical results for soil are summarized in Table 10.1.3. Table 10.1.4 summarizes all analytes detected in soil at the combined site. Appendix D contains a complete analytical data report for all Zone F sample collected.

Table 10.1.1
Zone F
SWMU 4 and AOC 619
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
004SB001	004SB00101 004SB00102	Upper Lower	9/17/96; 10/25/96**	Note 1	
004SB002	004SB00201* 004CB00201 004SB00202	Upper Lower	9/17/96; 10/25/96**	Notes 1/3*	
004SB003	004SB00301 004SB00302	Upper Lower	9/17/96; 10/25/96**	Note 1	
004SB004	004SB00401 004SB00402	Upper Lower	9/17/96; 10/25/96**	Note 1	
619SB001	619SB00101 619SB00102	Upper Lower	8/26/96	Note 2	

Table 10.1.1
Zone F
SWMU 4 and AOC 619
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
619SB002	619SB00201	Upper	8/27/96	Note 2	Lower interval not sampled
619SB003	619SB00301	Upper	11/12/96	Pesticides/	
	619SB00302	Lower		OP pesticides only	
619SB004	619SB00401	Upper	9/09/96	Note 2/cyanide	
	619SB00402	Lower			
619SB005	619SB00501	Upper	9/09/96	Note 2/cyanide	Lower interval not sampled
	619CB00501*			Note 3 *	
619SB006	619SB00601	Upper	9/18/96	Notes 2/3*	Lower interval not sampled
	619CB00601*				
619SB007	619SB00701	Upper	9/12/96	Note 2	Lower interval not sampled
619SB008	619SB00801	Upper	9/10/96	Note 2/cyanide	Lower interval not sampled
619SB009	619SB00901	Upper	9/09/96	Note 2/cyanide	
	619SB00902	Lower			
619SB010	619SB01001	Upper	9/17/96	Note 2	
	619SB01002	Lower			
619SB011	619SB01101	Upper	9/10/96	Note 2/cyanide	Lower interval not sampled
619SB012	619SB01201	Upper	9/17/96	Note 2	
	619SB01202	Lower			
619SB013	619SB01301	Upper	9/17/96	Note 2	
	619SB01302	Lower			
619SB014	619SB01401	Upper	10/22/96	Note 2	
	619SB01402	Lower			
619SB015	619SB01501	Upper	9/17/96	Note 2	
	619SB01502	Lower			

Notes:

1	=	SW-846 (metals, pesticide/PCBs, OP pesticides, herbicides, SVOAs, VOAs) at DQO Level III.
2	=	SW-846 (metals, pesticide/PCBs, SVOAs, VOAs) at DQO Level III.
3	=	Appendix IX suite: Appendix IX (pesticide/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV.
*	=	Duplicate sample.
**	=	Herbicides/OP pesticides collected.

Table 10.1.2
Zone F
SWMU 4 and AOC 619
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.[a] (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 18 Samples plus 3 Duplicate Samples/Lower Interval - 12 Samples) (µg/kg)						
2-Butanone (MEK)	Upper	3/18	4.00 - 7.00	5.00	4700000	0
	Lower	2/12	10.0 - 46.0	28.0	7900	0
1,1-Dichloroethene	Upper	0/18	ND	ND	1100	0
	Lower	2/12	4.00 - 44.0	24.0	60	0
1,2-Dichloroethene (total)	Upper	0/18	ND	ND	70000	0
	Lower	1/12	2.00	2.00	400	0
Benzene	Upper	0/18	ND	ND	22000	0
	Lower	2/12	7.00 - 62.0	34.5	30	1
Carbon disulfide	Upper	1/18	7.00	7.00	780000	0
	Lower	5/12	2.00 - 15.0	8.20	32000[a]	0
Chlorobenzene	Upper	0/18	ND	ND	160000	0
	Lower	2/12	6.00 - 64.0	35.0	1000	0
Chloroform	Upper	0/18	ND	ND	100000	0
	Lower	1/12	2.00	2.00	600	0
Methylene chloride	Upper	3/18	2.00 - 6.00	3.33	85000	0
	Lower	1/12	98.0	98.0	20[b]	1
Toluene	Upper	0/18	ND	ND	1600000	0
	Lower	2/12	6.00 - 61.0	33.5	12000	0
Trichloroethene	Upper	3/18	2.00	2.00	58000	0
	Lower	4/12	3.00 - 62.0	20.8	60	1

Table 10.1.2
Zone F
SWMU 4 and AOC 619
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
Semivolatile Organic Compounds (Upper Interval - 18 Samples plus 3 Duplicate Samples/Lower Interval - 12 Samples) (μg/kg)						
BEQs*	Upper	13/18	0.0820 - 540	185	88	9
	Lower	0/0	NA	NA	NA	0
Acenaphthene	Upper	1/18	340	340	470000	0
	Lower	0/12	ND	ND	570000[a]	0
Acenaphthylene	Upper	2/18	51.0 - 72.0	61.5	470000	0
	Lower	0/12	ND	ND	293000	0
Anthracene	Upper	6/18	48.0 - 750	183	2300000	0
	Lower	2/12	64.0 - 100	82.0	12000000[a]	0
Benzo(a)anthracene	Upper	10/18	53.5 - 600	160	880	0
	Lower	9/12	48.0 - 200	112	2000	0
Benzo(a)pyrene	Upper	12/18	43.0 - 410	160	88	9
	Lower	10/12	57.0 - 200	112	8000	0
Benzo(b)fluoranthene	Upper	11/18	57.0 - 460	205	880	0
	Lower	10/12	52.0 - 240	134	5000[b]	0
Benzo(g,h,i)perylene	Upper	11/18	59.0 - 200	85.0	230000	0
	Lower	4/12	66.0 - 90.0	75.3	4.66E+08	0
Benzo(k)fluoranthene	Upper	10/18	46.0 - 370	155	8800	0
	Lower	8/12	58.0 - 230	133	49000[b]	0
Benzoic acid	Upper	6/18	48.0 - 130	95.8	31000000	0
	Lower	5/12	42.0 - 110	74.6	400000[a,c]	0

Table 10.1.2
Zone F
SWMU 4 and AOC 619
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
bis(2-Ethylhexyl)phthalate	Upper	7/18	44.0 - 1400	278	46000	0
	Lower	0/12	ND	ND	3600000	0
Butylbenzlphthalate	Upper	1/18	42.0	42.0	1600000	0
	Lower	0/12	ND	ND	930000[d]	0
Chrysene	Upper	13/18	54.0 - 480	192	88000	0
	Lower	9/12	59.0 - 350	153	160000[b]	0
Dibenzofuran	Upper	1/18	41.0	41.0	31000	0
	Lower	0/12	ND	ND	240000	0
Diethylphthalate	Upper	0/18	ND	ND	6300000	0
	Lower	1/12	94.0	94.0	470000a	0
Di-n-butylphthalate	Upper	3/18	48.0 - 200	100	780000	0
	Lower	0/12	ND	ND	2300000	0
Di-n-octylphthalate	Upper	1/18	56.0	56.0	160000	0
	Lower	0/12	ND	ND	10000000[d]	0
Fluoranthene	Upper	12/18	53.0 - 3100	468	310000	0
	Lower	11/12	58.0 - 810	214	4300000[a]	0
Fluorene	Upper	2/18	110 - 195	153	310000	0
	Lower	0/12	ND	ND	560000[a]	0
Indeno(1,2,3-cd)pyrene	Upper	10/18	39.0 - 200	82.6	880	0
	Lower	5/12	62.0 - 100	76.2	14000[a]	0
2-Methylnaphthalene	Upper	5/18	45.0 - 600	238	310000	0
	Lower	0/12	ND	ND	126000	0

Table 10.1.2
Zone F
SWMU 4 and AOC 619
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
Naphthalene	Upper	1/18	680	680	310000	0
	Lower	0/12	ND	ND	84000[c]	0
Pentachlorophenol	Upper	1/18	74.0	74.0	5300	0
	Lower	0/12	ND	ND	30[c,e]	0
Phenanthrene	Upper	12/18	52.0 - 1200	227	230000	0
	Lower	5/12	45.0 - 85.0	69.2	1380000	0
Pyrene	Upper	13/18	44.0 - 2500	495	230000	0
	Lower	11/12	48.0 - 670	200	4200000[c]	0
Pesticides and PCBs (Upper Interval - 19 Samples plus 3 Duplicate Samples/Lower Interval - 13 Samples) (μg/kg)						
4,4'-DDD	Upper	6/19	4.45 - 200	56.6	2700	0
	Lower	1/13	16.0	16.0	16000[b]	0
4,4'-DDE	Upper	3/19	11.6 - 530	189	1900	0
	Lower	2/13	3.80 - 43.0	23.4	54000[b]	0
4,4'-DDT	Upper	3/19	11.3 - 52.0	27.1	1900	0
	Lower	0/13	ND	ND	320000[b]	0
Aroclor-1260	Upper	7/19	5.90 - 250	83.4	320	0
	Lower	1/13	210	210	1000	0
Endrin	Upper	3/19	4.60 - 14.0	9.00	2300	0
	Lower	0/13	ND	ND	1000	0
Heptachlor	Upper	0/19	ND	ND	140	0
	Lower	1/13	2.30	2.30	2300	0

Table 10.1.2
Zone F
SWMU 4 and AOC 619
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
Heptachlor epoxide	Upper	2/19	2.50 - 3.10	2.80	70	0
	Lower	0/13	ND	ND	700	0
alpha-Chlordane	Upper	7/19	2.50 - 19.5	8.50	490	0
	Lower	0/13	ND	ND	10000	0
gamma-Chlordane	Upper	7/19	4.30 - 54.5	23.1	490	0
	Lower	2/13	12.0 - 22.0	17.0	10000	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
a	=	Calculated values correspond to a noncancer hazard quotient of 1
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000
c	=	SSL for pH of 6.8
d	=	Soil saturation concentration (C_{sat})
e	=	Level is at or below contract laboratory program required quantitation limit for regular analytical services (RAS)
*	=	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
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable
μg/kg	=	Micrograms per kilogram

Table 10.1.3
Zone F
SWMU 4 and AOC 619
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 - 18 Samples plus 3 Duplicate Samples/Lower Interval - 12 Samples) (mg/kg)						
Aluminum	Upper	18/18	751 - 12600	5790	7800	4
	Lower	12/12	793 - 25200	15600	1000000	0
Antimony	Upper	2/18	0.530 - 0.670	0.600	3.1	0
	Lower	1/12	0.580	0.580	5	0
Arsenic	Upper	18/18	1.12 - 17.8	6.60	0.43	18
	Lower	12/12	1.40 - 28.1	15.1	29[b]	0
Barium	Upper	18/18	3.90 - 65.6	24.3	550	0
	Lower	12/12	7.20 - 40.2	30.8	1600[b]	0
Beryllium	Upper	15/18	0.0550 - 0.930	0.388	0.15	14
	Lower	12/12	0.170 - 1.50	0.958	63[b]	0
Cadmium	Upper	16/18	0.0500 - 0.990	0.294	3.9	0
	Lower	11/12	0.200 - 0.620	0.329	8[b]	0
Calcium	Upper	18/18	801 - 312000	34000	NL	NA
	Lower	12/12	319 - 322000	37900	NL	NA
Chromium	Upper	18/18	3.40 - 22.8	12.5	39	0
	Lower	12/12	2.70 - 43.4	28.9	38[b]	4
Cobalt	Upper	17/18	0.860 - 22.2	3.97	470	0
	Lower	11/12	3.00 - 7.80	5.62	2000	0

Table 10.1.3
Zone F
SWMU 4 and AOC 619
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.[a] (mg/kg)	Number of Samples Exceeding Reference
Copper	Upper	18/18	1.50 - 92.4	23.1	310	0
	Lower	11/12	3.90 - 44.1	27.1	920	0
Cyanide	Upper	1/7	0.17	0.17	160	0
	Lower	0/2	ND	ND	40	0
Iron	Upper	18/18	784 - 18900	7510	2300	14
	Lower	12/12	1900 - 33300	21200	NL	NA
Lead	Upper	18/18	1.30 - 197	51.1	400[c]	0
	Lower	12/12	3.70 - 214	56.2	400[c]	0
Magnesium	Upper	18/18	111 - 3420	1200	NL	NA
	Lower	12/12	187 - 5950	3780	NL	NA
Manganese	Upper	18/18	8.20 - 320	114	180	4
	Lower	12/12	8.30 - 701	351	1100	0
Mercury	Upper	14/18	0.0400 - 0.280	0.126	2.3	0
	Lower	11/12	0.180 - 1.40	0.481	2.0[b]	0
Nickel	Upper	18/18	0.515 - 14.0	6.25	160	0
	Lower	12/12	1.000 - 13.8	10.4	130[b]	0
Potassium	Upper	13/18	258 - 1110	599	NL	NA
	Lower	12/12	94.5 - 3130	1780	NL	NA
Selenium	Upper	5/18	0.450 - 0.640	0.570	39	0
	Lower	3/12	0.710 - 1.30	1.04	5	0

Table 10.1.3
Zone F
SWMU 4 and AOC 619
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
Silver	Upper	2/18	0.240 - 0.310	0.275	39	0
	Lower	1/12	0.380	0.38	34	0
Sodium	Upper	11/18	121 - 1430	531	NL	NA
	Lower	11/12	390 - 7480	3190	NL	NA
Thallium	Upper	1/18	0.57	0.57	0.63	0
	Lower	2/12	0.5 - 1.4	0.95	1.24	1
Tin (Sn)	Upper	1/18	12.3	12.3	4700	0
	Lower	0/12	ND	ND	11000	0
Vanadium	Upper	18/18	2.65 - 31.5	15.3	55	0
	Lower	12/12	4.10 - 72.5	44.9	6000[a]	0
Zinc	Upper	18/18	5.40 - 663	118	2300	0
	Lower	11/12	42.2 - 231	113	12000[a,b]	0

Notes:

a = Calculated values correspond to a noncancer hazard quotient of 1
b = SSL for pH of 6.8
c = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA 1994a)
* = 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
mg/kg = Milligrams per kilogram
ND = Not detected
NL = Not listed
NA = Not applicable

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)							
1,1-Dichloroethene	004SB003	ND	1100	NA	4.0	60	NA
	619SB001	ND			44.0		
1,2-Dichloroethene (total)	619SB015	ND	70000	NA	2.0	400	NA
2-Butanone (MEK)	619SB001	4.0	4700000	NA	10.0	7900	NA
	619SB004	7.0			46.0		
	619SB011	4.0			NT		
Benzene	004SB003	ND	22000	NA	7.0	30	NA
	619SB001	ND			62.0		
Carbon disulfide	004SB003	ND	780000	NA	12.0	32000[a]	NA
	004SB004	ND			15.0		
	619SB010	ND			6.0		
	619SB013	7.0			2.0		
	619SB015	NC			6.0		
Chlorobenzene	004SB003	ND	160000	NA	6.0	1000	NA
	619SB001	ND			64.0		
Chloroform	004SB004	ND	100000	NA	2.0	600	NA
Methylene chloride	004SB004	6.0	85000	NA	ND	20[b]	NA
	619SB004	ND			98.0		
	619SB005	2.0			NT		
	619SB015	2.0			ND		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Toluene	004SB003	ND	1600000	NA	6.0	12000	NA
	619SB001	ND			61.0		
Trichloroethene	004SB003	ND	58000	NA	8.0	60	NA
	004SB004	ND			3.0		
	619SB001	ND			**62.0**		
	619SB004	2.0			ND		
	619SB010	2.0			ND		
	619SB013	2.0			ND		
	619SB015	ND			10.0		
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	004SB001	0.082	88	NA	NA	NA	NA
	004SB002	69.233			NA		
	004SB003	ND			NA		
	004SB004	ND			NA		
	619SB001	**272.080**			NA		
	619SB002	49.214			NA		
	619SB004	**540.180**			NA		
	619SB005	**163.885**			NA		
	619SB006	**244.205**			NA		
	619SB007	**152.740**			NA		
	619SB008	84.842			NA		
	619SB009	**247.360**			NA		
	619SB010	ND			NA		
	619SB011	**176.360**			NA		
	619SB013	**190.980**			NA		
	619SB014	ND			NA		
	619SB015	**214.770**					

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
2-Methylnaphthalene	004SB001	600.0	310000	NA	ND	126000	NA
	004SB002	45.0			ND		
	619SB002	50.0			NT		
	619SB005	60.0			NT		
	619SB006	435.0			NT		
Acenaphthene	619SB006	340.0	470000	NA	NT	570000*	NA
Acenaphthylene	619SB004	72.0	470000	NA	ND	293000	NA
	619SB015	51.0			ND		
Anthracene	004SB004	ND	2300000	NA	64	12000000*	NA
	619SB001	62			ND		
	619SB004	750			ND		
	619SB007	120			NT		
	619SB009	50			ND		
	619SB013	65			100.0		
	619SB015	48			ND		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)anthracene	004SB001	ND	880	NA	92	2000[b]	NA
	004SB002	53.5			88		
	004SB003	ND			48		
	004SB004	ND			200		
	619SB001	220.0			ND		
	619SB004	600.0			120		
	619SB005	119.5			NT		
	619SB007	92.0			NT		
	619SB008	59.0			NT		
	619SB009	86.0			ND		
	619SB010	ND			100		
	619SB011	120.0			NT		
	619SB013	130.0			180		
	619SB014	ND			82		
	619SB015	120.0			96		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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	004SB001	ND	88	NA	110.0	8000	NA
	004SB002	56.0			91.0		
	004SB003	ND			57.0		
	004SB004	ND			200.0		
	619SB001	**220.0**			63.0		
	619SB002	43.0			NT		
	619SB004	**410.0**			130.0		
	619SB005	**125.0**			NT		
	619SB006	**240.0**			NT		
	619SB007	**120.0**			NT		
	619SB008	66.0			NT		
	619SB009	**190.0**			ND		
	619SB010	ND			100.0		
	619SB011	**140.0**			NT		
	619SB013	**140.0**			150.0		
	619SB014	ND			92.0		
	619SB015	**170.0**			130.0		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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(b)fluoranthene	004SB001	ND	880	NA	110.0	5000	NA
	004SB002	72.5			120.0		
	004SB003	ND			52.0		
	004SB004	ND			220.0		
	619SB001	220.0			ND		
	619SB002	57.0			NT		
	619SB004	460.0			240.0		
	619SB005	165.0			NT		
	619SB007	160.0			NT		
	619SB008	69.0			NT		
	619SB009	400.0			70.0		
	619SB010	ND			110.0		
	619SB011	160.0			NT		
	619SB013	270.0			170.0		
	619SB014	ND			120.0		
	619SB015	220.0			130.0		
Benzo(g,h,i)perylene	004SB001	ND	230000	NA	78.0	4.66E+08	NA
	004SB002	60.0			ND		
	004SB004	ND			90.0		
	619SB001	62.0			ND		
	619SB004	200.0			ND		
	619SB005	110.0			NT		
	619SB006	63.0			NT		
	619SB007	62.0			NT		
	619SB008	59.0			NT		
	619SB009	100.0			ND		
	619SB010	ND			67.0		
	619SB011	65.0			NT		
	619SB013	79.0			66.0		
	619SB015	75.0			ND		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Benzo(k)fluoranthene	004SB001	ND	8800	NA	110.0	49000[a]	NA
	004SB002	55.50			94.0		
	004SB003	ND			58.0		
	004SB004	ND			230.0		
	619SB001	220.0			ND		
	619SB002	46.0			NT		
	619SB004	370.0			ND		
	619SB005	120.0			NT		
	619SB007	120.0			NT		
	619SB008	67.0			NT		
	619SB010	ND			110.0		
	619SB011	140.0			NT		
	619SB013	210.0			180.0		
	619SB014	ND			140.0		
	619SB015	200.0			140.0		
Benzoic acid	004SB003	ND	31000000	NA	49.0	400000[a,c]	NA
	004SB004	48.0			ND		
	619SB001	ND			42.0		
	619SB002	97.0			NT		
	619SB004	110.0			110.0		
	619SB005	130.0			NT		
	619SB007	60.0			NT		
	619SB009	130.0			110.0		
	619SB010	ND			62.0		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
bis(2-Ethylhexyl)phthalate	004SB002	253.50	46000	NA	ND	3600000	NA
	619SB001	85.00			ND		
	619SB004	45.00			ND		
	610SB005	44.00			NT		
	619SB007	60.00			NT		
	619SB008	1400.00			NT		
	619SB011	57.00			NT		
Butylbenzylphthalate	619SB008	42.0	1600000	NA	ND	930000[c]	NA
Chrysene	004SB001	82.0	88000	NA	110.0	160000[a]	NA
	004SB002	78.0			120.0		
	004SB003	ND			59.0		
	004SB004	ND			350.0		
	619SB001	280.0			ND		
	619SB002	54.0			NT		
	619SB004	480.0			130.0		
	619SB005	135.0			NT		
	619SB006	305.0			NT		
	619SB007	140.0			NT		
	619SB008	72.0			NT		
	619SB009	160.0			ND		
	619SB010	ND			110.0		
	619SB011	160.0			NT		
	619SB013	380.0			240.0		
	619SB014	ND			130.0		
	619SB015	170.0			130.0		
Diethylphthate	004SB001	ND	6300000	NA	94	470000[a]	NA
Di-n-butylphthalate	004SB001	200.0	780000	NA	ND	2300000	NA
	619SB004	53.0			ND		
	619SB005	48.0			NT		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Di-n-octylphthalate	619SB008	56.0	160000	NA	NT	10000000[a]	NA
Dibenzofuran	004SB001	41.0	31000	NA	ND	240000	NA
Fluoranthene	004SB001	ND	310000	NA	130	4300000[a]	NA
	004SB002	84			140		
	004SB003	ND			99		
	004SB004	ND			410		
	619SB001	370			ND		
	619SB002	53			NT		
	619SB004	3100			160		
	619SB005	210			NT		
	619SB006	280			NT		
	619SB007	120			NT		
	619SB008	110			NT		
	619SB009	88			64		
	619SB010	ND			200		
	619SB011	150			NT		
	619SB012	ND			58		
	619SB013	890			810		
	619SB014	ND			140		
	619SB015	160			140		
Fluorene	619SB004	110.0	310000	NA	ND	560000[a]	NA
	619SB006	195.0			NT		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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	004SB001	ND	880	NA	92	14000[a]	NA
	004SB004	ND			100		
	619SB001	56			ND		
	619SB004	200			ND		
	619SB005	91			NT		
	619SB006	39			NT		
	619SB007	62			NT		
	619SB008	53			NT		
	619SB009	86			ND		
	619SB010	ND			62		
	619SB011	68			NT		
	619SB013	85			65		
	619SB015	86			62		
Naphthalene	004SB001	680.0	310000	NA	ND	84000[a]	NA
Pentachlorophenol	619SB005	74.0	5300	NA	NT	30[e,f]	NA

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Phenanthrene	004SB001	93	230000	NA	ND	1380000	NA
	004SB002	53			61		
	004SB004	ND			85		
	619SB001	120			ND		
	619SB002	52			NT		
	619SB004	1200			83		
	619SB005	180			NT		
	619SB006	490			NT		
	619SB007	54			NT		
	619SB008	89			NT		
	619SB011	55			NT		
	619SB013	280			72		
	619SB014	ND			45		
	619SB015	60			ND		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Pyrene	004SB001	44	230000	NA	120	4200000[a]	NA
	004SB002	89.5			140		
	004SB003	ND			110		
	004SB004	ND			390		
	619SB001	910			ND		
	619SB002	55			NT		
	619SB004	2500			160		
	619SB005	225			NT		
	619SB006	1260			NT		
	619SB007	140			NT		
	619SB008	100			NT		
	619SB009	130			76		
	619SB010	ND			210		
	619SB011	130			NT		
	619SB012	ND			48		
	619SB013	670			670		
	619SB014	ND			150		
	619SB015	180			130		
Pesticides and PCBs (μg/kg)							
4,4'-DDD	004SB001	13.0	2700	NA	ND	16000[b]	NA
	004SB002	7.2			ND		
	619SB005	4.45			NT		
	619SB006	5.05			NT		
	619SB011	110.0			NT		
	619SB013	200.0			16.0		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
4,4'-DDE	619SB005	11.6	1900	NA	NT	54000[b]	NA
	619SB011	25.0			NT		
	619SB013	530.0			43.0		
	619SB014	ND			3.8		
4,4'-DDT	004SB002	18.0	1900	NA	ND	32000[b]	NA
	619SB005	11.3			NT		
	619SB013	52.0			ND		
Aroclor-1260	004SB002	250.0	320	NA	ND	1000	NA
	004SB004	5.9			ND		
	619SB002	87.0			NT		
	619SB010	19.0			ND		
	619SB011	110.0			NT		
	619SB014	27.0			210.0		
	619SB015	85.0			ND		
Endrin	004SB001	8.4	2300	NA	ND	1000	NA
	619SB011	4.6			NT		
	619SB013	14.0			ND		
Heptachlor	004SB004	ND	140	NA	2.3	2300	NA
Heptachlor epoxide	004SB002	3.1	70	NA	ND	700	NA
	619SB015	2.5			ND		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
alpha-Chlordane	004SB001	2.5	490	NA	ND	10000	NA
	004SB002	19.5			ND		
	619SB004	3.1			ND		
	619SB005	16.0			NT		
	619SB008	8.1			NT		
	619SB011	4.5			NT		
	619SB015	5.8			ND		
gamma-Chlordane	004SB001	4.3	490	NA	ND	10000	NA
	004SB002	54.5			ND		
	619SB003	ND			22.0		
	619SB005	26.0			NT		
	619SB008	10.0			NT		
	619SB011	5.7			NT		
	619SB013	27.0			12.0		
	619SB015	34.0			ND		
Dioxin (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQ')	004SB002	0.5463	1000	NA	ND	1900	NA
	619SB005	0.5039			NT		
	619SB006	2.4560			NT		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	4460	7800.0	18500	13000	1000000	17100
	004SB002	4510			18800		
	004SB003	4450			24700		
	004SB004	1220			16200		
	619SB001	8400			1840		
	619SB002	7450			NT		
	619SB004	12100			24500		
	619SB005	4720			NT		
	619SB006	2170			NT		
	619SB007	12600			NT		
	619SB008	4480			NT		
	619SB009	5110			24600		
	619SB010	5950			25200		
	619SB011	5570			NT		
	619SB012	751			793		
	619SB013	5300			10700		
	619SB014	5270			11800		
	619SB015	9790			15200		
Antimony (Sb)	004SB002	0.670	3.1	0.79	ND	5	NL
	619SB005	0.530			NT		
	619SB014	ND			0.580		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	10.500	0.43	19.9	12.2	29[c]	18.2
	004SB002	6.050			23.0		
	004SB003	1.200			28.1		
	004SB004	1.500			12.3		
	619SB001	8.100			1.4		
	619SB002	11.200			NT		
	619SB004	7.600			19.8		
	619SB005	2.900			NT		
	619SB006	1.115			NT		
	619SB007	11.500			NT		
	619SB008	8.900			NT		
	619SB009	3.400			24.3		
	619SB010	2.500			18.2		
	619SB011	8.800			NT		
	619SB012	3.500			2.3		
	619SB013	9.900			11.2		
	619SB014	2.300			10.5		
	619SB015	17.800			18.1		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Barium (Ba)	004SB001	29.3	550.0	61.5	27.1	1600[c]	51.8
	004SB002	18.8			34.2		
	004SB003	4.6			40.2		
	004SB004	4.9			30.5		
	619SB001	51.0			7.8		
	619SB002	35.1			NT		
	619SB004	28.6			39.6		
	619SB005	17.4			NT		
	619SB006	3.9			NT		
	619SB007	28.3			NT		
	619SB008	16.9			NT		
	619SB009	12.8			38.9		
	619SB010	15.3			37.7		
	619SB011	65.6			NT		
	619SB012	7.6			7.2		
	619SB013	41.4			38.7		
	619SB014	4.2			33.2		
	619SB015	50.8			33.9		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	0.410	0.15	1.05	0.92	63[c]	1.20
	004SB002	0.290			13.00		
	004SB003	0.170			1.20		
	004SB004	0.130			0.85		
	619SB001	0.570			0.17		
	619SB002	0.550			NT		
	619SB004	0.530			1.30		
	619SB005	0.265			NT		
	619SB006	0.055			NT		
	619SB007	0.610			NT		
	619SB009	0.240			1.50		
	619SB010	0.290			1.50		
	619SB012	0.280			0.28		
	619SB013	0.500			0.69		
	619SB014	0.580			ND		
	619SB015	0.930			1.20		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Cadmium (Cd)	004SB001	0.210	3.9	0.26	0.26	8[c]	0.09
	004SB002	0.295			0.28		
	004SB003	ND			0.32		
	004SB004	0.080			0.26		
	619SB001	0.480			ND		
	619SB002	0.420			NT		
	619SB004	0.140			0.24		
	619SB005	0.215			NT		
	619SB006	0.050			NT		
	619SB007	0.130			NT		
	619SB008	0.200			NT		
	619SB009	ND			0.20		
	619SB010	0.160			0.27		
	619SB011	0.280			NT		
	619SB012	0.600			0.61		
	619SB013	0.990			0.62		
	619SB014	0.050			0.26		
	619SB015	0.410			0.30		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Calcium (Ca)	004SB001	20400.0	NL	NL	20900.0	NL	NL
	004SB002	14905.0			13700.0		
	004SB003	8410.0			14700.0		
	004SB004	14200.0			11200.0		
	619SB001	15300.0			319.0		
	619SB002	6100.0			NT		
	619SB004	18900.0			12900.0		
	619SB005	12650.0			NT		
	619SB006	801.0			NT		
	619SB007	11500.0			NT		
	619SB008	39700.0			NT		
	619SB009	3510.0			12300.0		
	619SB010	46100.0			9130.0		
	619SB011	32500.0			NT		
	619SB012	312000.0			322000.0		
	619SB013	36000.0			12700.0		
	619SB014	8830.0			12600.0		
	619SB015	10700.0			12800.0		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	10.10	39 VI	34.8	25.20	38[c] (total)	32.2
	004SB002	10.90	7800 III		**36.60**		
	004SB003	5.90			**38.80**		
	004SB004	3.40			28.10		
	619SB001	17.70			2.70		
	619SB002	20.40			NT		
	619SB004	22.30			**40.40**		
	619SB005	9.25			NT		
	619SB006	3.45			NT		
	619SB007	21.70			NT		
	619SB008	10.60			NT		
	619SB009	8.00			**43.40**		
	619SB010	10.70			**42.80**		
	619SB011	17.10			NT		
	619SB012	4.40			4.20		
	619SB013	20.40			32.60		
	619SB014	6.20			21.00		
	619SB015	22.80			30.40		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	2.4	470.0	15.1	4.2	2000	6.85
	004SB002	2.4			6.9		
	004SB003	22.20			6.4		
	004SB004	0.86			5.1		
	619SB001	2.3			ND		
	619SB002	3.8			NT		
	619SB004	2.8			7.6		
	619SB005	1.6			NT		
	619SB007	3.3			NT		
	619SB008	1.7			NT		
	619SB009	1.2			7.8		
	619SB010	5.9			7.8		
	619SB011	2.1			NT		
	619SB012	3.1			3.2		
	619SB013	3.3			4.2		
	619SB014	1.0			3.0		
	619SB015	7.5			5.6		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Copper (Cu)	004SB001	18.7	310.0	48.2	20.00	920	30.4
	004SB002	17.95			26.30		
	004SB003	4.9			26.50		
	004SB004	4.2			19.30		
	619SB001	70.30			ND		
	619SB002	20.00			NT		
	619SB004	13.7			28.40		
	619SB005	17.1			NT		
	619SB006	1.5			NT		
	619SB007	14.3			NT		
	619SB008	15.8			NT		
	619SB009	13.5			29.90		
	619SB010	12.3			32.30		
	619SB011	21.9			NT		
	619SB012	2.1			3.90		
	619SB013	72.8			44.10		
	619SB014	2.8			43.70		
	619SB015	92.40			23.60		
Cyanide (CN)	004SB002	0.170	160	0.29	NT	40	0.24

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	**6470**	2300.0	NL	20200	NL	NL
	004SB002	**5805**			31000		
	004SB003	**3080**			26200		
	004SB004	1360			19500		
	619SB001	**11800**			1900		
	619SB002	**15000**			NT		
	619SB004	**14000**			33200		
	619SB005	**4410**			NT		
	619SB006	784			NT		
	619SB007	**15500**			NT		
	619SB008	**6300**			NT		
	619SB009	**5400**			33300		
	619SB010	**5240**			32100		
	619SB011	**7800**			NT		
	619SB012	2120			1920		
	619SB013	**9360**			15200		
	619SB014	1840			13500		
	619SB015	**18900**			26400		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Lead(Pb)	004SB001	112.0	400.0[d]	180	51.6	400[d]	51.7
	004SB002	57.5			45.7		
	004SB003	3.0			48.1		
	004SB004	6.8			43.1		
	619SB001	197.0			3.7		
	619SB002	58.8			NT		
	619SB004	45.0			54.9		
	619SB005	43.3			NT		
	619SB006	5.7			NT		
	619SB007	32.0			NT		
	619SB008	28.7			NT		
	619SB009	11.5			50.2		
	619SB010	12.8			49.8		
	619SB011	58.7			NT		
	619SB012	1.3			6.4		
	619SB013	126.0			214.0		
	619SB014	7.3			60.8		
	619SB015	113.0			46.5		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	541.00	NL	NL	3050.0	NL	NL
	004SB002	680.00			5290.0		
	004SB003	318.00			4510.0		
	004SB004	293.00			3160.0		
	619SB001	1710.00			187.0		
	619SB002	1260.00			NT		
	619SB004	2740.00			5370.0		
	619SB005	605.00			NT		
	619SB006	110.85			NT		
	619SB007	2440.00			NT		
	619SB008	1130.00			NT		
	619SB009	756.00			5740.0		
	619SB010	1170.00			5950.0		
	619SB011	1260.00			NT		
	619SB012	3420.00			3610.0		
	619SB013	1380.00			2600.0		
	619SB014	194.00			1760.0		
	619SB015	1660.00			4180.0		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Manganese (Mn)	004SB001	66.7	180.0	307	388.0	1100	469
	004SB002	91.2			701.0		
	004SB003	13.8			286.0		
	004SB004	20.4			227.0		
	619SB001	104.0			8.3		
	619SB002	115.0			NT		
	619SB004	283.0			556.0		
	619SB005	41.6			NT		
	619SB006	9.5			NT		
	619SB007	216.0			NT		
	619SB008	110.0			NT		
	619SB009	54.5			567.0		
	619SB010	81.0			455.0		
	619SB011	150.0			NT		
	619SB012	243.0			234.0		
	610SB013	118.0			181.0		
	610SB014	8.2			140.0		
	610SB015	**320.0**			474.0		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	0.060	2.3	0.62	0.83	2[c]	0.23
	004SB002	0.055			0.31		
	004SB003	ND			0.51		
	004SB004	0.060			0.23		
	619SB001	ND			1.40		
	619SB002	0.140			NT		
	619SB004	0.160			0.39		
	619SB005	0.065			NT		
	619SB006	0.070			NT		
	619SB007	0.280			NT		
	619SB008	0.180			NT		
	619SB009	0.080			0.24		
	619SB010	0.040			0.34		
	619SB011	0.100			NT		
	619SB013	0.240			0.52		
	619SB014	ND			0.18		
	619SB015	0.230			0.34		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	8.30	160.0	12.6	8.0	130[c]	8.85
	004SB002	4.45			11.2		
	004SB003	3.70			13.1		
	004SB004	2.10			10.0		
	619SB001	12.00			1.0		
	619SB002	9.80			NT		
	619SB004	6.40			12.7		
	619SB005	4.80			NT		
	619SB006	0.51			NT		
	619SB007	7.20			NT		
	619SB008	3.90			NT		
	619SB009	2.50			13.8		
	619SB010	5.90			13.2		
	619SB011	5.20			NT		
	619SB012	10.50			12.9		
	619SB013	14.00			12.1		
	619SB014	1.80			7.8		
	619SB015	9.40			9.4		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Potassium (K)	004SB001	ND	NL	NL	1260.0	NL	NL
	004SB002	258.0			2350.0		
	004SB003	ND			2440.0		
	004SB004	ND			1640.0		
	619SB001	761.0			94.5		
	619SB002	639.0			NT		
	619SB004	1100.0			2760.0		
	619SB005	263.5			NT		
	619SB007	1110.0			NT		
	619SB008	353.0			NT		
	619SB009	429.0			3130.0		
	619SB010	500.0			3050.0		
	619SB011	495.0			NT		
	619SB012	485.0			423.0		
	619SB013	620.0			1300.0		
	619SB014	ND			864.0		
	619SB015	767.0			2010.0		
Selenium (Se)	004SB002	0.52	39	1.15	ND	5	1.24
	619SB001	0.64			ND		
	619SB002	0.45			NT		
	619SB004	0.61			1.10		
	619SB007	0.63			NT		
	619SB009	ND			1.30		
	610SB014	ND			0.71		
Silver (Ag)	004SB002	0.24	39	1.85	0.38	34	ND
	619SB006	0.31			NT		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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
Sodium (Na)	004SB001	ND	NL	NL	693	NL	NL
	004SB002	205			3800		
	004SB003	ND			4130		
	004SB004	ND			2620		
	619SB001	620			390		
	619SB002	281			NT		
	619SB004	1170			5190		
	619SB005	216			NT		
	619SB007	1430			NT		
	619SB008	215			NT		
	619SB009	770			6540		
	619SB010	534			7480		
	619SB011	280			NT		
	619SB013	ND			2500		
	619SB014	121			833		
	619SB015	ND			904		
Thallium (Tl)	619SB007	0.57	0.63	NL	NT	1.24	1.24
	619SB009	ND			1.40		
	619SB013	ND			0.50		
Tin (Sn)	619SB001	12.30	4700	9.38	ND	11000	NL

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	15.40	55.0	48.9	42.1	6000[a]	49.4
	004SB002	11.40			65.2		
	004SB003	6.30			58.7		
	004SB004	3.80			40.0		
	619SB001	24.90			4.1		
	619SB002	30.20			NT		
	619SB004	30.20			67.1		
	619SB005	10.45			NT		
	619SB006	2.65			NT		
	619SB007	31.50			NT		
	619SB008	12.40			NT		
	619SB009	10.50			71.7		
	619SB010	12.10			72.5		
	619SB011	13.30			NT		
	619SB012	6.90			5.6		
	619SB013	20.50			30.7		
	619SB014	5.50			26.6		
	619SB015	28.20			54.8		

Table 10.1.4
Zone F
SWMU 4 and AOC 619
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)	004SB001	65.0	2300.0	198	86.8	12000[a,c]	84.2
	004SB002	172.5			102.0		
	004SB003	7.8			106.0		
	004SB004	19.5			87.5		
	619SB001	317.0			ND		
	619SB002	123.0			NT		
	619SB004	64.0			118.0		
	619SB005	111.5			NT		
	619SB006	5.4			NT		
	619SB007	65.4			NT		
	619SB008	72.9			NT		
	619SB009	19.3			115.0		
	619SB010	41.6			116.0		
	619SB011	81.2			NT		
	619SB012	19.4			42.2		
	619SB013	258.0			231.0		
	619SB014	11.3			135.0		
	619SB015	663.0			108.0		

Notes:

a	=	Calculated values correspond to a noncancer hazard quotient of 1
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000
c	=	SSL for pH of 6.8
d	=	A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a)
e	=	Soil saturation concentration (C_{sat})
f	=	Level is at or below contract laboratory program required quantitation limit for regular analytical services (RAS)
*	=	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
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
μg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

Volatile Organic Compounds in Soil

No VOCs were detected above their respective RBCs in surface soil samples. Concentrations of benzene, methylene chloride and trichloroethene (TCE) were detected above their respective SSLs in subsurface soil. Figures 10.1-6 through 10.1-8 illustrate the distribution of these compounds in subsurface soil at the combines SWMU 4/AOC 619 site.

Semivolatile Organic Compounds in Soil

Benzo(a)pyrene was detected above its RBC in surface soil. Figure 10.1-9 illustrates the distribution of Benzo(a)pyrene as total BEQ concentrations in surface soil. No SVOCs were detected in subsurface soil above their SSLs.

Pesticides and PCBs in Soil

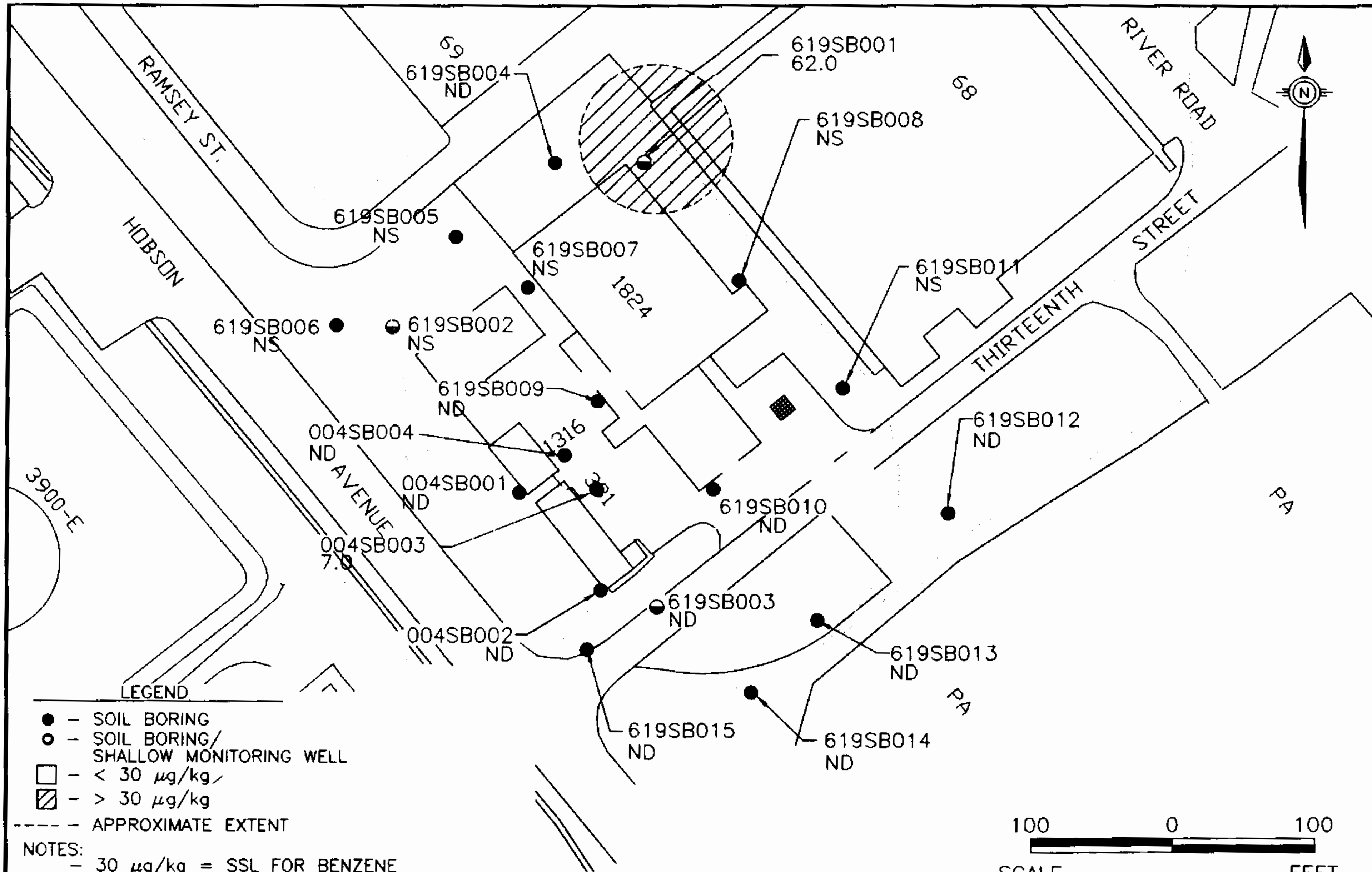
No pesticides or PCBs were detected in surface or subsurface soil samples at concentrations which exceeded RBCs or SSLs.

Other Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in the duplicate of three surface soil samples at concentrations below the RBC.

Inorganic Elements in Soil

Twenty-four metals and cyanide were detected in soil samples collected at SWMU 4/AOC 619. Iron and manganese were detected above their RBCs in surface soil. The concentration of manganese also exceeded its Zone F background concentration. No background was established for iron because it is considered to be an essential nutrient. The distribution of manganese in surface soil is illustrated on Figure 10.1-10. Chromium and thallium were each detected at concentrations exceeding both their SSL and Zone F background concentrations. Figures 10.1-11 and 10.1-12 present the distribution of chromium and thallium in subsurface soil at SWMU 4/AOC 619.



LEGEND

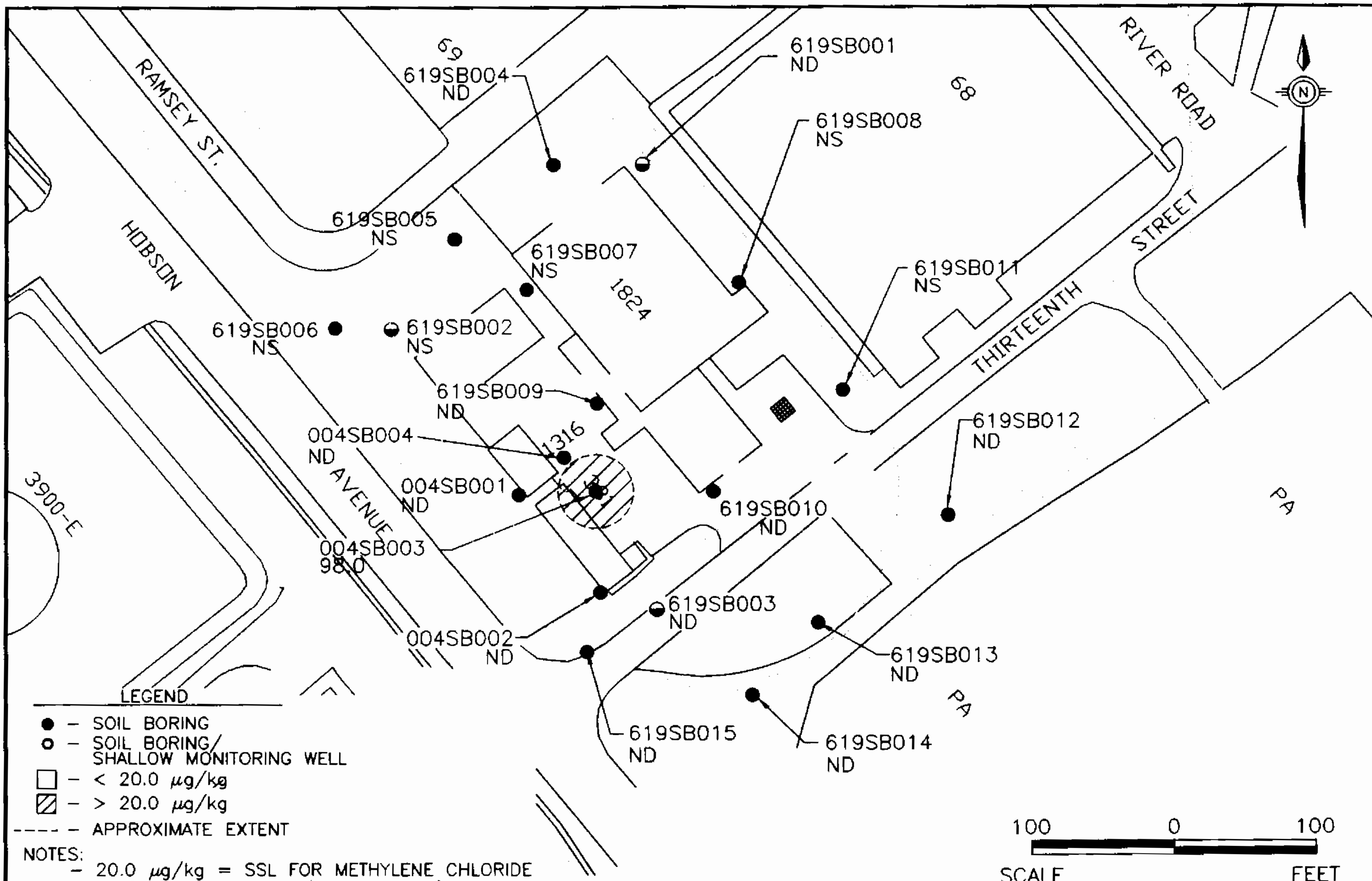
- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- □ – < 30 μg/kg
- ▨ – > 30 μg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 30 μg/kg = SSL FOR BENZENE IN SUBSURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NS = NOT SAMPLED

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

FIGURE 10.1–6
BENZENE IN SUBSURFACE SOIL
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

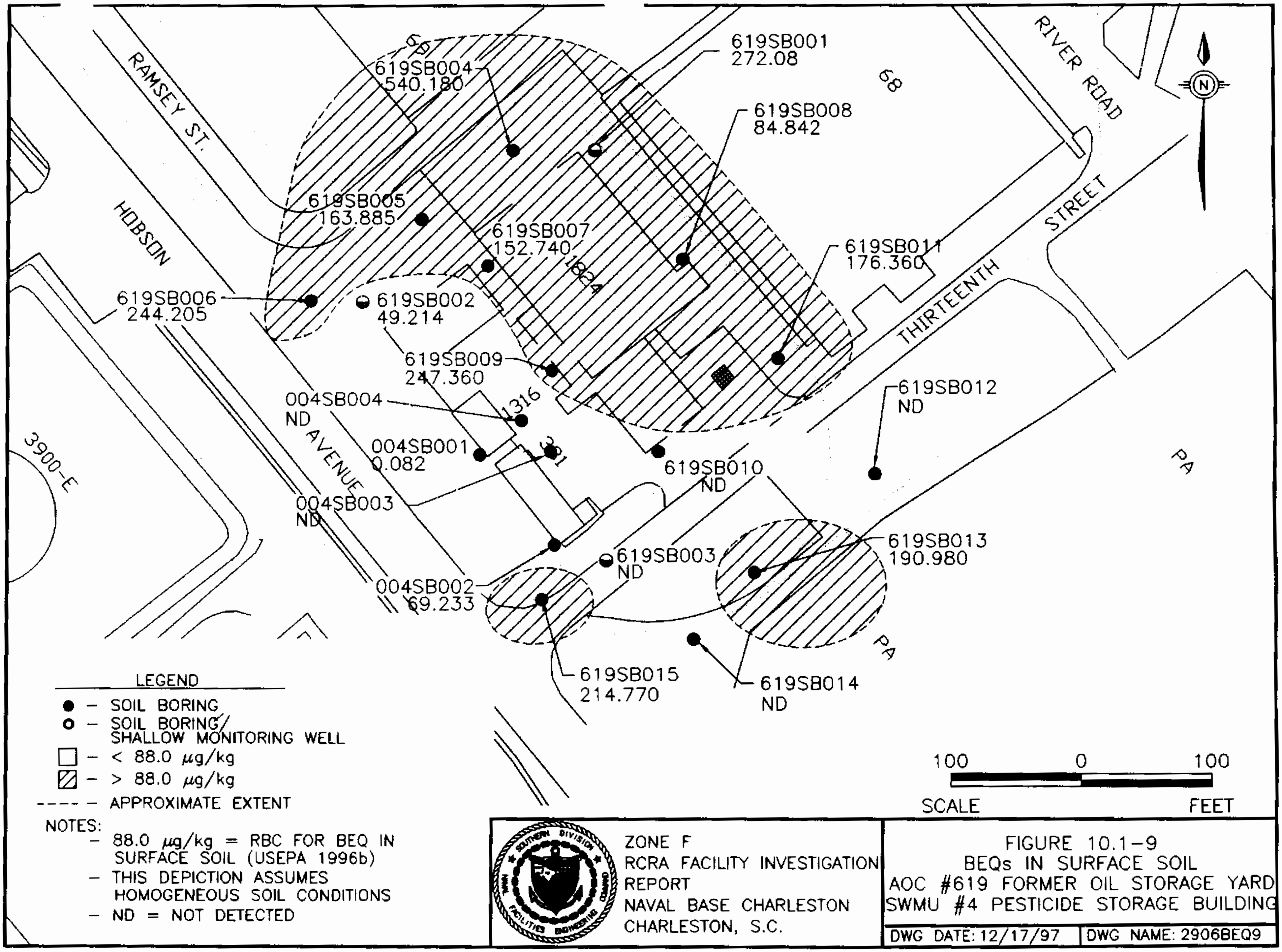
DWG DATE: 12/17/97 | DWG NAME: 2906BZS6



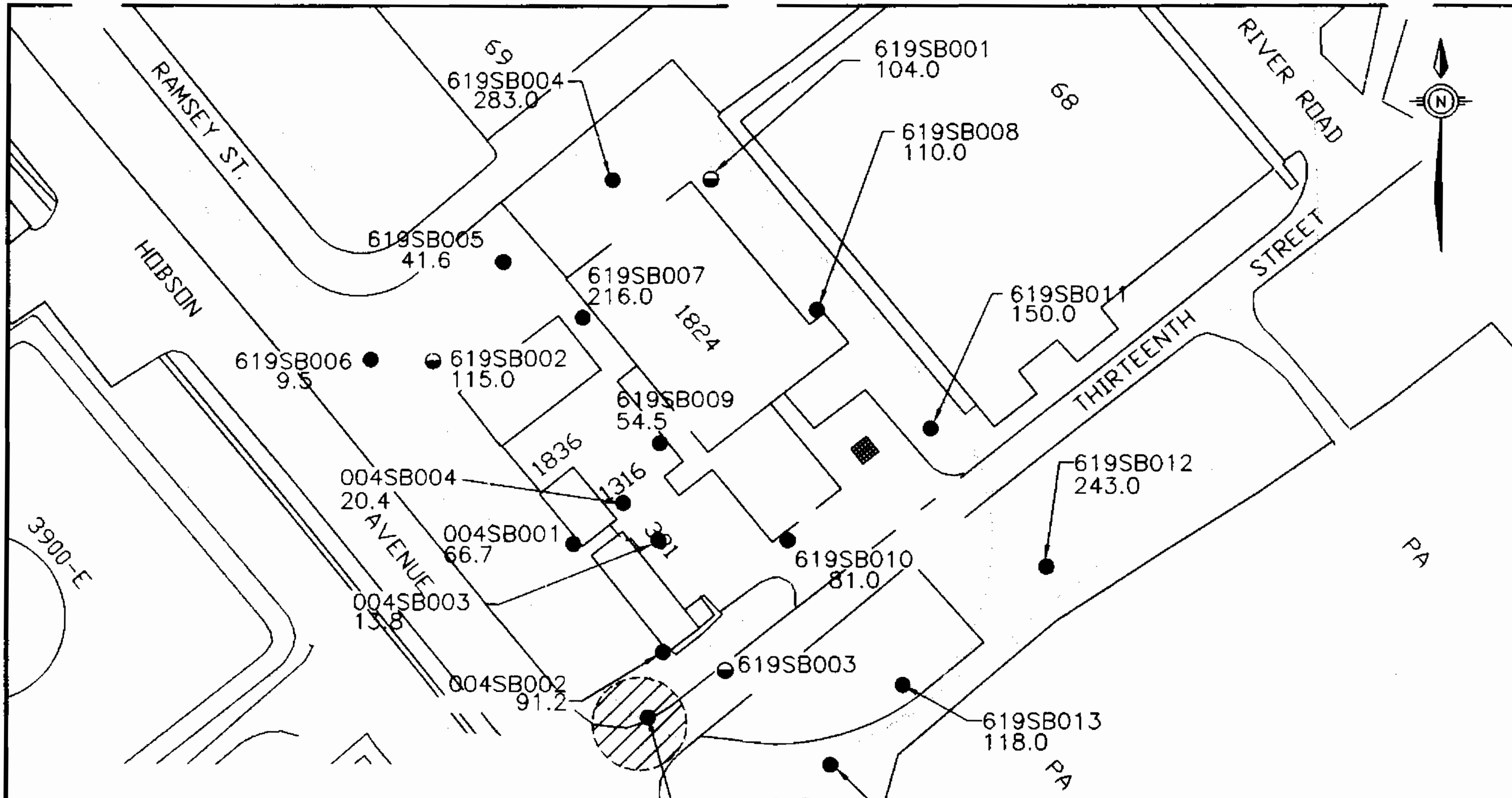
ZONE F
RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1–8
METHYLENE CHLORIDE IN SUBSURFACE SOIL
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

DWG DATE: 12/17/97 | DWG NAME: 2906MCL8



RAMSEY ST.
HOBSON
AVENUE
RIVER ROAD
THIRTEENTH
STREET
3900-E
68
1824
1316
PA
PA
619SB001
272.08
619SB004
540.180
619SB008
84.842
619SB005
163.885
619SB007
152.740
619SB011
176.360
619SB006
244.205
619SB002
49.214
619SB009
247.360
619SB012
ND
004SB004
ND
004SB001
0.082
619SB010
ND
004SB003
ND
619SB013
190.980
619SB003
ND
004SB002
69.233
619SB015
214.770
619SB014
ND
N
LEGEND
● – SOIL BORING
○ – SOIL BORING/ SHALLOW MONITORING WELL
– < 88.0 μg/kg
– > 88.0 μg/kg
---- – APPROXIMATE EXTENT
NOTES:
– 88.0 μg/kg = RBC FOR BEQ IN SURFACE SOIL (USEPA 1996b)
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
– ND = NOT DETECTED
100
0
100
SCALE
FEET
ZONE F
RCRA FACILITY INVESTIGATION
REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.1-9
BEQs IN SURFACE SOIL
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING
DWG DATE: 12/17/97
DWG NAME: 2906BEQ9



LEGEND

- ● – SOIL BORING
- ○ – SOIL BORING/ SHALLOW MONITORING WELL
- ☐ – < 307 mg/kg
- ▨ – > 307 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:

- 307 mg/kg = ZONE F BACKGROUND FOR MANGANESE IN SURFACE SOIL
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

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

FIGURE 10.1-11
MANGANESE IN SURFACE SOIL
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

DWG DATE: 12/17/97	DWG NAME: 2906MSW4

10.1.4 Sediment Sampling and Analysis

The approved final RFI work plan also proposed three sediment samples from onsite storm sewer drains to assess the impact of surface runoff to the storm sewer system. Only one of the three drains proposed for sampling (619M0001, a loading dock platform drain) yielded sediments. The other two proposed sampling locations (619M0002, a wash rack grate; and 004M0001, a storm sewer drain) contained insufficient sediment for sample collection. Therefore, only 619M0001 was collected during the field investigation, as depicted in Figure 10.1-1. In accordance with the approved final RFI work plan, this sample was analyzed for metals, pesticide/PCBs, SVOAs, and VOAs at DQO Level III. This sample was also analyzed for cyanide.

10.1.4.1 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.1.5. Inorganic analytical results for sediment are summarized in Table 10.1.6. Table 10.1.7 summarizes all analytes detected in sediment at the combined site.

The following sections discuss sediment sample analytical results relative to detected soil parameters as an indication of soil contaminant migration via storm water flow. Given that this sediment was collected from engineered structures (storm catch basins, storm water culverts, etc.), it is not true sediment generated in a native setting, and therefore, is not compared to reference concentrations or other criteria. The storm sewer system will be addressed in the Zone L RFI.

Table 10.1.5
Zone F
SWMU 4 and AOC 619
Organic Compound Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)
Volatile Organic Compounds (1 Sample) (µg/kg)			
Trichloroethene	1/1	4.00	4.00
Semivolatile Organic Compounds (1 Sample) (µg/kg)			
BEQs[1]	1/1	81.0	81.0
Benzo(a)anthracene	1/1	86.0	86.0
Benzo(a)pyrene	1/1	67.0	67.0
Benzo(b)fluoranthene	1/1	46.0	46.0
Benzo(g,h,i)perylene	1/1	56.0	56.0
Benzo(k)fluoranthene	1/1	72.0	72.0
Bis(2-Ethylhexyl)phthalate	1/1	410	410
Chrysene	1/1	100	100
Fluoranthene	1/1	180	180
Phenanthrene	1/1	87.0	87.0
Pyrene	1/1	140	140
Pesticides (1 Sample) (µg/kg)			
4,4'-DDE	1/1	6.70	6.70
4,4'-DDT	1/1	7.60	7.60
Endrin aldehyde	1/1	7.40	7.40
alpha-Chlordane	1/1	2.40	2.40

Notes:
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
µg/kg = Micrograms per kilograms

Table 10.1.6
Zone F
SWMU 4 and AOC 619
Inorganics Analytical Results for Sediment

Parameters	Frequency of Detection s	Range of Detections (mg/kg)	Mean of Detections (mg/kg)
Inorganics (1 Sample) (mg/kg)			
Aluminum	1/1	2070	2070
Arsenic	1/1	3.40	3.40
Barium	1/1	22.7	22.7
Cadmium	1/1	0.310	0.310
Calcium	1/1	56500	56500
Chromium	1/1	12.0	12.0
Cyanide	1/1	0.310	0.310
Iron	1/1	5400	5400
Lead	1/1	24.1	24.1
Magnesium	1/1	1440	1440
Manganese	1/1	105	105
Nickel	1/1	6.00	6.00
Potassium	1/1	276	276
Vanadium	1/1	6.40	6.40
Zinc	1/1	563	563

Notes:
mg/kg = Milligrams per kilograms

Table 10.1.7
Zone F
Analytes Detected in SWMU 4 and AOC 619 Sediment Samples

Parameters	Location	Concentration
Volatile Organic Compounds (μg/kg)		
Trichloroethene	619M0001	4.0
Semivolatile Organic Compounds (μg/kg)		
Benzo(a)anthracene	619M0001	86.0
Benzo(a)pyrene	619M0001	67.0
Benzo(b)fluoranthene	619M0001	46.0
Benzo(g,h,i)perylene	619M0001	56.0
Benzo(k)fluoranthene	619M0001	72.0
bis(2-Ethylhexyl)phthalate (BEHP)	619M0001	410.0
Chrysene	619M0001	100.0
Fluoranthene	619M0001	180.0
Phenanthrene	619M0001	87.0
Pyrene	619M0001	140.0
Pesticides (μg/kg)		
4,4'-DDE	619M0001	6.70
4,4'-DDT	619M0001	7.60
Endrin aldehyde	619M0001	7.40
alpha-Chlordane	619M0001	2.40
Inorganics (mg/kg)		
Aluminum (Al)	619M0001	2070.00
Arsenic (As)	619M0001	3.40
Barium (Ba)	619M0001	22.70
Cadmium (Cd)	619M0001	0.31
Calcium (Ca)	619M0001	56500.00
Chromium (Cr)	619M0001	12.00
Cyanide (CN)	619M0001	0.31
Iron (Fe)	619M0001	5400.00

Table 10.1.7
Zone F
Analytes Detected in SWMU 4 and AOC 619 Sediment Samples

Parameters	Location	Concentration
Lead(Pb)	619M0001	24.10
Magnesium (Mg)	619M0001	1440.00
Manganese (Mn)	619M0001	105.00
Nickel (Ni)	619M0001	6.00
Potassium (K)	619M0001	276.00
Vanadium (V)	619M0001	6.40
Zinc (Zn)	619M0001	563.00

Notes:
NA = Not available
ND = Not detected
NT = Not taken
mg\kg = Milligrams per kilogram

Volatile Organic Compounds in Sediment

TCE was the only VOC detected in the sediment. It was also detected in onsite surface and subsurface soil samples.

Semivolatile Organic Compounds in Sediment

Ten semivolatile compounds were detected in the sediment samples. Concentrations of all ten benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, phenanthrene and pyrene, were detected in both onsite soil and sediment.

Pesticides and PCBs in Sediment

Four pesticides were detected in the sediment sample. Concentrations of 4,4'-DDE, 4,4'-DDT, and alpha-chlordane were present in sediment and soil samples. No PCBs were detected in the sediment sample.

Inorganic Elements in Sediment

Fourteen metals and cyanide were detected in the sediment sample. The analytes detected in the sediment were also present in site soil samples.

10.1.5 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of two shallow monitoring wells within the SWMU 4 and AOC 619 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. Three shallow monitoring wells were installed and sampled during the field investigation, as shown in Figure 10.1-2. These wells were installed at approximately 12 ft bgs in the upper sand layer of the Wando Formation. Per the approved final RFI work plan, groundwater samples were analyed for metals, pesticide/PCBs, VOAs, and SVOAs at DQO Level III. They were also analyzed for OP-pesticides. Table 10.1.8 summarizes the groundwater samples and analyses at these sites.

Table 10.1.8
SWMU 4 and AOC 619
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
619001	Shallow	61900101	11/10/96	See note	
619002	Shallow	61900201	11/10/96	See note	
619003	Shallow	61900301	11/09/96	See note	

Note:
SW-846 (metals, pesticide/PCBs, OP-pesticides, SVOAs, and VOAs) at DQO Level III.

10.1.5.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater are summarized in Table 10.1.9. Inorganic analytical results for groundwater are summarized in Table 10.1.10. Table 10.1.11 presents a summary of all analytes detected at SWMU 4 and AOC 619.

Table 10.1.9
Zone F
SWMU 4 and AOC 619
Organic Compound Analytical Results for Groundwater

Parameters	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Tap Water RBC* (μg/kg)	MCL/SMCL* (μg/kg)	Number of Samples Exceeding RBC
Volatile Organic Compounds (3 Samples) (μg/kg)						
Chloromethane	1/3	8.0	8.0	1.4	NL	1
Semivolatile Organic Compounds (3 Samples) (μg/kg)						
2-Methylnaphthalene	1/3	3.0	3.0	150	NL	0
4-Methylphenol (p-Cresol)	2/3	1.0 - 6.0	3.5	18	NL	0
Acenaphthene	1/3	2.0	2.0	220	NL	0
Benzoic acid	1/3	2.0	2.0	15000	NL	0
Dibenzofuran	1/3	2.0	2.0	15	NL	0
Fluorene	1/3	4.0	4.0	150	NL	0
Naphthalene	1/3	2.0	2.0	150	NL	0
Phenanthrene	1/3	2.0	2.0	150	NL	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
μg/kg	=	Micrograms per kilogram
*	=	Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
MCL	=	Maximum contaminant level
SMCL	=	Secondary maximum contaminant level

Table 10.1.10
Zone F
SWMU 4 and AOC 619
Inorganics Analytical Results for Groundwater

Parameters	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Tap Water RBC* µg/L	MCL/SMCL* (µg/L)	Number of Samples Exceeding RBC
Inorganics (3 Samples) (mg/L)						
Aluminum	3/3	105 - 523	287	3700	50	0
Arsenic	2/3	3.00 - 6.50	4.75	0.045	50	2
Barium	3/3	18.2 - 92.2	45.0	260	2000	0
Calcium	3/3	9450 - 205000	93600	NL	NL	NL
Chromium	3/3	1.000 - 2.30	1.43	18	100	0
Iron	3/3	3040 - 32000	13200	1100	300	3
Magnesium	3/3	8480 - 356000	133000	NL	NL	NL
Manganese	3/3	61.2 - 1420	575	84	50	2
Potassium	3/3	3230 - 163000	70600	NL	NL	NL
Sodium	3/3	262000 - 3840000	1600000	NL	NL	NL
Thallium	2/3	3.40 - 6.60	5.00	0.29	2.0	2
Vanadium	2/3	1.60 - 5.10	3.35	26	NL	0

Notes:
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.

Table 10.1.11
Zone F
SWMU 4 and AOC 619
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Volatile Organic Compounds (µg/L)							
Chloromethane	619003	**8.0**	ND	ND	1.4	NL	NA
Semivolatile Organic Compounds (µg/L)							
2-Methylnaphthalene	619003	3.0	ND	1.0	150	NL	NA
4-Methylphenol (p-Cresol)	619002	1.0	ND	ND			
	619003	6.0	ND	ND	18	NL	NA
Acenaphthene	619003	2.0	ND	1.0	220	NL	NA
Benzoic Acid	619002	2.0	ND	5.0	15000	NL	NA
Dibenzofuran	619003	2.0	ND	1.0	15	NL	NA
Fluorene	619003	4.0	ND	2.0	150	NL	NA
Naphthalene	619003	2.0	1.0	1.0	150	NL	NA
Phenanthrene	619003	2.0	ND	ND	150	NL	NA
Inorganics (µg/L)							
Aluminum (Al)	619001	523.0	ND	ND	3700	50	224
	619002	105.0	66.70	311			
	619003	233.0	10.30	189			
Antimony (Sb)	619002	ND	3.2	4.9	1.5	6	NL
	619003	ND	4.9	ND			

Table 10.1.11
Zone F
SWMU 4 and AOC 619
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Arsenic (As)	619001	ND	ND	9.8	0.045	50	16.7
	619002	6.5	4.9	5.4			
	619003	3.0	8.0	3.8			
Barium (Ba)	619001	24.6	ND	17.8	260	2000	94.3
	619002	18.2	18.0	22.6			
	619003	92.2	69.2	49.3			
Beryllium (Be)	619003	ND	0.3900	ND	0.016	4	0.66
Calcium (Ca)	619001	9450.0	14900.0	14000	NL	NL	NL
	619002	66200.0	64200.0	62400			
	619003	205000.0	200000.0	76500			
Chromium (Cr)	619001	1.0	ND	ND	18	100	2.05
	619002	2.3	1.0	1.9			
	619003	1.0	1.5	1.4			
Cobalt (Co)	619001	ND	ND	1.6	220	NL	10.9
	619003	ND	1.4	ND			
Copper (Cu)	619001	ND	4.2	ND	150	1000	NL
	619003	ND	ND	3.6			
Iron (Fe)	619001	3040.0	1190.0	4620	1100	300	NL
	619002	4490.0	3270.0	2420			
	619003	32000.0	17000.0	3330			
Lead (Pb)	619002	ND	0.940	ND	15	15	NL

Table 10.1.11
Zone F
SWMU 4 and AOC 619
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Magnesium (Mg)	619001	8480.0	4140.0	5980	NL	NL	NL
	619002	35400.0	15100.0	18300			
	619003	356000.0	497000.0	122000			
Manganese (Mn)	619001	61.2	22.0	56	84	50	2010
	619002	243.0	264.0	215			
	619003	1420.0	702.0	314			
Mercury (Hg)	619001	ND	ND	0.11	1.1	2	NL
	619002	ND	ND	0.17			
Nickel (Ni)	619002	ND	1.5	ND	73	100	5.55
	619003	ND	1.5	ND			
Potassium (K)	619001	3230.0	3840.0	3800	NL	NL	NL
	619002	45600.0	16200.0	23600			
	619003	163000.0	158000.0	46400			
Sodium (Na)	619001	262000.0	134000.0	182000	NL	NL	NL
	619002	689000.0	234000.0	346000			
	619003	3840000.0	4600000.0	1240000			
Thallium (Tl)	619001	3.4	6.8	1.2	0.29	2	5.58
	619003	6.6	ND	ND			
Vanadium (V)	619001	1.6	ND	ND	26	NL	1.58
	619002	5.1	2.3	3.2			
	619003	ND	7.5	9.4			

Table 10.1.11
Zone F
SWMU 4 and AOC 619
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
pH							
pH	619001	NT	5.750	NT			

Notes:
NL = Not listed
ND = Not detected
NA = Not applicable
NT = Not taken
* = Tap Water RBCs (THQ=0.1) from *Risk-based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulatins and Health Advisories* (USEPA, 1996e), were used as reference concentrations
Bolded concentrations exceed both the RBC and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background values for groundwater are based on two sampling rounds in two wells at each depth.

Volatile Organic Compounds in Groundwater

Chloromethene was detected in shallow groundwater above its RBC. Figure 10.1-13 illustrates the distribution at the site.

Semivolatile Organic Compounds in Groundwater

Eight SVOCs were detected in shallow groundwater. No concentrations exceeded the tap water RBCs.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow groundwater at SWMU 4/AOC 619.

Inorganic Elements in Groundwater

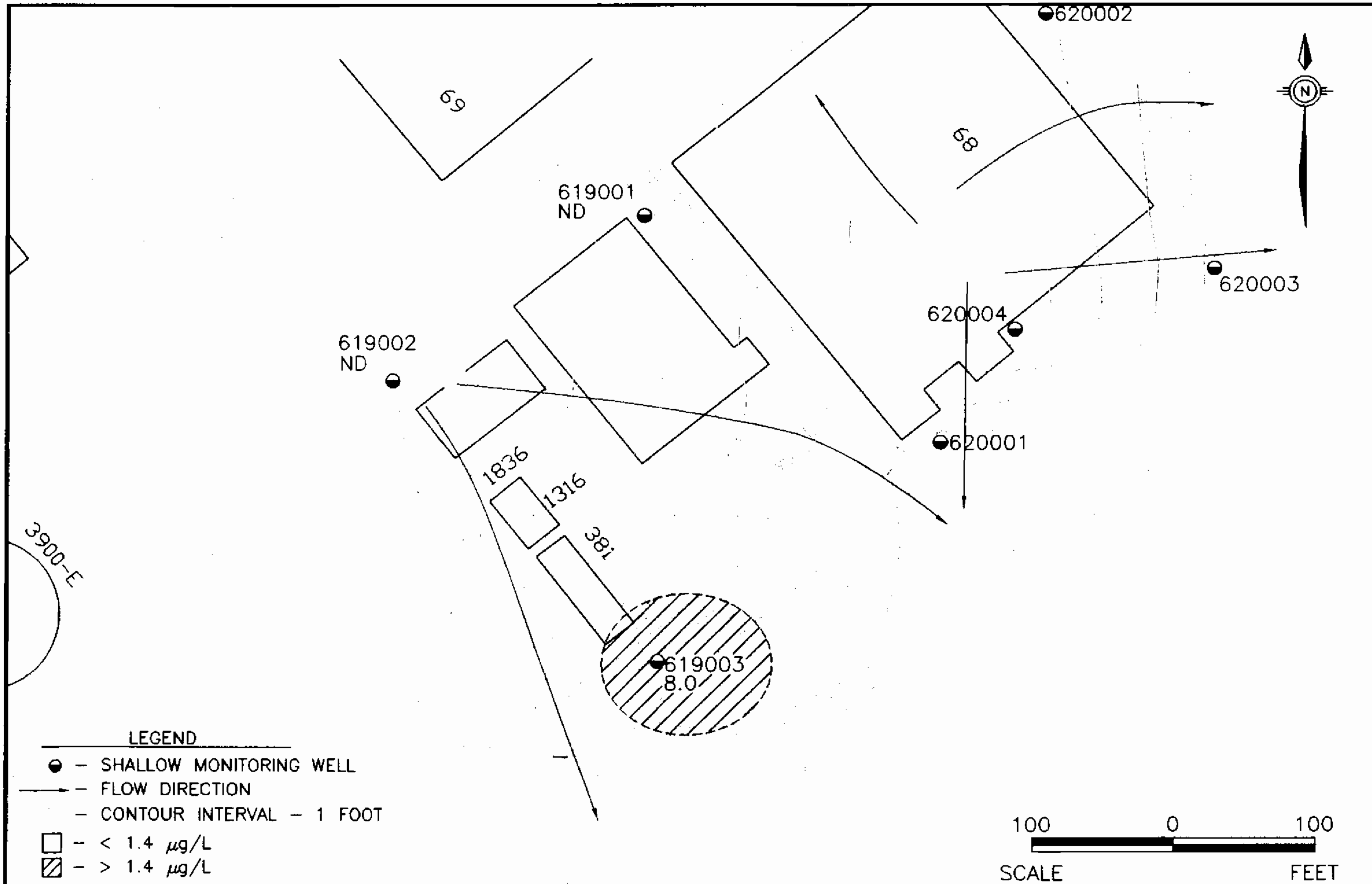
Nineteen metals ere detected in groundwater samples. Thallium was the only metal detected at concentrations exceeding both its RBC and background concentration. Arsenic and manganese were detected above their respective RBCs but below their background concentrations. Iron also exceeded its RBC, no background was determined for the essential nutrient iron. Figure 10.1-14 presents the distribution of thallium in shallow groundwater.

10.1.6 Fate and Transport Assessment for SWMU 4 and AOC 619

Environmental media sampled as part of the combined SWMU 4 and AOC 619 site include surface soil, subsurface soil, shallow groundwater, and storm sewer sediment. Potential constituent migration pathways investigated include soil-to-groundwater, groundwater-to-surface water, surface soil-to-sediment, and emission of volatiles from surface soil-to-air.

10.1.6.2 Soil-to-Groundwater Cross-Media Transport

Table 10.1.12 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater.



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 1 FOOT
- < 1.4 µg/L
- > 1.4 µg/L
- APPROXIMATE EXTENT

NOTES:
- 1.4 µg/L = TAP RBC FOR CHLOROMETHANE (USEPA 1996b)
- RESULTS IN µg/L
- ND = NOT DETECTED

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

FIGURE 10.1-13
CHLOROMETHANE IN SHALLOW GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

DWG DATE: 12/17/97 | DWG NAME: 2906C619

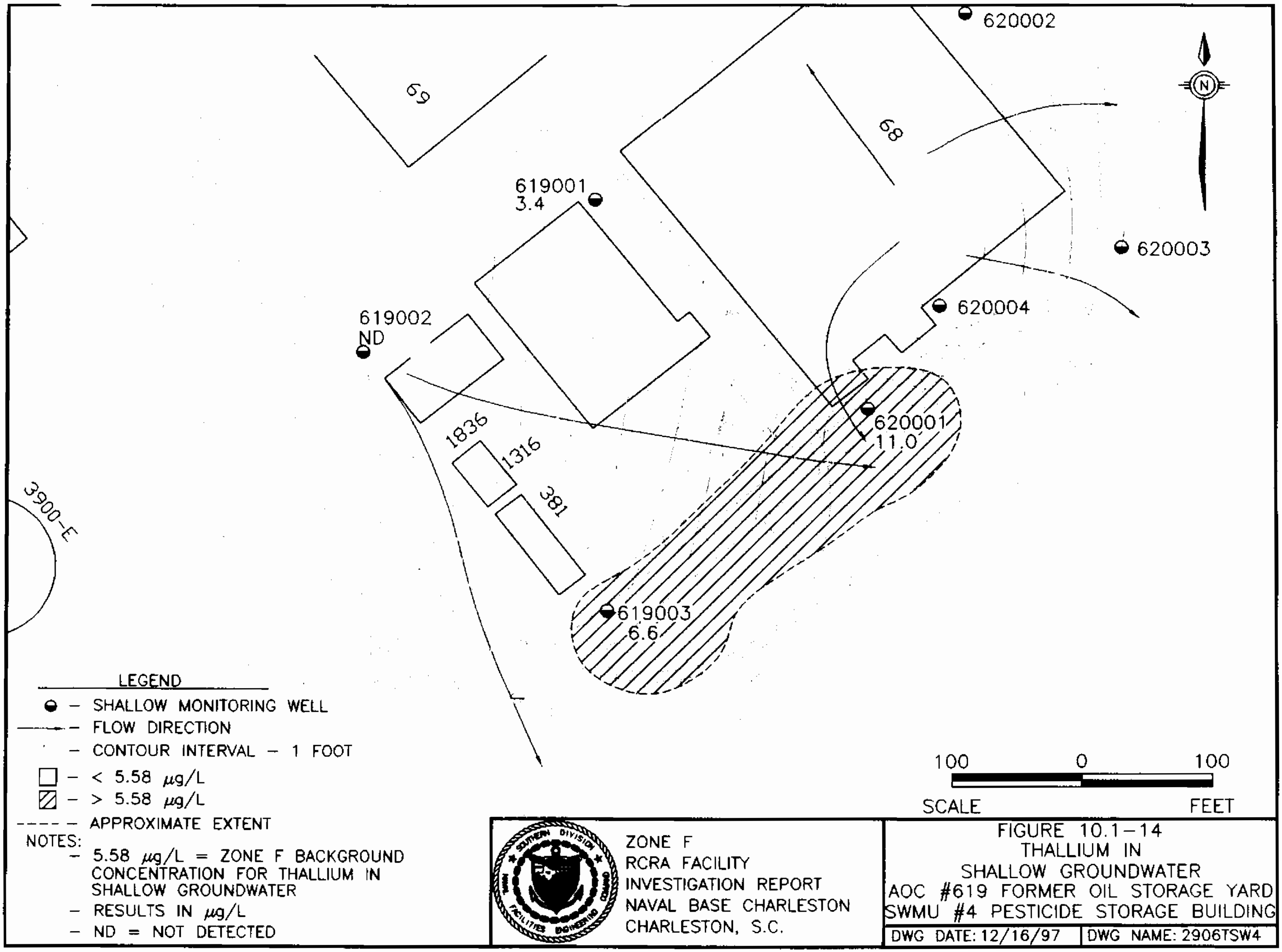


FIGURE 10.1–14
THALLIUM IN
SHALLOW GROUNDWATER
AOC #619 FORMER OIL STORAGE YARD
SWMU #4 PESTICIDE STORAGE BUILDING

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).

One organic compound - pentachlorophenol (PCP) - was detected in surface soil exceeding its SSL. Three additional organic compounds — benzene, methylene chloride, and TCE - were detected in subsurface soil at concentrations exceeding their SSL. Importantly, PCP was not detected in subsurface soil or shallow groundwater samples. Methylene chloride, TCE, and benzene were not detected in any of the three groundwater samples. Benzene and TCE screens were exceeded in the same sample, 619SB001, the methylene chloride screen was exceeded in only one location 619SB004) and PCP was exceeded in only one location 619SB005. Ten volatile organic species were detected in site soil, and without exception they all exhibited an enrichment with depth. In addition to the organic compounds present above their screening levels, a number of other semivolatile compounds, pesticides and PCBs, and dioxin were detected in site soil samples. Generally these detected species exhibited marked depletion with depth. The nature of contamination detected is consistent with past site activities. The vertical distribution of volatiles is counter-intuitive enigmatic, and suggests their occurrence is a relict of a past release(s) in which volatilization has purged surface soil horizons of these constituents; their absence in groundwater indicates that volatilization from this media as a source for soil contamination is not probable. The lateral distribution of volatile and exceedances is indicative of very little residual mass remaining that poses a potential threat to groundwater, and the lack of soil-detected species in groundwater verifies this. The vertical distribution of the other detected organic species is consistent with their characteristically high affinities for attenuation through soil media adsorption, and their absence to low concentrations in groundwater proves that they pose no threat to groundwater.

Table 10.1.12
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: SWMU 4 and AOC 619
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	ND	62	ND	NA	30	0.36	109	UG/KG	UG/L	YES	NO	NO
2-Butanone (MEK)	7	46	ND	NA	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	7	15	ND	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	ND	64	ND	NA	1000	39	105	UG/KG	UG/L	NO	NO	NO
Chloroform	ND	2	ND	NA	600	0.15	815	UG/KG	UG/L	NO	NO	NO
Chloromethane	ND	ND	8	NA	6.6	1.4	NA	UG/KG	UG/L	NO	YES	NO
1,1-Dichloroethene	ND	44	ND	NA	60	0.044	2240	UG/KG	UG/L	NO	NO	NO
1,2-Dichloroethene (total)	ND	2	ND	NA	400	55	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	6	98	ND	NA	20	4.1	2560	UG/KG	UG/L	YES	NO	NO
Toluene	ND	61	ND	NA	12000	750	37	UG/KG	UG/L	NO	NO	NO
Trichloroethene	2	62	ND	NA	60	1.6	NA	UG/KG	UG/L	YES	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	340	ND	2	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	72	ND	ND	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	750	100	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	130	110	2	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	200	90	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	600	200	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	410	200	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	460	240	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	370	230	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	480	350	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	200	100	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	42	ND	ND	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	41	ND	2	NA	240000	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	200	ND	ND	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Diethylphthalate	94	ND	ND	NA	470000	29000	75.9	UG/KG	UG/L	NO	NO	NO
Di-n-octylphthalate	56	ND	ND	NA	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	1400	ND	ND	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	3100	810	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	195	ND	4	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	600	ND	3	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	ND	6	NA	1380	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	680	ND	2	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	74	ND	ND	NA	30	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Phenanthrene	1200	85	2	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	2500	670	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	250	210	ND	NA	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO
alpha-Chlordane	19.5	ND	ND	NA	10000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	54.5	22	ND	NA	10000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	200	16	ND	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	530	43	ND	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	52	ND	ND	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Endrin	14	ND	ND	NA	1000	11	0.0023	UG/KG	UG/L	NO	NO	NO
Heptachlor	ND	2.3	ND	NA	23000	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	3.1	ND	ND	NA	700	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	2.46	NA	NA	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	12600	25200	523	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	0.67	0.58	ND	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	17.8	28.1	6.5	NA	29	16.7	36	MG/KG	UG/L	NO	NO	NO
Barium	65.6	40.2	92.2	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO

Table 10.1.12
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: SWMU 4 and AOC 619
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
Beryllium	0.93	1.5	ND	NA	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.99	0.62	ND	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	22.8	43.4	2.3	NA	38	180	50	MG/KG	UG/L	YES	NO	NO
Cobalt	22.2	7.8	ND	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	92.4	44.1	ND	NA	920	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.17	ND	NA	NA	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	197	214	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	320	701	1420	NA	1100	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.28	1.4	ND	NA	2	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	14	13.8	ND	NA	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	0.64	1.3	ND	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.31	0.38	ND	NA	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Thallium	0.57	1.4	6.6	NA	1.24	2.9	21.3	MG/KG	UG/L	YES	YES	NO
Tin	12.3	ND	ND	NA	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	31.5	72.5	5.1	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	663	231	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, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 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 reference value

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
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

Two inorganics - chromium and thallium - were present in subsurface soil at concentrations exceeding their SSLs. These species wee also present in surface soil, at lesser concentrations. Chromium was exceeded at four locations (004SB003, 619SB004, 619SB009, 619SB010), while thallium was exceeded at only one (619SB009). Several other inorganic species exhibited increased concentrations with depth. The chromium and thallium detections may be associated with past site activities. Additionally, their vertical distribution is inconsistent with surface releases as a provenance. However, given that indigenous and "fill"subsurface soil is very heterogenous, consideration should be given that these may represent ambient concentrations and may not be related to site activities. Chromium concentrations do not appear to pose a risk to groundwater through leaching, as no chromium exceedances in groundwater were present. Thallium, however, is present above screening levels in groundwater, but only slightly. Overall, the data provide that the soil to groundwater pathway is not expected to result in significant risk to human health or the environment.

10.1.6.3 Groundwater-to-Surface Water Cross-Media Transport

Table 10.1.12 also 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 one organic compound — chloromethane - was detected in groundwater at concentrations only slightly above its tap water RBC, and it did not exceed the salt water screening criteria. This exceedance was only present at one location (619SB003), which is downgradient of the general site area. This constituent is conceivably remotely associated with past site activities. However, this constituent was not detected in the colocated site soil samples, so a clear link between soil and groundwater is absent, effectively eliminating this site as a source for this exceedance. Only one inorganic - thallium - was detected in groundwater very slightly above its RBC; and it did not exceed the saltwater screening criteria. As previously discussed, the source of thallium is unclear, and cannot be linked directly to this site. Overall, the clear lack of source attribution, the general low concentrations of exceedances, and the limited lateral presistence of exceeding constituents provide that the groundwater migration pathway is insignificant at this site. In addition, and most importantly, the risk-based pathway from this site is invalid due to non-use of the resource. As for migration to surface water, no constituents were detected at deleterious concentrations; an additional factor is that the migration pathway to the nearest surface water (Cooper River, 1100 feet northeast of this site) is invalid through the inconsistency between local flow directions and the location of the River.

10.1.6.4 Soil-to-Sediment Cross Media Transport

One sediment sample was collected from a stormwater catch basin that drains the dock area of Building 1824. Table 10.1.7 summarizes the analytes detected in the sediment sample. The only VOC found in common between the surface soil and sediment was TCE. Ten SVOCs and three pesticides were also detected in the surface soil and sediment sample. For inorganics, many of the constituents detected in soil samples were also detected in sediment samples at the site. Of 25 species present in surface soil, 15 were also detected in sediment. This relationship establishes a link between surface soil and sediment, and implies either that surface soil is a source of these constituents in sediment, or at least contributes to the sediment load present in the stormwater drainage system.

10.1.6.5 Soil-to-Air Cross-Media Transport

Table 10.1.13 lists the VOCs detected in surface soil samples collected at this site along with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at SWMU 4/AOC 619. In addition, none of the VOCs was reported at a maximum concentration exceeding its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not valid at SWMU 4 and AOC 619.

10.1.6.6 Fate and Transport Summary

Three volatiles and one semivolatile were present in site soil at concentrations above their SSLs. Additionally, a number of other organics (volatiles, semivolatiles, pesticide/PCBs, and dioxin) were present in site soil. The vertical distribution of volatiles suggest association with old release(s) in which purging of surface soil has occurred, while the vertical distribution of other organics is consistent with their adsorption and demobilization in surface soil horizons. Only two inorganics, chromium and thallium, were present in site subsurface soil at levels exceeding SSLs, they both were present at lesser concentrations in surface soil. The vertical distribution of these is inconsistent with the site as a provenence, and may be related to ambient subsurface concentrations. One volatile (chloromethane) and one inorganic (thallium) were present in groundwater above RBCs, and both were below their saltwater screening criteria. Neither of these exceedances can be linked empirically to the site as a provenance, and neither is laterally persistent. The risk-based groundwater migration pathway is invalid due to non-use of the resource, and the surface water migration pathway is invalid due to an absence of screening exceedances and inconsistency between groundwater flow directions and the location of the Cooper River. The soil-to-air pathway is invalid at this site due to an absence of screening exceedances.

Table 10.1.13
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone F: SWMU 4 and AOC 619
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
2-Butanone (MEK)	7	10000	UG/KG	NO
Carbon disulfide	7	720000	UG/KG	NO
Methylene chloride	6	13000	UG/KG	NO
Trichloroethene	2	5000	UG/KG	NO

* - 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. Value for 2-Butanone was estimated.

NA - Not available

10.1.7 Human Health Risk Assessment for SWMU 4 and AOC 619

10.1.7.1 Site Background and Investigative Approach

SWMU 4 is pesticide storage area located in Building 3810 and AOC 619 is a former oil storage yard in the vicinity of Buildings 316, 381, 1824, and 1836. Data generated for these two sites have been combined for the purposes of this HHRA. The following refers to these sites as combined SWMU 4.

During the RFI, 19 upper and 13 lower interval soil samples were collected to assess potential impacts resulting from the activities listed above. Surface and subsurface soil samples analyses are shown on Table 10.1.1. Surface soil data were used to quantitatively assess direct contact pathways. Fate and Transport, Section 10.1.6 quantitatively addresses surface and subsurface soil with respect to indirect exposure pathways. Three monitoring wells were installed in the shallow aquifer, and sampled for VOAs, SVOAs, pesticides, and metals. Data from the first quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.1.3 and 10.1.5 provide summaries of the sampling effort for combined SWMU 4 soil and groundwater.

10.1.7.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.1.14, the focus of this HHRA is on the following COPCs: BEQs and manganese. Aluminum, arsenic, and beryllium were detected at maximum concentrations exceeding their RBCs, however, these constituents were eliminated from consideration in the risk assessment based on comparison to their background concentrations. 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 10.1.14
Chemicals Present in Site Samples
SWMU 4 and AOC 619 - Surface Soil
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Screening Concentration Reference	Units	Number Exceeding RBC	Number Exceeding Ref.
PCBs													
Aroclor-1260		7	19	5.9	250	83.4	46	150	320	NA	UG/KG		
Carcinogenic PAHs													
B(a)P Equiv.	*	13	18	0.082	540.18	185	831.96	924.4	88	NA	UG/KG	9	
Benzo(a)anthracene		10	18	53.5	600	160	360	420	880	NA	UG/KG		
Benzo(b)fluoranthene		11	18	57	460	205	360	400	880	NA	UG/KG		
Chrysene		13	18	54	480	192	360	400	88000	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		10	18	39	200	82.6	360	420	880	NA	UG/KG		
Benzo(k)fluoranthene		10	18	46	370	155	360	400	8800	NA	UG/KG		
Benzo(a)pyrene	*	12	18	43	410	160	360	400	88	NA	UG/KG	9	
TCDD Equivalents													
Dioxin Equiv.		3	3	0.5039	2.456	1.17	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		2	3	20.1	102	61.1	58.5	58.5	NA	NA	NG/KG		
1234789-HpCDF		1	3	1.09	1.09	1.09	1.31	1.35	NA	NA	NG/KG		
1234678-HpCDF		2	3	19.1	25.8	22.5	6.6	6.6	NA	NA	NG/KG		
123678-HxCDD		2	3	0.848	3.57	2.21	1.52	1.52	NA	NA	NG/KG		
123789-HxCDD		1	3	1.49	1.49	1.49	0.305	1.02	NA	NA	NG/KG		
123678-HxCDF		1	3	0.508	0.508	0.51	0.335	0.82	NA	NA	NG/KG		
OCDD		2	3	149	703	426	468	468	NA	NA	NG/KG		
OCDF		3	3	18.3	118	56.6	NA	NA	NA	NA	NG/KG		
12378-PeCDF		1	3	0.596	0.596	0.60	0.108	0.762	NA	NA	NG/KG		
2378-TCDF		1	3	1.32	1.32	1.32	0.229	0.52	NA	NA	NG/KG		
Inoganics													
Aluminum (Al)		18	18	751	12600	5795	NA	NA	7800	18500	MG/KG	4	
Antimony (Sb)		2	18	0.53	0.67	0.60	0.33	2	3.1	0.79	MG/KG		
Arsenic (As)		18	18	1.115	17.8	6.60	NA	NA	0.43	19.9	MG/KG	18	
Barium (Ba)		18	18	3.9	65.6	24.3	NA	NA	550	61.5	MG/KG		1
Beryllium (Be)		15	18	0.055	0.93	0.39	0.27	0.34	0.15	1.05	MG/KG	13	
Cadmium (Cd)		16	18	0.06	0.99	0.29	0.05	0.05	3.9	0.26	MG/KG		7
Calcium (Ca)	N	18	18	801	312000	34028	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		18	18	3.4	22.8	12.5	NA	NA	39	34.8	MG/KG		
Cobalt (Co)		17	18	0.86	22.2	3.97	0.34	0.34	470	15.1	MG/KG		1
Copper (Cu)		18	18	1.5	92.4	23.1	NA	NA	310	48.2	MG/KG		3
Cyanide (CN)		1	7	0.17	0.17	0.17	0.11	0.25	160	0.29	MG/KG		
Iron (Fe)	N	18	18	784	18900	7509	NA	NA	NA	NA	MG/KG		
Lead (Pb)		18	18	1.3	197	51.1	NA	NA	400	180	MG/KG		1
Magnesium (Mg)	N	18	18	110.85	3420	1204	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	18	18	8.2	320	114	NA	NA	180	307	MG/KG	4	1
Mercury (Hg)		14	18	0.04	0.28	0.13	0.04	0.04	2.3	0.62	MG/KG		
Nickel (Ni)		18	18	0.515	14	6.25	NA	NA	160	12.6	MG/KG		1
Potassium (K)	N	13	18	258	1110	599	221	243	NA	NA	MG/KG		
Selenium (Se)		5	18	0.45	0.64	0.57	0.33	0.71	39	1.15	MG/KG		
Silver (Ag)		2	18	0.24	0.31	0.28	0.21	0.29	39	1.85	MG/KG		
Sodium (Na)	N	11	18	121	1430	531	134	524	NA	NA	MG/KG		
Thallium (Tl)		1	18	0.57	0.57	0.57	0.37	0.44	0.63	NA	MG/KG		
Tin (Sn)		1	18	12.3	12.3	12.3	0.64	8.1	4700	9.38	MG/KG		1
Vanadium (V)		18	18	2.65	31.5	15.3	NA	NA	55	48.9	MG/KG		
Zinc (Zn)		18	18	5.4	663	118	NA	NA	2300	198	MG/KG		3
Pesticides													
alpha-Chlordane		7	19	2.5	19.5	8.50	1.4	14	490	NA	UG/KG		
gamma-Chlordane		7	19	4.3	54.5	23.1	1.4	2.2	490	NA	UG/KG		
4,4'-DDD		6	19	4.45	200	56.6	2.6	3.4	2700	NA	UG/KG		
4,4'-DDE		3	19	11.6	530	189	2.6	3.4	1900	NA	UG/KG		
4,4'-DDT		3	19	11.3	52	27.1	2.6	5.4	1900	NA	UG/KG		
Endrin		3	19	4.6	14	9.00	2.6	3.4	2300	NA	UG/KG		
Heptachlor epoxide		2	19	2.5	3.1	2.80	1.4	1.8	70	NA	UG/KG		
Semivolatile Organics													
Acenaphthene		1	18	340	340	340	360	440	470000	NA	UG/KG		
Acenaphthylene		2	18	51	72	61.5	360	440	310000	NA	UG/KG		
Anthracene		6	18	48	750	183	360	420	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		11	18	59	200	85.0	360	420	310000	NA	UG/KG		
Benzoic acid		6	18	48	130	95.8	1800	2000	31000000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate		7	18	44	1400	278	360	420	46000	NA	UG/KG		
Butylbenzylphthalate		1	18	42	42	42.0	360	440	1600000	NA	UG/KG		
Dibenzofuran		1	18	41	41	41.0	360	440	31000	NA	UG/KG		
Di-n-butylphthalate		3	18	48	200	100	360	440	780000	NA	UG/KG		
Di-n-octylphthalate		1	18	56	56	56.0	360	440	160000	NA	UG/KG		
Fluoranthene		12	18	53	3100	468	360	400	310000	NA	UG/KG		
Fluorene		2	18	110	195	153	360	440	310000	NA	UG/KG		
2-Methylnaphthalene		5	18	45	800	238	360	440	310000	NA	UG/KG		
Naphthalene		1	18	680	680	680	360	440	310000	NA	UG/KG		
Pentachlorophenol		1	18	74	74	74.0	1800	2200	5300	NA	UG/KG		
Phenanthrene		12	18	52	1200	227	360	400	310000	NA	UG/KG		
Pyrene		13	18	44	2500	495	360	400	230000	NA	UG/KG		
Volatile Organics													
2-Butanone		3	18	4	7	5.00	6	85	4700000	NA	UG/KG		
Carbon disulfide		1	18	7	7	7.00	5	29	780000	NA	UG/KG		
Methylene chloride		3	18	2	6	3.33	4	29	85000	NA	UG/KG		
Trichloroethene		3	18	2	2	2.00	5	29	58000	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
NA - Not applicable

Groundwater

As shown in Table 10.1.15, chloromethane and thallium were identified as COPCs in shallow groundwater for combined SWMU 4. Arsenic and manganese were detected at maximum concentrations which exceeded their RBCs and were eliminated from consideration in the risk assessment based on comparison to their background values. An inadequate number of groundwater background samples were collected in order to run Wilcoxon rank sum test analyses; therefore these analyses were not performed for Zone F.

10.1.7.3 Exposure Assessment

Exposure Setting

Combined SWMU 4 is located in an industrialized setting, approximately 1150 feet southwest of the water front along the Cooper River. The site is mostly surrounded by buildings, roads, railroad right-of-ways, and paved parking areas. In general, direct contact with soil, and migration of potential contaminants to groundwater or air is currently limited by these surface coverings. 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. Additional potentially exposed populations are hypothetical future site residents. 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 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 (the entire area is paved). Therefore, future worker assessment is considered to be conservatively representative of current site users. The

Table 10.1.15
Chemicals Present in Site Samples
SWMU 4 and AOC 619 - Groundwater
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Reference	Units	Number Exceeding RBC	Ref.
Inorganics													
Aluminum (Al)		3	3	105	523	287	NA	NA	3700	224	UG/L		2
Arsenic (As)		2	3	3	6.5	4.75	2.5	2.5	0.045	16.7	UG/L	2	
Barium (Ba)		3	3	18.2	92.2	45.0	NA	NA	260	94.3	UG/L		
Calcium (Ca)	N	3	3	9450	205000	93550	NA	NA	NA	NA	UG/L		
Chromium (Cr)		3	3	1	2.3	1.43	NA	NA	18	2.05	UG/L		1
Iron (Fe)	N	3	3	3040	32000	13177	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	N	3	3	8480	356000	133293	NA	NA	NA	NA	UG/L		
Manganese (Mn)		3	3	61.2	1420	575	NA	NA	84	2010	UG/L	2	
Potassium (K)	N	3	3	3230	163000	70610	NA	NA	NA	NA	UG/L		
Sodium (Na)	N	3	3	262000	3840000	1597000	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	2	3	3.4	6.6	5.00	2.7	2.7	0.29	5.58	UG/L	2	2
Vanadium (V)		2	3	1.6	5.1	3.35	0.5	0.5	26	1.58	UG/L		2
Semivolatile Organics													
Acenaphthene		1	3	2	2	2.00	10	10	220	NA	UG/L		
Benzoic acid		1	3	2	2	2.00	50	50	15000	NA	UG/L		
Dibenzofuran		1	3	2	2	2.00	10	10	15	NA	UG/L		
Fluorene		1	3	4	4	4.00	10	10	150	NA	UG/L		
2-Methylnaphthalene		1	3	3	3	3.00	10	10	150	NA	UG/L		
4-Methylphenol		2	3	1	6	3.50	10	10	18	NA	UG/L		
Naphthalene		1	3	2	2	2.00	10	10	150	NA	UG/L		
Phenanthrene		1	3	2	2	2.00	10	10	150	NA	UG/L		
Volatile Organics													
Chloromethane	*	1	3	8	8	8.00	10	10	1.4	NA	UG/L	1	

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - microgram per liter
NA - Not applicable

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 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 and inhalation of VOCs resulting from domestic use. Table 10.1.16 presents the justification for exposure pathways assessed in this HHRA.

Table 10.1.16
Exposure Pathways Summary — Combined SWMU 4
NAVBASE — Zone F
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	Little surface soil is exposed at combined SWMU 4, inhibiting fugitive dust generation. Therefore, 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 nonresidential water at combined SWMU 4.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at combined SWMU 4.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.

Table 10.1.16
Exposure Pathways Summary — Combined SWMU 4
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	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 combined SWMU 4, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Groundwater is not likely to be used as a source of potable water at combined SWMU 4; however, this pathway was included as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Groundwater is not likely to be used as a source of domestic or process water at combined SWMU 4; however, this pathway was included as a conservative measure.
	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

For soil, exposure point concentrations were set equal to the 95% UCL as presented on Table 10.1.17 and discussed in Section 7 of this RFI. Since neither groundwater COPC could be associated with a specific plume, exposure point concentrations were set equal to their maximum detected concentrations.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.1.18 and 10.1.19, respectively.

Groundwater

The CDIs for groundwater ingestion are presented in Table 10.1.20.

10.1.7.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.1.21 presents toxicological information specific to each COPC identified at combined SWMU 4. 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.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating

Table 10.1.17
Summary of Statistical Analysis
Surface Soil COPCs; SWMU 4 and AOC 619
Naval Base Charleston, Zone F
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Inorganic								
Manganese (Mn)	18	4.277	1.130	2.461	197	320	197	95% UCL
Semivolatile Organics								
Benzo(a)pyrene equivalents	18	4.962	1.986	2.461	0.20	0.54	0.20	95% 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 10.1.18
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics							
Manganese (Mn)	1	197	2.7E-04	2.5E-03	3.1E-04	9.6E-05	3.4E-05
Semivolatile Organics							
Benzo(a)pyrene equivalents	1	0.20	2.7E-07	2.5E-06	3.1E-07	9.6E-08	3.4E-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 10.1.19
Chronic Daily Intakes
Dermal Contact with Surface Soil
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics								
Manganese (Mn)	1	197	0.001	1.1E-05	3.7E-05	6.9E-06	7.9E-06	2.8E-06
Semivolatile Organics								
Benzo(a)pyrene equivalents	1	0.20	0.01	1.1E-07	3.7E-07	6.9E-08	7.9E-08	2.8E-08

NOTES:

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.
- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.1.20
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
SWMU 4 and AOC 619
Naval Base Charleston Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics						
Thallium	0.0066	1.81E-04	4.22E-04	9.95E-05	6.46E-05	3.18E-05
Volatile Organics						
Chloromethane	0.008	2.19E-04	5.11E-04	1.21E-04	7.83E-05	3.85E-05

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.1.21
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 4 and AOC 619
Zone F
NAVBASE - Charleston

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
ical	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
(a)pyrene equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	6.1	c	B2	mutagen
omethane	0.257		H	hepatotoxicity	300	0.257		H	hepatotoxicity	NA	0.012	b	0.0063	b	C	kidney tumors
anese	0.047	a	NA	neurological effects	1	0.0000143	a	M	neurological effects	1000	NA		NA		D	NA
um	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA		NA		D	NA

- = Integrated Risk Information System (IRIS)
- = Health Effects Assessment Summary Tables (HEAST)
- = Withdrawn from IRIS/HEAST
- = Not applicable or not available
- = High confidence
- = Low confidence
- = Medium confidence

intake from soil and water. In addition, the body is roughly twice as efficient absorbing manganese in water compared to manganese in food. Because of the different uptake rates in water and food, two RfDs are provided for manganese – one for water and one for food/soil. The RfDs used are 0.047 food and 0.023 water mg/kg-day. The RfD for food/soil (0.047) is used on Table 10.1.21. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

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 RfDo for thallium (as thallium carbonate) is 0.00008 mg/kg-day (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

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 7.3 $(mg/kg\text{-}day)^{-1}$. 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 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 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 (see Additional Comments for Oral Exposure). 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. The classification reflects 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 presented as the risk per (mg/kg-day). The unit risk is the 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.

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. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

Chloromethane is a clear, colorless gas that has a faintly sweet, nonirritating odor at high levels in the air. A naturally occurring chemical, it is made in large amounts in the oceans and is produced by some plants and rotting wood and when such materials as grass, wood, charcoal, and coal burn. Chloromethane is also produced industrially, but most of it is destroyed during use.

It is used mainly in the production of other chemicals such as silicones (72%), agricultural chemicals (8%), quaternary mines, and butyl rubber.

Case reports of humans exposed acutely to high concentrations of chloromethane have described severe neurological effects, sometimes followed by death. Effects on the cardiovascular system, liver, and kidney have also been described in the case reports of humans exposed for brief periods or for more prolonged periods occupationally (Gummart, 1961; McNally, 1946; Spevak et al., 1976). Numerous acute inhalation studies have identified the liver and kidney as target organs in rats and mice, the spleen in mice and dogs, and the testes and epididymides as target organs in rats. These studies have shown that species differences in susceptibility exist and that generally animals are more susceptible to relatively low exposures given continuously than to relatively high exposures given intermittently (ATSDR, 1990). USEPA has ranked chloromethane as a group C carcinogen (USEPA, 1993). Chloromethane has an oral SF as well as an inhalation SF that are 1.3E-02 and 6.3E-03, respectively (USEPA, 1996f)

10.1.7.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (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 10.1.22 and 10.1.23 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Table 10.1.22
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
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							
Manganese (Mn)	0.047	NA	0.0057	0.054	ND	0.0021	ND
Semivolatile Organics							
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	2.3E-06	ND	2.5E-07
SUM Hazard Index/ILCR			0.006	0.05	2E-06	0.002	3E-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 10.1.23
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
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 Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganics								
Manganese (Mn)	0.2	0.009	NA	0.0012	0.0039	ND	0.00084	ND
Semivolatile Organics								
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	1.0E-06	ND	4.1E-07
SUM Hazard Index/ILCR				0.001	0.004	1E-06	0.0008	4E-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 Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for combined SWMU 4 surface soils is 2E-6. The dermal pathway ILCR is 1E-6. BEQs were the sole contributors to risk projections for the ingestion and dermal pathways.

The computed hazard indices for the adult resident was 0.006 for the soil ingestion pathway and 0.001 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 0.05 and 0.004, respectively.

Hypothetical Site Workers

Site worker ILCRs are 3E-7 and 4E-7 for the ingestion and dermal contact pathways, respectively. Hazard indices for the ingestion and dermal pathways were projected to be 0.002 and 0.0008, respectively, for the hypothetical site worker scenario.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under residential and industrial scenarios based on the results of the first quarter sampling event. Exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes 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 10.1.24 presents the risk and hazard for the ingestion pathway, and Table 10.1.25 presents the risk and hazard for the inhalation pathway.

Hypothetical Site Residents

The ingestion and inhalation lifetime-weighed average ILCRs are 2E-6 and 8E-7, respectively, for the residential scenario. Chloromethane is the sole contributor the risk projections for the groundwater pathways. Ingestion HIs are 2 and 5 for the adult and child residents, respectively.

Table 10.1.24
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
SWMU 4 and AOC 619
Naval Base Charleston Zone F
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							
Thallium	8E-05	NA	2.3	5.3	ND	0.81	ND
Volatile Organics							
Chloromethane	NA	0.013	ND	ND	1.6E-06	ND	5.0E-07
SUM Hazard Index/ILCR			2	5	2E-06	0.8	5E-07

NOTES:

NA Not available
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.1.25
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Groundwater Contamiants Through Domestic Use
SWMU 4 and AOC 619
Naval Base Charleston Zone F
Charleston, South Carolina

Chemical	Inhalation Rf Used (mg/kg-day)	Inhalation 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
Volatile Organics							
Chloromethane	NA	0.0063	ND	ND	7.6E-07	ND	2.4E-07
SUM Hazard Index/ILCR			ND	ND	8E-07	ND	2E-07

NOTES:

NA Not available
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Thallium is the sole contributor to groundwater hazard index projections for the groundwater ingestion pathway. Hazard index was not determined for the inhalation pathway, due to the absence of appropriate toxicological data.

Hypothetical Site Workers

The ingestion and inhalation ILCRs for the site worker scenario are 5E-7 and 2E-7, respectively. The hazard index projection for the ingestion pathway is 0.8.

Current Site Workers

Groundwater is not currently used as a potable water source for combined SWMU 4 or other areas of Zone F. 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 of 1E-06 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 in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.1.26 presents the COCs identified for combined SWMU 4 surface soil and shallow groundwater.

Table 10.1.26
Summary of Risk and Hazard-based COCs
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Inorganics**						
		Manganese (Mn)	0.0057	0.054	ND	0.0021	ND	
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	2.3E-06	ND	2.5E-07	2
	Dermal	**Inorganics**						
		Manganese (Mn)	0.0012	0.0039	ND	0.00084	ND	
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	1.0E-06	ND	4.1E-07	2
Surface Soil Pathway Sum			0.007	0.06	3E-06	0.003	7E-07	
Groundwater	Ingestion	**Inorganics**						
		Thallium (Tl)	2.3	5.3	ND	0.81	ND	1
		Volatile Organics						
		Chloromethane	ND	ND	1.6E-06	ND	5.0E-07	2
	Inhalation	**Volatile Organics**						
		Chloromethane	ND	ND	7.6E-07	ND	2.4E-07	
Groundwater Pathway Sum			2	5	2E-06	0.8	7E-07	
Sum of All Pathways			2	5	6E-06	0.8	1E-06	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence noncarcinogenic 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 noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Future Site Residents

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

Future Site Workers

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

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 identified above. BEQs were detected above the residential RBC in nine of 18 surface soil samples collected for combined SWMU 4. Elevated BEQs were identified in surface soil samples which were located either underneath asphalt pavement or adjacent to railroad right-of-ways.

First Quarter Groundwater

Thallium was detected in the two of the three shallow groundwater samples collected at combined SWMU 4 at a concentration exceeding its RBC. Chloromethane was detected in only one of three groundwater samples.

10.1.7.6 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 this area of Zone F. If this area were to be used as a residential site, the buildings 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 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 combined SWMU 4 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone F. 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

For soil, 95% UCLs were used as EPCs to estimate exposure for combined SWMU 4. It is unlikely that 95% UCLs are exceeded by true average site concentrations for COPCs identified at this site. Maximum detected concentrations were used as EPCs to estimate exposure to groundwater for combined SWMU 4. Since no obvious plumes or sources were identified, it is difficult to conclude how representative maximum concentrations are in relation to the true average concentrations. As a result, risk could be over- or underestimated for the groundwater pathways with use of maximum concentrations as EPCs.

Frequency of Detection and Spatial Distribution

BEQs compounds were detected above risk-based concentrations in nine of 18 surface soil samples and were generally evenly distributed across the site. Background levels of BEQs at NAVBASE have also exceeded risk-based concentrations. Many of the soil sample locations were situated underneath asphalt or near railroad right-of-ways, which may explain the presence of this group of constituents. No areas of elevated BEQs concentration were identified and their concentrations were evenly distributed across the site.

Thallium was detected in two of three groundwater samples in the first quarter and in only one of three second quarter groundwater samples at concentrations above its RBC. The concentration decreased to below the RBC in the third quarter sampling event. All of the thallium detections were reported in groundwater samples collected from monitoring wells established in the southern end of the site. Elevated concentrations of thallium were also reported in background monitoring wells at concentrations ranging from 4.8 to 6.6 ug/L. First quarter thallium concentrations ranged from 3.4 to 6.6 ug/L for combined SWMU 4. These finding suggest the occurrence of thallium in the surficial aquifer is common to Zone F.

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.

Soil

A conservative screening process was used to identify COPCs for combined SWMU 4. 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, only thallium was reported at a concentration near its RBCs (e.g. within 10% of its RBC). Aluminum, arsenic, and beryllium were detected at maximum concentrations exceeding their RBCs and were eliminated from consideration in the risk assessment based on direct comparison to their background concentrations and based on Wilcoxon rank sum test analysis.

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). Arsenic and manganese were reported at maximum concentrations exceeding their respective RBCs and were eliminated from consideration in the risk assessment based on comparison to their background concentrations. Wilcoxon rank sum test analysis was not performed as a corollary because there were too few Zone F groundwater background samples to provide a valid result.

Groundwater is not currently used as a potable water source at combined SWMU 4, 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.

Background-related Risk

Aluminum, arsenic, and beryllium were detected in combined SWMU 4 surface soil at concentrations above their RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to their background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. 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 maximum surface soil concentration of aluminum (12,600 mg/kg), arsenic (17.8 mg/kg), and beryllium (0.93 mg/kg) equate with hazard quotients of 0.2, 0.8, and 0.003, respectively, for the resident child. The maximum concentration of arsenic and beryllium would equate with risks of 5E-05 and 7E-06, respectively, under the residential scenario. The background concentrations of aluminum (18,500 mg/kg), arsenic (19.9 mg/kg), and beryllium (1.05 mg/kg) equate with hazard quotients of 0.3, 0.9, and 0.003, respectively, for the resident child. The background concentrations of arsenic and beryllium equate with risk of 5E-05 and 8E-06, respectively, under a residential scenario.

The maximum groundwater concentrations of arsenic (6.5 μg/L) and manganese (1,420 μg/L) equate with hazard quotients of 1 and 4, respectively, for the resident child. The maximum arsenic concentration equates with a risk of 1E-04 under a residential scenario. The background concentrations of arsenic (16.7 μg/L) and manganese (2,010 μg/L) equate with hazard quotients of 4 and 6, respectively, for the resident child. The background concentration of arsenic equates with a risk of 4E-04 for the residential scenario.

10.1.7.7 Risk Summary

The risk and hazard posed by contaminants at combined SWMU 4 were assessed for the future 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 pathways included both ingestion and inhalation (VOCs only) and were based on first quarter groundwater data. Table 10.1.27 presents the risk summary for each pathway/receptor group evaluated for combined SWMU 4.

Soil - Residential Scenario

Residential soil pathway COCs identified for combined SWMU 4 include BEQs. Figures 10.1.15 and 10.1.16 illustrate point risk and hazard indices for SWMU 109 surface soil exposure by potential future site residents. Table 10.1.28 summarizes the risk and hazard contribution of each COPC at each sample location. The 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.

BEQs, identified as COCs in the formal risk assessment, contribute to risk estimate above 1E-06 at most surface soil sample locations. Of the samples with reported concentrations of BEQs above the quantitation limit, risks estimates ranged from 1E-06 (004SB002) to 9E-06 (619SB004). Hazard indices only did not exceed unity at any sample location.

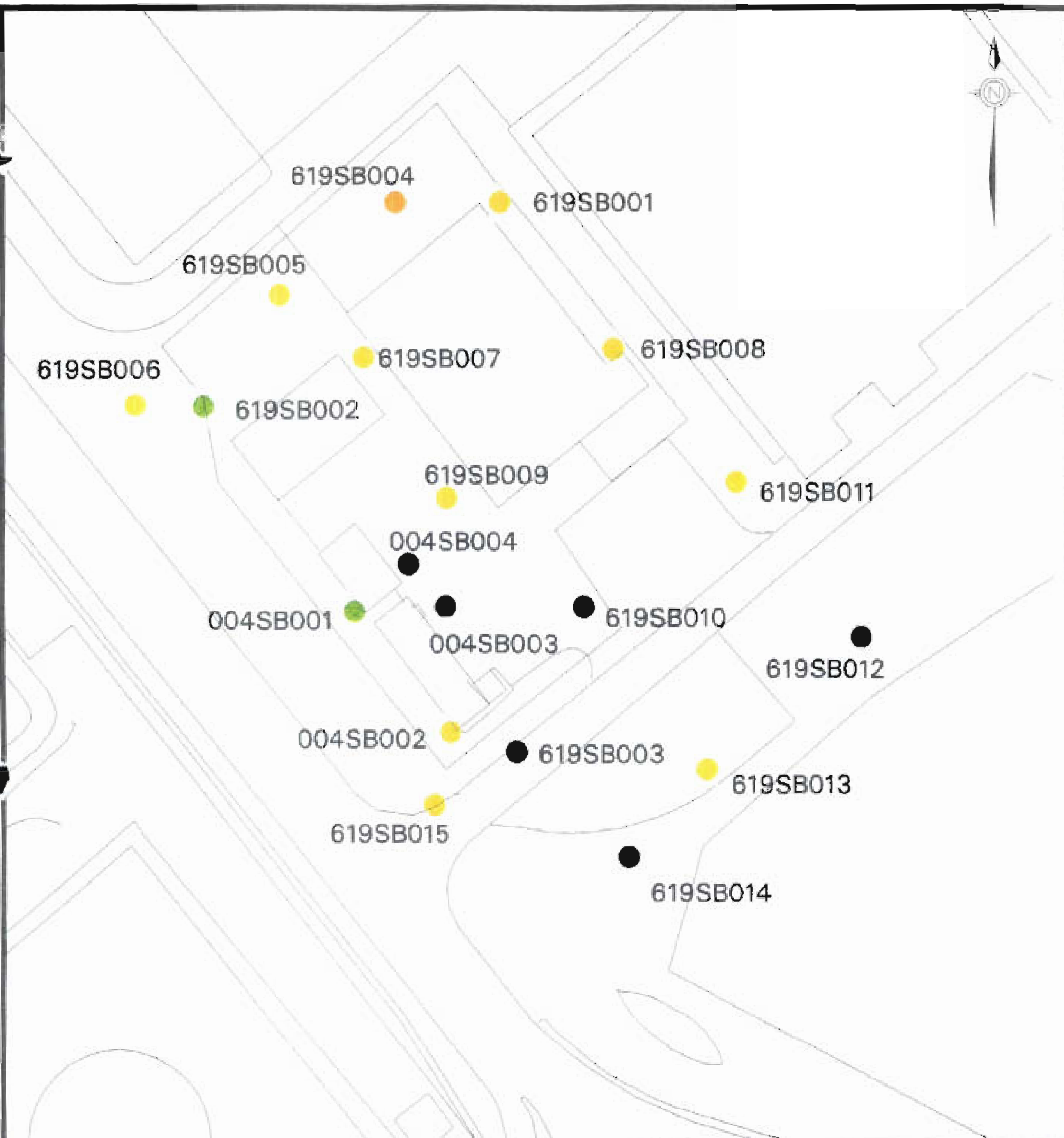
Soil - Site Worker Scenario

No COCs were identified for combined SWMU 4 based on the site worker scenario.

Table 10.1.27
Summary of Risk and Hazard
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.006	0.05	2E-06	0.002	3E-07
	Dermal Contact	0.001	0.004	1E-06	0.0008	4E-07
Sum of Soil Pathways		0.007	0.06	3E-06	0.003	7E-07
Groundwater	Ingestion	2	5	2E-06	0.8	5E-07
	Inhalation	ND	ND	8E-07	ND	2E-07
Sum of Groundwater Pathways		2	5	2E-06	0.8	7E-07
Sum of All Pathways		2	5	6E-06	0.8	1E-06

Notes:
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

0 feet 160

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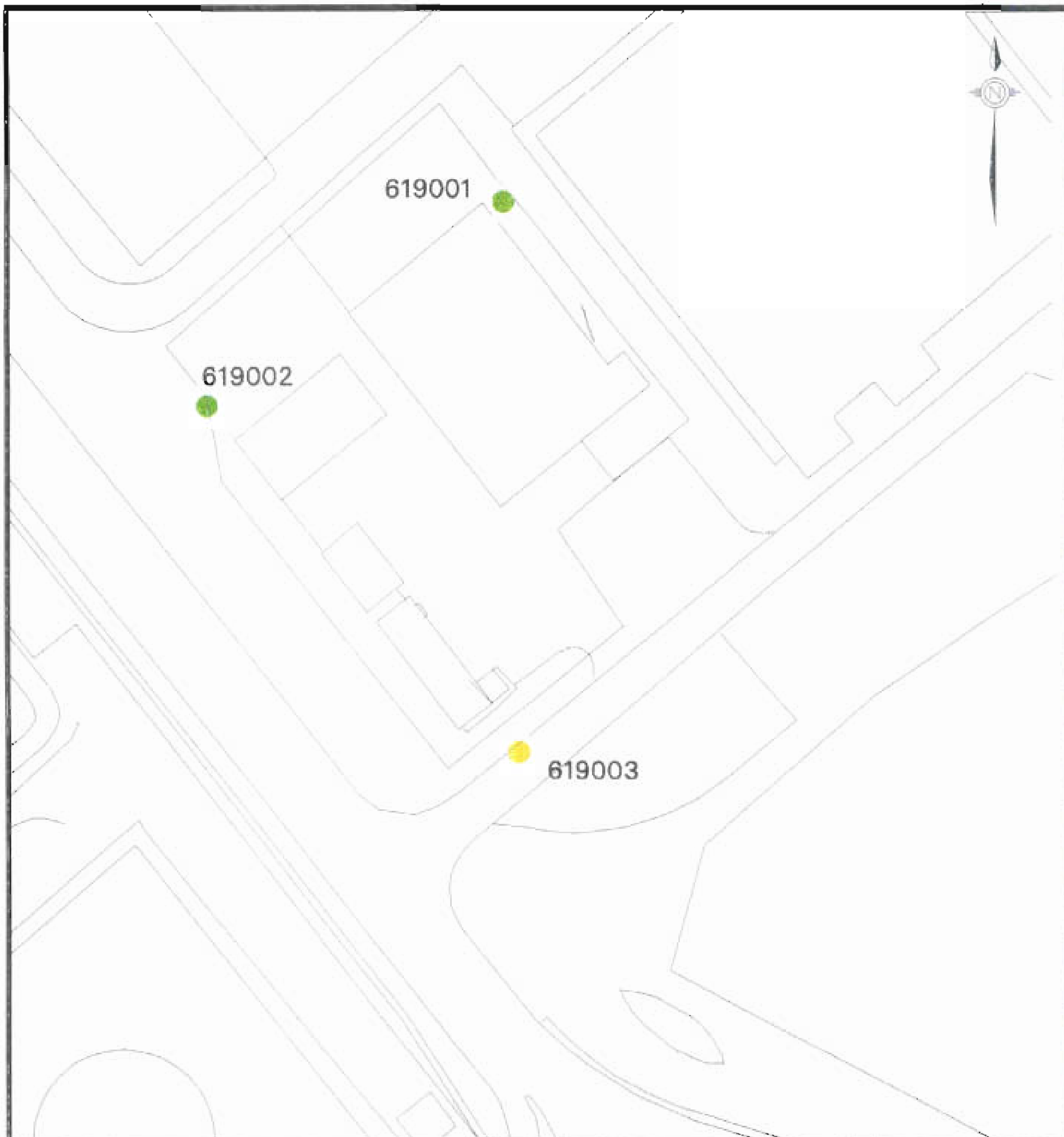
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1.15
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 4, AOC 619



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 160

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NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1.16
POINT RISK ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
SWMU 4, AOC 619

Table 10.1.28
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 4 and AOC 619
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
004	001	B(a)P Equiv.	0.082	UG/KG	NA		0.0014	100
004	001	Manganese (Mn)	66.7	MG/KG	0.0195	100	NA	
		Total			0.0195		0.0014	
004	002	B(a)P Equiv.	69.233	UG/KG	NA		1.1465	100
004	002	Manganese (Mn)	91.2	MG/KG	0.0266	100	NA	
		Total			0.0266		1.1465	
004	003	B(a)P Equiv.	ND	UG/KG	NA		NA	
004	003	Manganese (Mn)	13.8	MG/KG	0.0040	100	NA	
		Total			0.0040		NA	
004	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
004	004	Manganese (Mn)	20.4	MG/KG	0.0060	100	NA	
		Total			0.0060		NA	
619	001	B(a)P Equiv.	272.08	UG/KG	NA		4.5057	100
619	001	Manganese (Mn)	104	MG/KG	0.0303	100	NA	
		Total			0.0303		4.5057	
619	002	B(a)P Equiv.	49.214	UG/KG	NA		0.8150	100
619	002	Manganese (Mn)	115	MG/KG	0.0335	100	NA	
		Total			0.0335		0.8150	
619	003	No COPCs Detected	ND	UG/KG	NA		NA	
		Total			NA		NA	
619	004	B(a)P Equiv.	540.18	UG/KG	NA		8.9455	100
619	004	Manganese (Mn)	283	MG/KG	0.0826	100	NA	
		Total			0.0826		8.9455	
619	005	B(a)P Equiv.	163.885	UG/KG	NA		2.7140	100
619	005	Manganese (Mn)	41.6	MG/KG	0.0121	100	NA	
		Total			0.0121		2.7140	
619	006	B(a)P Equiv.	244.205	UG/KG	NA		4.0441	100
619	006	Manganese (Mn)	9.45	MG/KG	0.0028	100	NA	
		Total			0.0028		4.0441	
619	007	B(a)P Equiv.	152.74	UG/KG	NA		2.5294	100
619	007	Manganese (Mn)	216	MG/KG	0.0630	100	NA	
		Total			0.0630		2.5294	
619	008	B(a)P Equiv.	84.842	UG/KG	NA		1.4050	100
619	008	Manganese (Mn)	110	MG/KG	0.0321	100	NA	
		Total			0.0321		1.4050	
619	009	B(a)P Equiv.	247.36	UG/KG	NA		4.0964	100
619	009	Manganese (Mn)	54.5	MG/KG	0.0159	100	NA	
		Total			0.0159		4.0964	
619	010	B(a)P Equiv.	ND	UG/KG	NA		NA	
619	010	Manganese (Mn)	81	MG/KG	0.0236	100	NA	
		Total			0.0236		NA	

Table 10.1.28
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 4 and AOC 619
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
619	011	B(a)P Equiv.	176.36	UG/KG	NA		2.9206	100
619	011	Manganese (Mn)	150	MG/KG	0.0438	100	NA	
		Total			0.0438		2.9206	
619	012	B(a)P Equiv.	ND	UG/KG	NA		NA	
619	012	Manganese (Mn)	243	MG/KG	0.0709	100	NA	
		Total			0.0709		NA	
619	013	B(a)P Equiv.	190.98	UG/KG	NA		3.1627	100
619	013	Manganese (Mn)	118	MG/KG	0.0344	100	NA	
		Total			0.0344		3.1627	
619	014	B(a)P Equiv.	ND	UG/KG	NA		NA	
619	014	Manganese (Mn)	8.2	MG/KG	0.0024	100	NA	
		Total			0.0024		NA	
619	015	B(a)P Equiv.	214.77	UG/KG	NA		3.5567	100
619	015	Manganese (Mn)	320	MG/KG	0.0933	100	NA	
		Total			0.0933		3.5567	

Groundwater - Residential Scenario

As shown in Figure 10.1.17 and Table 10.1.29, the concentration of thallium in groundwater sampled from monitoring wells NBCF619001 and NBCF619003 equate with hazard indices of 3 and 5, respectively. The concentration of chloromethane reported in the groundwater sample colleted from monitoring well 619003 equates with a risk of 2E-06. Thallium was only detected in the groundwater sample collected from monitoring well 619001 in the second quarter. Chloromethane was not detected in any second quarter groundwater sample.

10.1.7.8 Remedial Goal Options

Soil

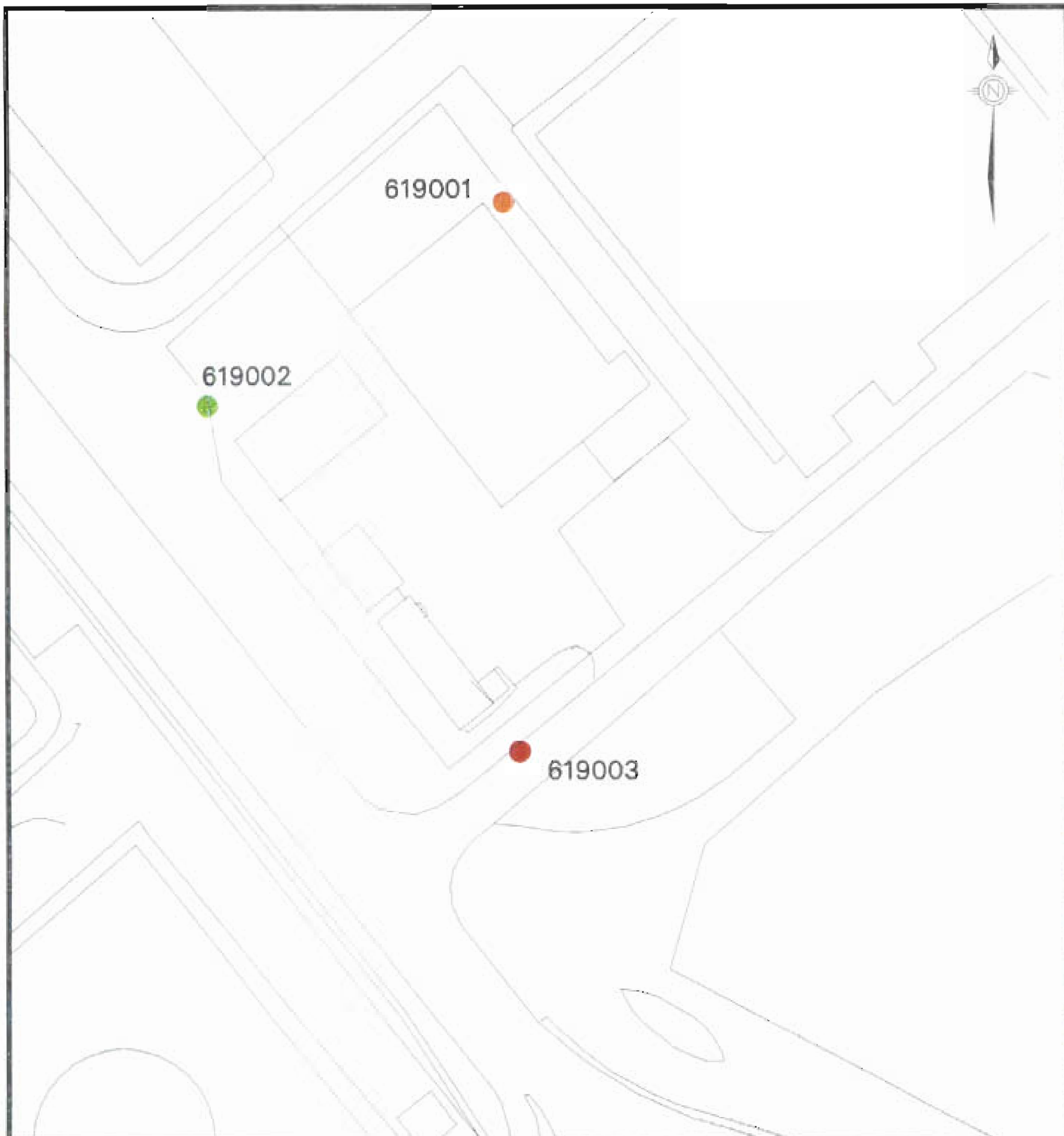
RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.1.30 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident.

Groundwater

Groundwater RGOs based on the site resident scenario are shown in Table 10.1.31.

10.1.8 Corrective Measures Considerations

For SWMU 4 and AOC 619, the upper and lower soil intervals and shallow groundwater were investigated. During the RFI 19 upper and 13 lower interval soil samples were collected. Three groundwater monitoring wells were installed in the shallow aquifer. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is partly paved with asphalt or concrete.



LEGEND

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

0 feet

ZONE F - RCRA FACILITY INVESTIGATION REPORT
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CHARLESTON, S.C.

FIGURE 10.1.17
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
SWMU 4, AOC 619

Table 10.1.29
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
619	001	Chloromethane	ND	UG/L	NA		NA	
619	001	Thallium (Tl)	3.4	UG/L	2.7169	100	NA	
		Total			2.7169		NA	
619	002	Chloromethane	ND	UG/L	NA		NA	
619	002	Thallium (Tl)	ND	UG/L	NA		NA	
		Total			NA		NA	
619	003	Chloromethane	8	UG/L	NA		2.2964	100
619	003	Thallium (Tl)	6.6	UG/L	5.2740	100	NA	
		Total			5.2740		2.2964	

Table 10.1.30
Remedial Goal Options for Soil
SWMU 4 and AOC 619
Naval Base Charleston, Zone F
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 Organic Compounds										
Benzo(a)pyrene equivalents	7.3	NA	0.2	NA	NA	NA	0.060	0.60	6.0	NA

NOTES:

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

Table 10.1.31
Residential-Based Remedial Goal Options Groundwater
SWMU 4 and AOC 619
Naval Base Charleston Zone F
Charleston, South Carolina

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	MCL mg/l	Background Concentration mg/l
Inorganics											
Thallium	NA	8E-05	0.0066	0.00013	0.0013	0.013	NA	NA	NA	0.002	NA
Chloromethane	0.013	NA	0.008	NA	NA	NA	0.0034	0.034	0.34	NA	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

BEQs were identified as COCs in the upper soil interval. The soil pathway cumulative residential exposure risk is 3E-06. This is within USEPA's acceptable risk range between 1E-06 and 1E-04.

Residential risk-based remedial goals for surface soil for BEQs is 0.06 mg/kg based on a target risk of 1E-06. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.1.32.

Two COCs, thallium and chloromethane, was identified in the shallow groundwater for AOC 619. Thallium was identified in the shallow groundwater at AOC 619 in two of the three wells. Chloromethane was detected in one well. The shallow groundwater pathway cumulative residential exposure risk is 2E-06 and the cumulative HI is 5 (resident child). The residential risk is within USEPA's acceptable risk range between 1E-06 and 1E-04.

Table 10.1.32
Potential Corrective Measures for SWMU 4 and AOC 619

Medium	Compounds	Potential Corrective Measures
Soil	Manganese and BEQs	a) No Action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment f) Ex-situ, chemical and physical treatment
Shallow Groundwater	Thallium and chloromethane	a) No Action b) Intrinsic remediation and monitoring c) In-situ, chemical and physical treatment d) Ex-situ, chemical and physical treatment

The cumulative HI is above USEPA's acceptable HI of 1. The hazard-based RGO for thallium is 0.0013 mg/L based on a target HI of 1 and the risk-based RGO for chloromethane is 0.0034 mg/L based on a target risk of 1E-06.

Potential corrective measures for the shallow groundwater and respective COCs are in Table 10.1.32. Corrective measures for SWMU 4 and AOC 619 are detailed in Section 9.

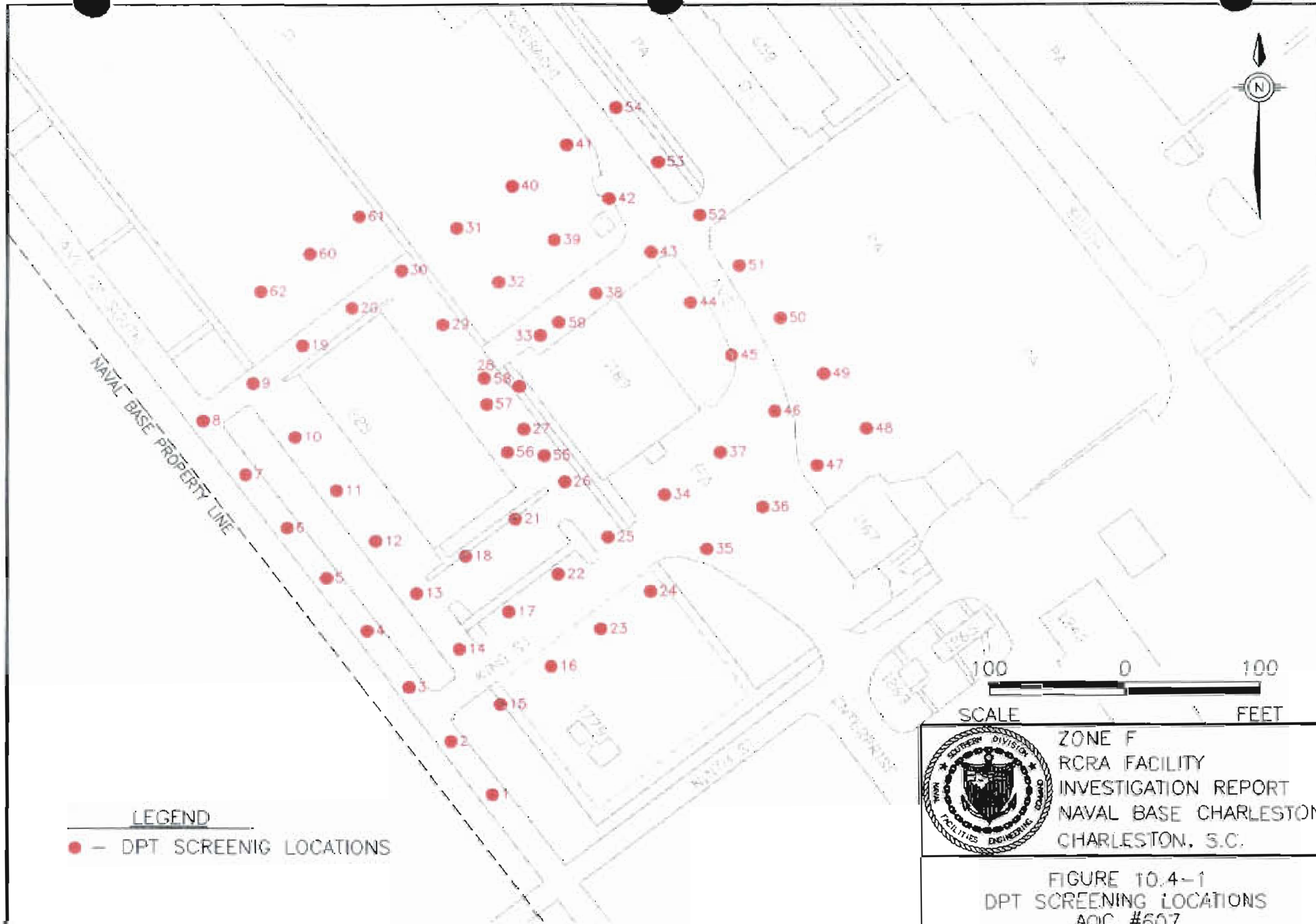
10.4 AOC 607, Dry Cleaning Building 1189

A RFI site, AOC 607 is the former dry-cleaning facility at Building 1189, which operated from 1942 to 1986. From 1986, the facility was used as a laundry, housing two industrial washers and dryers. While operating as a dry-cleaning establishment, the facility was classified as a minor emitter of total hydrocarbons. Materials released, stored, or disposed of at the site included perchlorethylene solvent.

10.4.1 Site Geology and Hydrogeology

A total of 19 monitoring well borings were used to assess the stratigraphy and hydrogeology at AOC 607. Prior to well boring advancement, DPT samples were collected at 62 locations, as shown on Figure 10.4-1. The soil, sediment and groundwater sample locations associated with the RFI are shown on Figure 10.4-2. The stratigraphy consists of Quaternary silty sand and sandy clay overlying sandy silt containing phosphate nodules and shells. The silty sand and sandy clay deposits extend to a depth of approximately 15 feet bgs. These sediments exhibit an average grain size distribution of 14% sand, 32% silt, and 54% clay. The sandy silt deposits exhibit an average grain size distribution of 58% sand, 19% silt, and 23% clay. The total depths of the monitoring wells vary and range from 10 ft bgs to 33 ft bgs. Figures 10.4-3 and 10.4-4 present geologic cross sections of the site geology. Boring logs are contained in Appendix A.

Figures 10.4-5 and 10.4-6 depict the shallow groundwater potentiometric surface and inferred flow direction at low and high tides, respectively. Very little difference in the static water levels and the overall flow pattern at the AOC 607 area were observed between high and low tide. The radial flow regime depicted in the figures suggest shallow groundwater infiltration to the storm sewer which runs parallel to the southwest side of Building 1189. The hydraulic conductivity of the shallow deposits, calculated from slug testing, varied from 0.19 to 1.8 ft/day. The horizontal hydraulic gradient based on Figure 10.4-5 ranges from 7.7×10^{-3} on the northern side of the site to 3.3×10^{-2} on the south side of the site. These anomalously high gradients support influence by



LEGEND

● – DPT SCREENIG LOCATIONS

ZONE F
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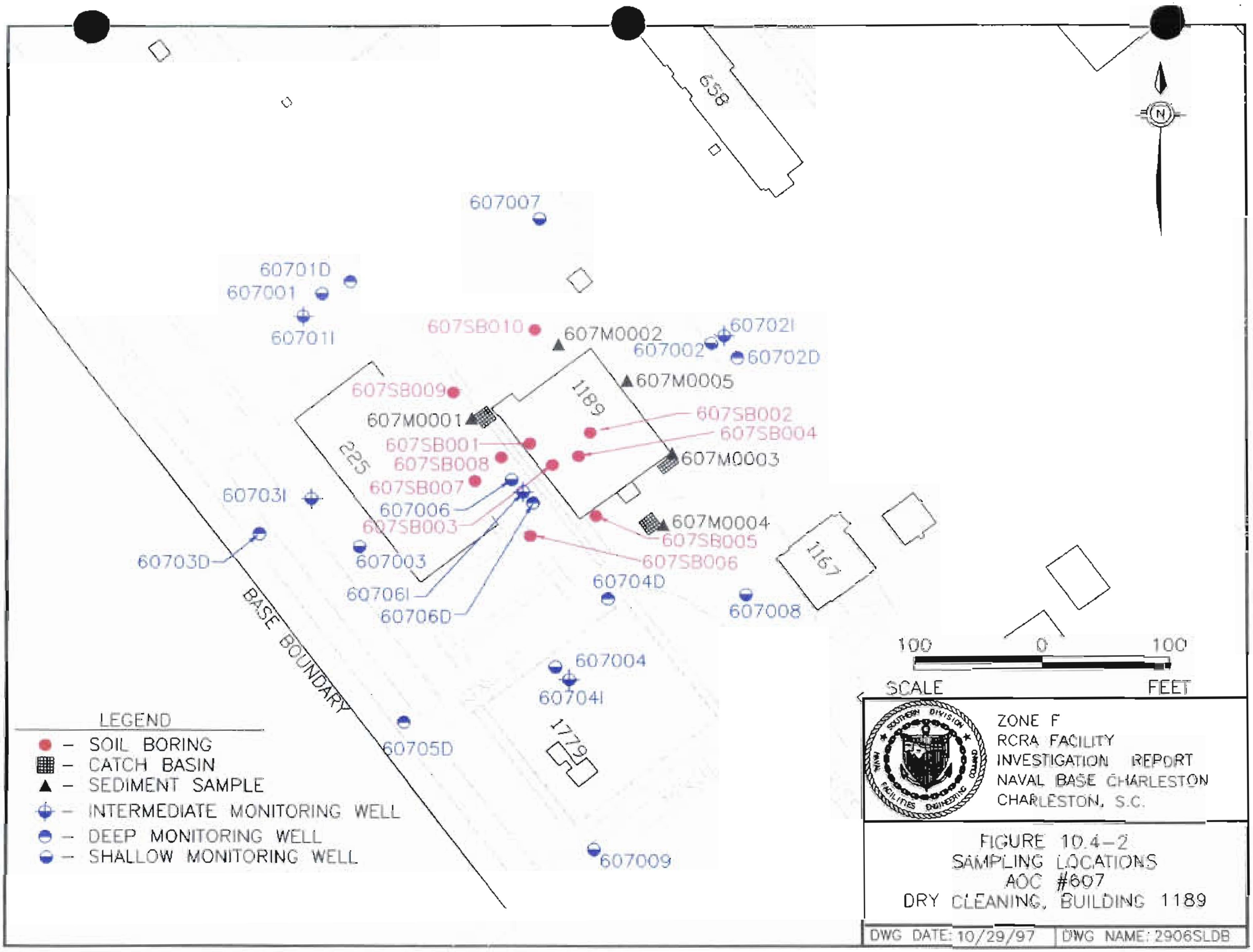
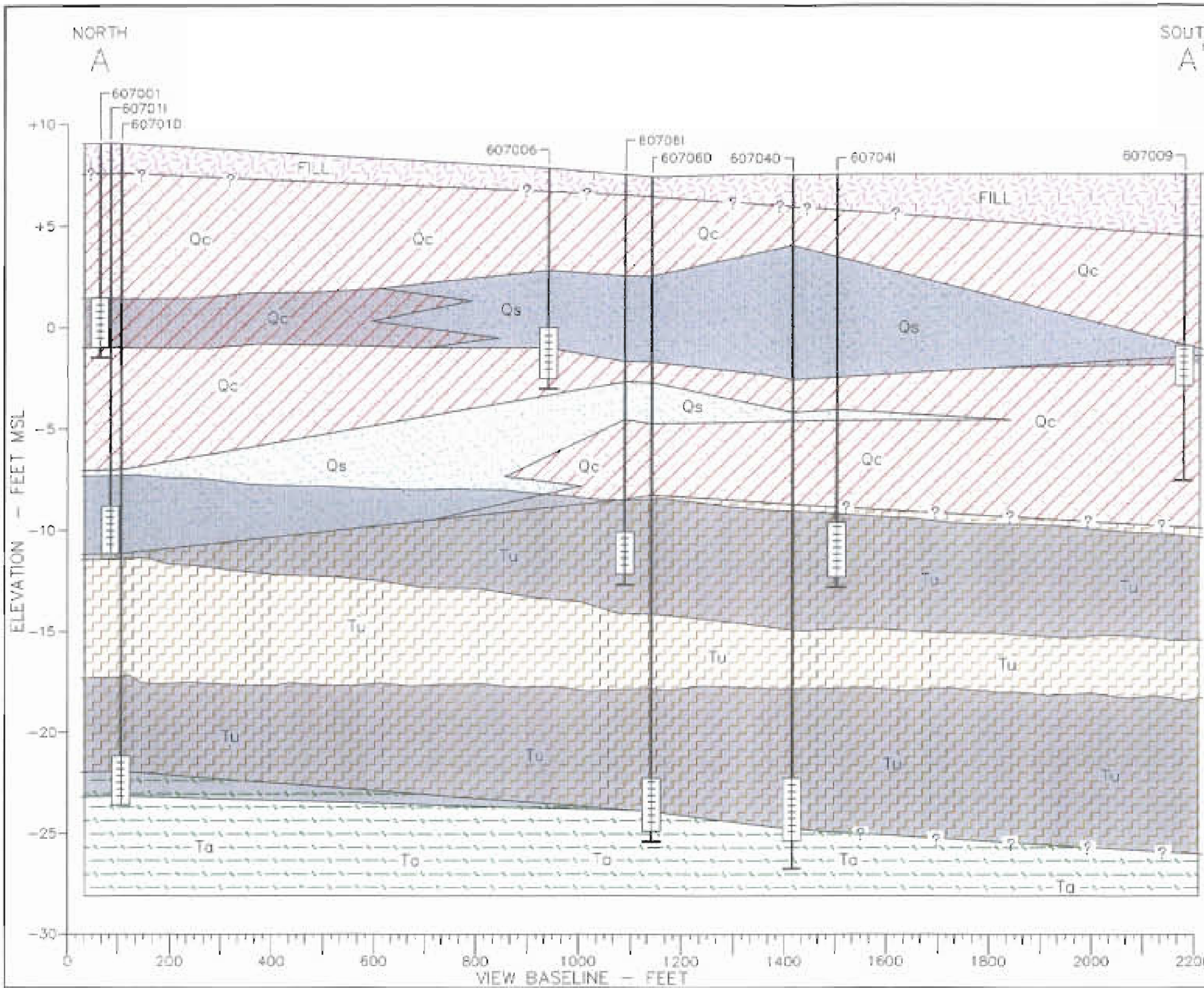
CHARLESTON, S.C.

FIGURE 10.4-1
DPT SCREENING LOCATIONS
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 11/18/97 | DWG NAME: 2906DPTS



658
607007
60701D
607001
60701I
607SB010
607M0002
60702I
607002
60702D
1189
607M0005
607SB009
607M0001
607SB002
607SB004
225
607SB001
607SB008
607M0003
607SB007
60703I
607006
607SB003
607M0004
607SB005
60703D
607003
607SB006
1167
60704D
607008
60706I
60706D
BASE BOUNDARY
100
0
100
SCALE
FEET
607004
60704I
1779
60705D
607009
LEGEND
– SOIL BORING
– CATCH BASIN
– SEDIMENT SAMPLE
– INTERMEDIATE MONITORING WELL
– DEEP MONITORING WELL
– SHALLOW MONITORING WELL
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.4–2
SAMPLING LOCATIONS
AOC #607
DRY CLEANING, BUILDING 1189
DWG DATE: 10/29/97
DWG NAME: 2906SLDB

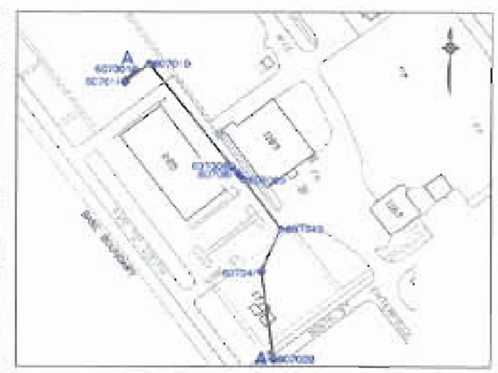


LEGEND

FILL	Undifferentiated mixture of medium to high plasticity clays, fine sand, silt, gravel and ROC. Varies greatly with location.
Qc	QUATERNARY CLAYEY SAND AND SILTY SAND--brown, orange-brown, gray, green, and tan, very fine to fine sand often with trace medium grains, varying amounts of silt and inorganic gray clay; often interbedded with soft gray medium plasticity clay laminae; sand occasionally unconsolidated and loose.
Qs	QUATERNARY SAND--undifferentiated olive-brown, gray, and orange sand, primarily very fine to fine and moderately to well-sorted but typically increases in grain size with depth (from fine to medium with some coarse); clean to silty sand.
Tu	TERTIARY - UNDIFFERENTIATED--olive-gray to gray-green silt with varying amounts of very fine to fine quartz and phosphate sand with some clay, low plasticity, soft; intermixed with small subrounded phosphate pebbles, coarse shell hash, and oyster shells.
Ta	TERTIARY ASHLEY FORMATION--olive-green to olive-brown silt with varying amounts of clay and very fine sand, firm to stiff, calcareous in part. CONFINING UNIT.
	"AQUIFER" UNIT

VERTICAL SCALE: 1"=5'
HORIZONTAL SCALE: 1"=200'
VERTICAL EXAGGERATION 1:40

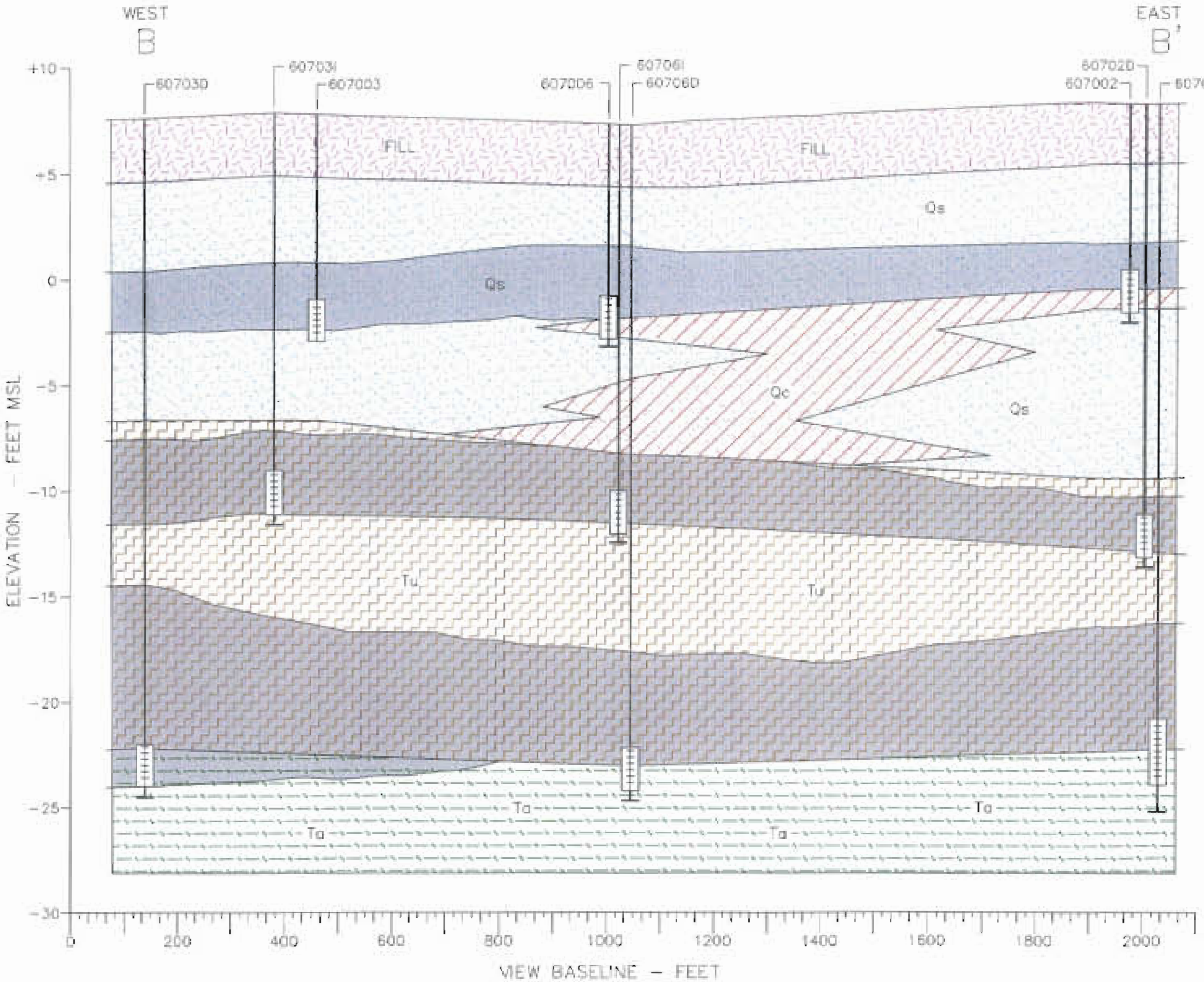
607020 — MONITORING WELL IDENTIFICATION
SCREENED INTERVAL OF WELL
TOTAL DEPTH OF WELL



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

FIGURE 10.4-3
AOC 607
LITHOLOGIC CROSS SECTION A-A'

DWG DATE: 11/17/97	DWG NAME: 029LCSAA

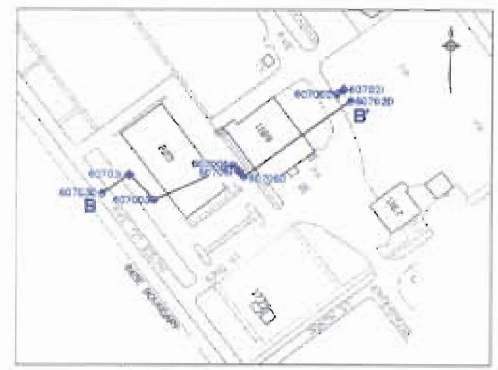


LEGEND

FILL	Undifferentiated mixture of medium to high plasticity clays, fine sand, silt, gravel and rock. Varies greatly with location.
Qc	QUATERNARY CLAYEY SAND AND SILTY SAND—brown, orange-brown, gray, green, and tan, very fine to fine sand often with trace medium grains, varying amounts of silt and inorganic gray clay, often interbedded with soft gray medium plasticity clay laminae; sand occasionally unconsolidated and loose.
Qs	QUATERNARY SAND—undifferentiated olive-brown, gray, and orange sand, primarily very fine to fine and moderately to well-sorted but typically increases in grain size with depth (from fine to medium with some coarse); clean to silty sand.
Tu	TERTIARY - UNDIFFERENTIATED—olive-gray to gray-green silt with varying amounts of very fine to fine quartz and phosphate sand with some clay; low plasticity, soft; intermixed with small subrounded phosphate pebbles, coarse shell hash, and oyster shells.
Ta	TERTIARY ASHLEY FORMATION—olive-green to olive-brown silt with varying amounts of clay and very fine sand, firm to stiff, calcareous in part. CONFINING UNIT.
	"AQUIFER" UNIT

VERTICAL SCALE: 1"=5'
HORIZONTAL SCALE: 1"=200'
VERTICAL EXAGGERATION: 1:40

607020 — MONITORING WELL IDENTIFICATION
SCREENED INTERVAL OF WELL
TOTAL DEPTH OF WELL



ZONE F
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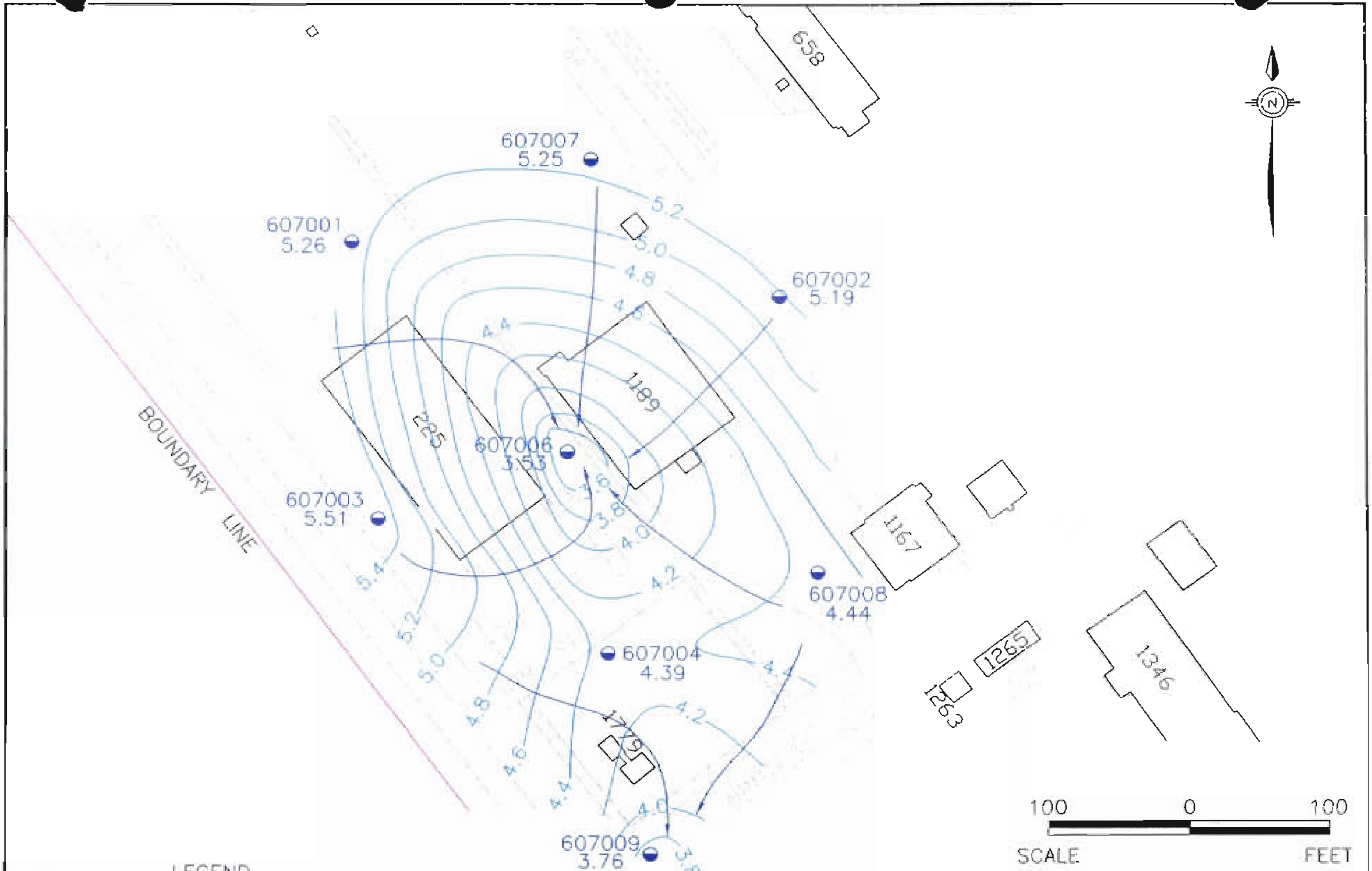
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.4-4
AOC 607
LITHOLOGIC CROSS SECTION B-B'

DWG DATE: 11/17/97 | DWG NAME: 029LCSBB



LEGEND

- SHALLOW MONITORING WELL
- CONTOUR INTERVAL – 0.2 FOOT
- FLOW DIRECTION

ZONE F
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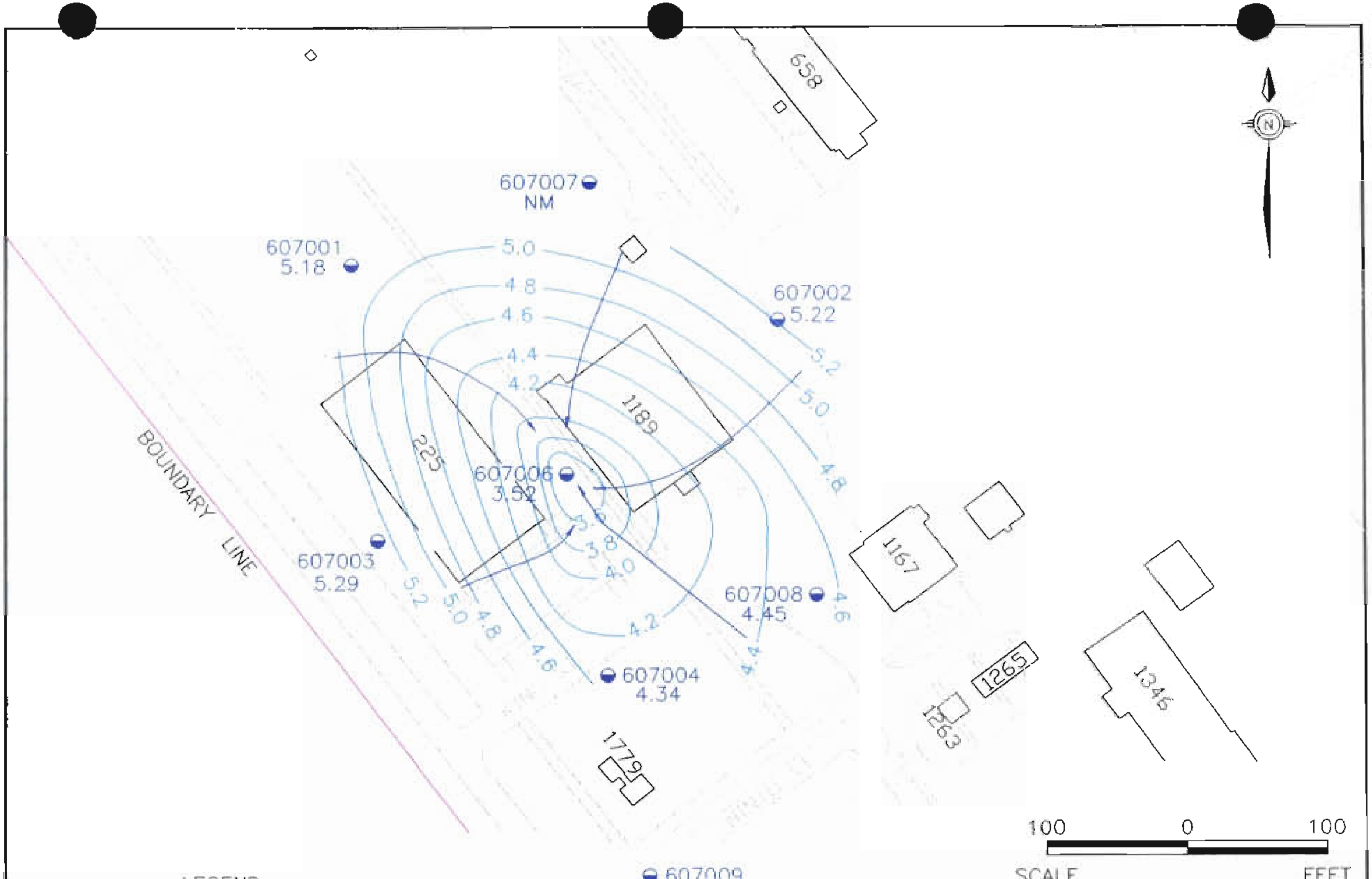
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.4–5
SHALLOW GROUNDWATER
LOW–TIDE POTENTIOMETRIC MAP
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 11/12/97 | DWG NAME: 2906SGLT



LEGEND

- DEEP MONITORING WELL
- 4 – CONTOUR INTERVAL – 0.2 FOOT
- FLOW DIRECTION
- NM – WATER LEVEL ELEVATION NOT MEASURED

ZONE F
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.4–6
SHALLOW GROUNDWATER HIGH–TIDE POTENTIOMETRIC MAP
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 11/12/97 | DWG NAME: 2906SGHT

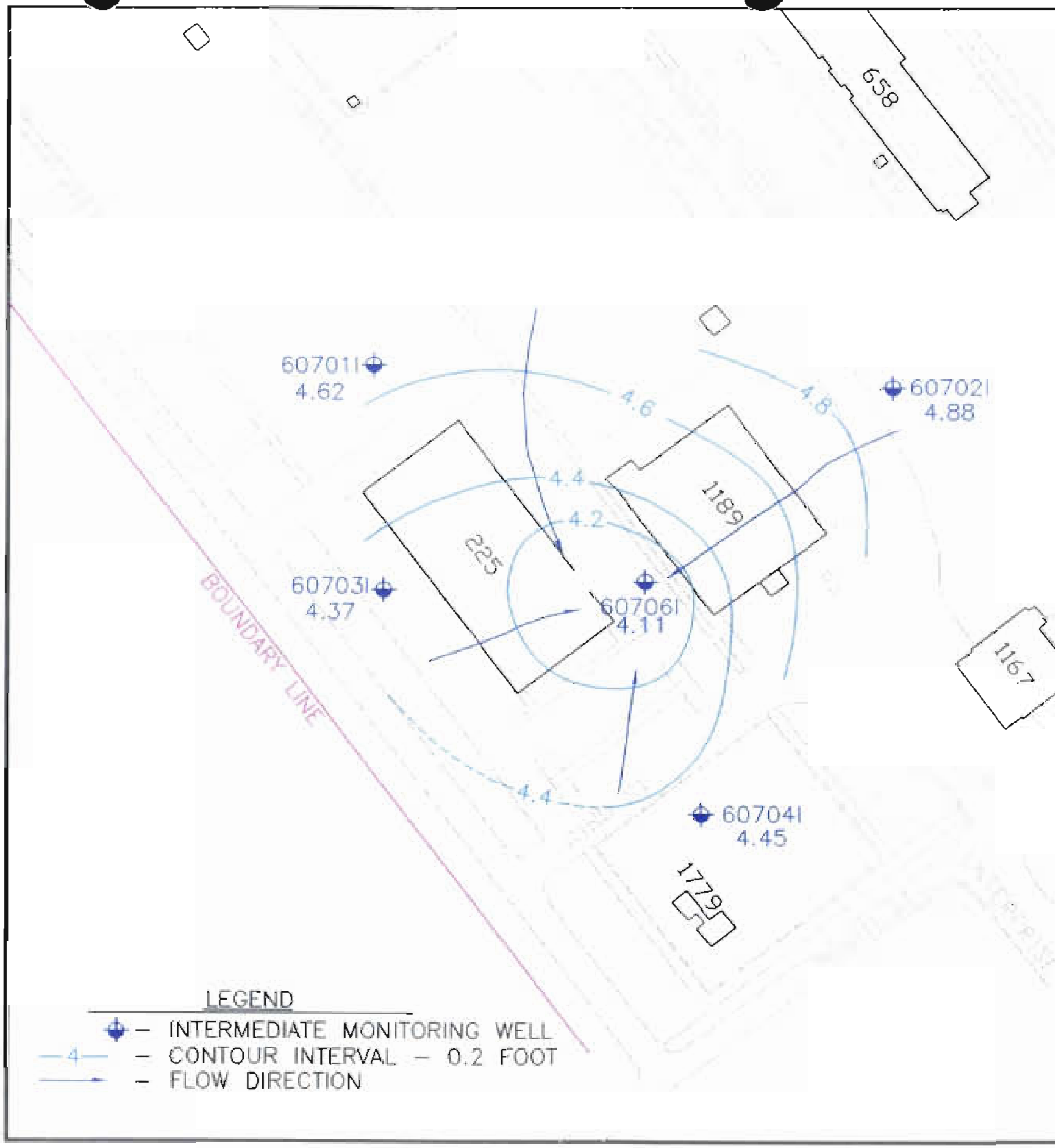
the sewer. The horizontal flow rate was calculated to range from 1.4 x 10^{-3} ft/day to 5.9 x 10^{-2} ft/day in the shallow deposits at AOC 607.

Figure 10.4-7 depicts the intermediate groundwater potentiometric surface and inferred flow direction at low tide. Limited high tide measurements were conducted, therefore, a high tide potentiometric map is not provided. The radial flow pattern and steep gradient observed in the shallow horizon is minimized in the intermediate, suggesting the influence by the sewer in this horizon. The hydraulic conductivity measured in the intermediate wells range from 0.45 to 1.25 ft/day. The horizontal hydraulic gradient, based on Figure 10.4-7, was 3.6 x 10^{-3}. The horizontal flow rate was calculated to range from 1.6 x 10^{-3} ft/day to 4.7 x 10^{-3} ft/day in the intermediate horizon at AOC 607.

Figures 10.4-8 and 10.4-9 depict the deep groundwater potentiometric surface and inferred flow direction at low and high tide respectively. The radial flow pattern observed in the shallow and intermediate horizons is reversed in the deep, suggesting potential recharge by overlying horizons. The hydraulic conductivity within the deep wells at the site range from 8.1 x 10^{-3} to 2.3 x 10^{-2} ft/day. The horizontal hydraulic gradient, based on Figure 10.4-5, ranges from 1.1 x 10^{-2} on the north, south and east sides of the site was 8.0 x 10^{-3} on the west side of the site. The horizontal flow rate was calculated to range from 6.5 x 10^{-5} ft/day to 2.3 x 10^{-2} ft/day in the deep horizon at AOC 607.

Figure 10.4-10 presents the vertical hydraulic gradients between the shallow and intermediate horizons at AOC 607. The moderate upward potential observed at the well 607006/60706I pair also supports groundwater infiltration to the sewer system, Figure 10.4-11 presents the vertical hydraulic gradients between the intermediate and deep horizons.

Figures 10.4-12 and 10.4-13 present the tidal variation between low and high tides in the shallow and deep horizons at AOC 607.



ZONE F
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NAVAL BASE CHARLESTON
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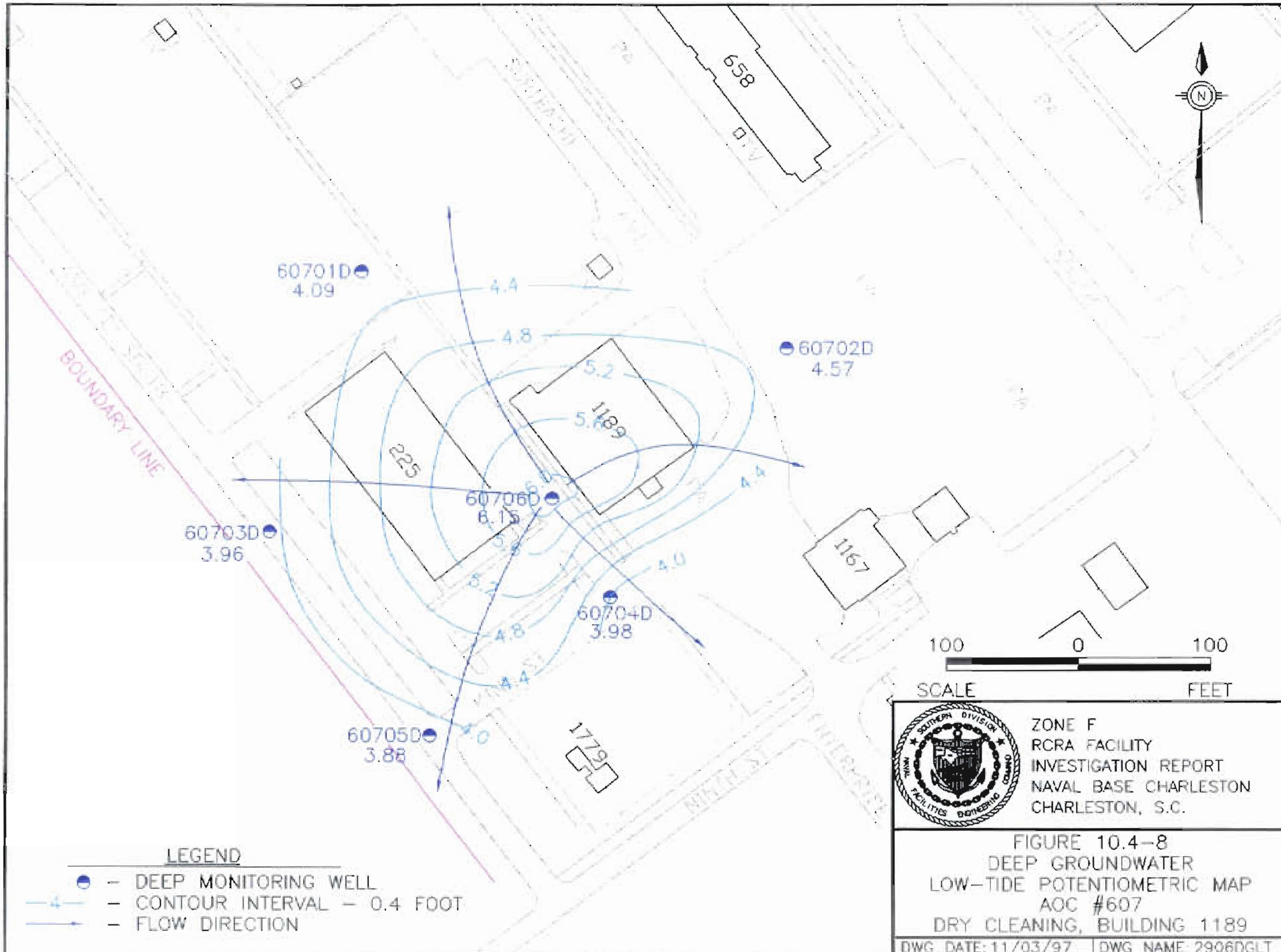
FIGURE 10.4–7
INTERMEDIATE GROUNDWATER
LOW–TIDE POTENTIOMETRIC MAP
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 11/12/97 | DWG NAME: 2906LTPM



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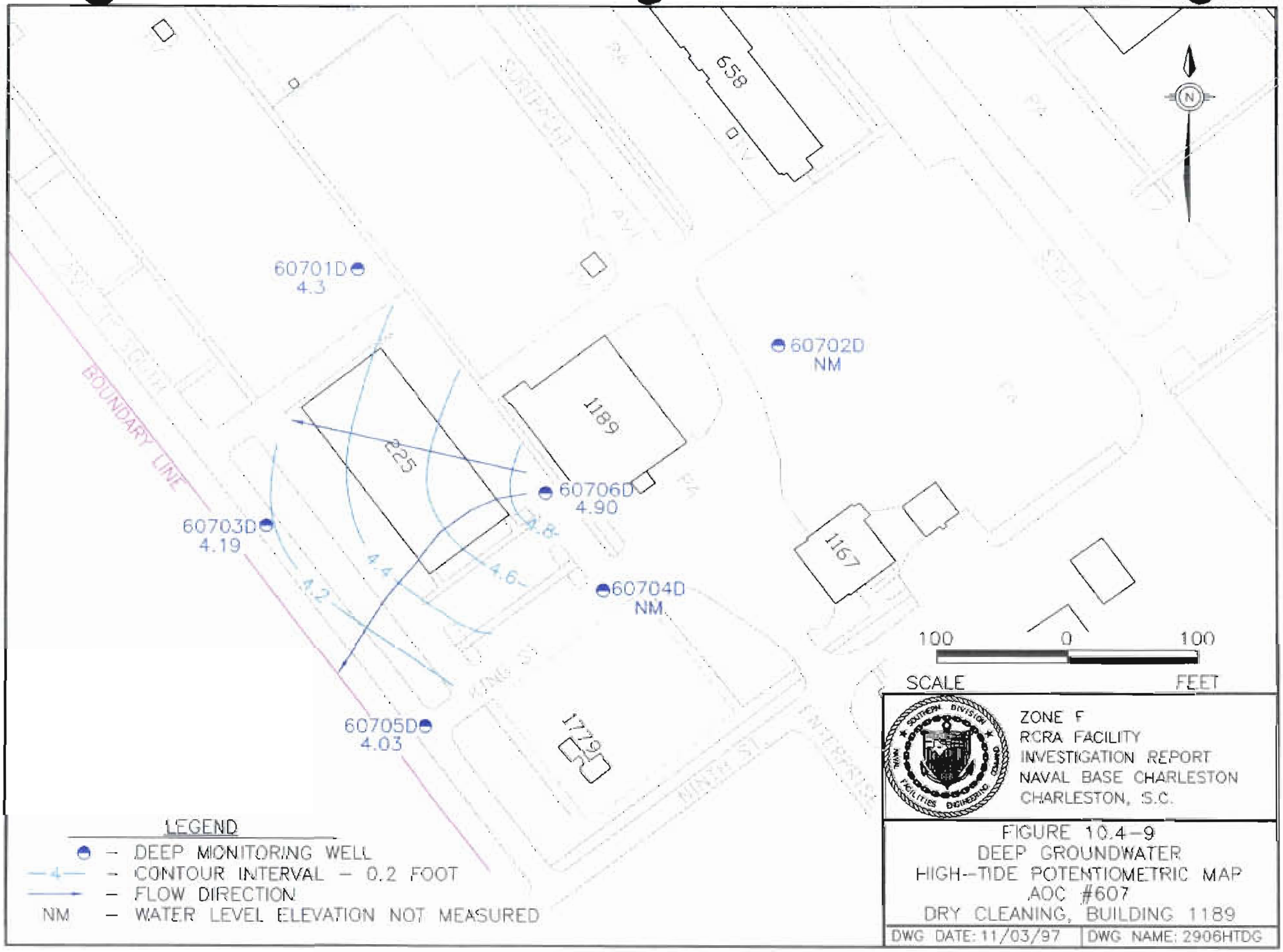
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

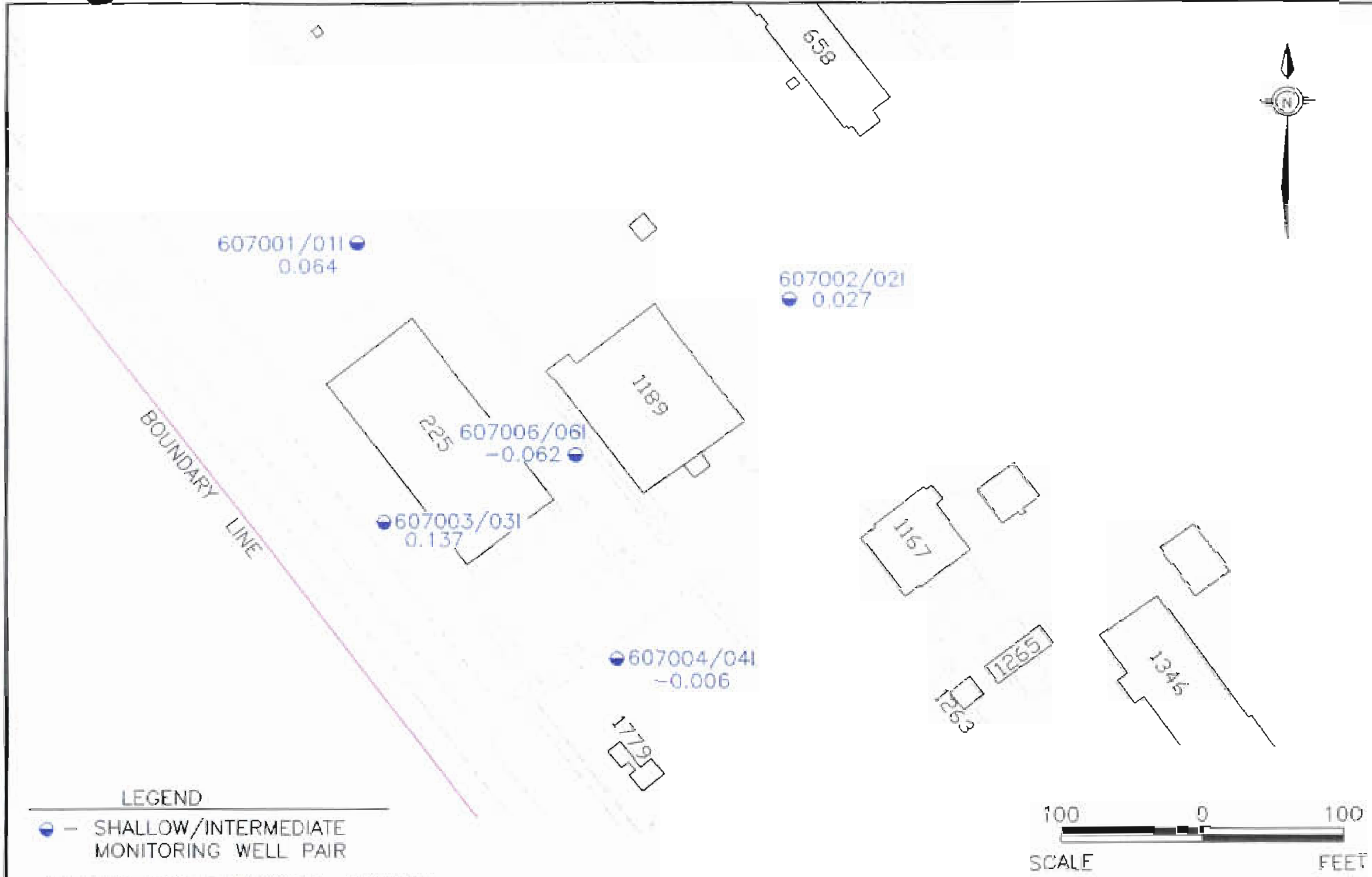
FIGURE 10.4-8
DEEP GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 11/03/97 | DWG NAME: 2906DGLT

LEGEND
- DEEP MONITORING WELL
- CONTOUR INTERVAL – 0.4 FOOT
- FLOW DIRECTION



658
1189
225
1167
1779
60701D
4.3
60702D
NM
60706D
4.90
60703D
4.19
60704D
NM
60705D
4.03
4.2
4.4
4.6
4.8
BOUNDARY LINE
100
0
100
SCALE
FEET
LEGEND
- DEEP MONITORING WELL
- CONTOUR INTERVAL - 0.2 FOOT
- FLOW DIRECTION
NM - WATER LEVEL ELEVATION NOT MEASURED
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.4-9
DEEP GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC #607
DRY CLEANING, BUILDING 1189
DWG DATE: 11/03/97
DWG NAME: 2906HTDG



LEGEND

◒ – SHALLOW/INTERMEDIATE MONITORING WELL PAIR

NEGATIVE VALUE INDICATES UPWARD FLOW POTENTIAL

GRADIENTS WERE CALCULATED USING LOW-TIDE MEASUREMENTS

ZONE F
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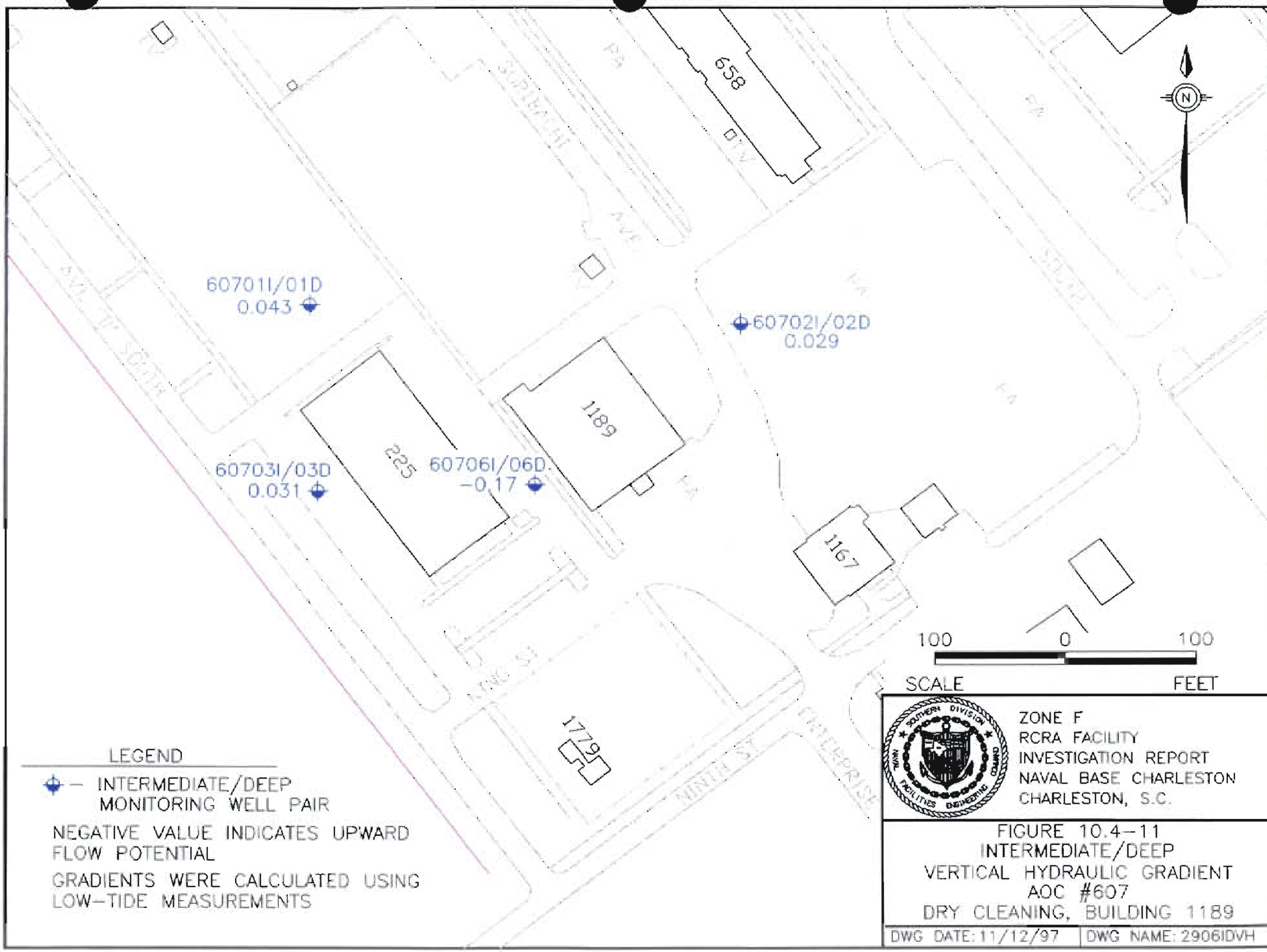
FIGURE 10.4-10
SHALLOW/INTERMEDIATE
VERTICAL HYDRAULIC GRADIENT
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 11/03/97 | DWG NAME: 2906SIVH



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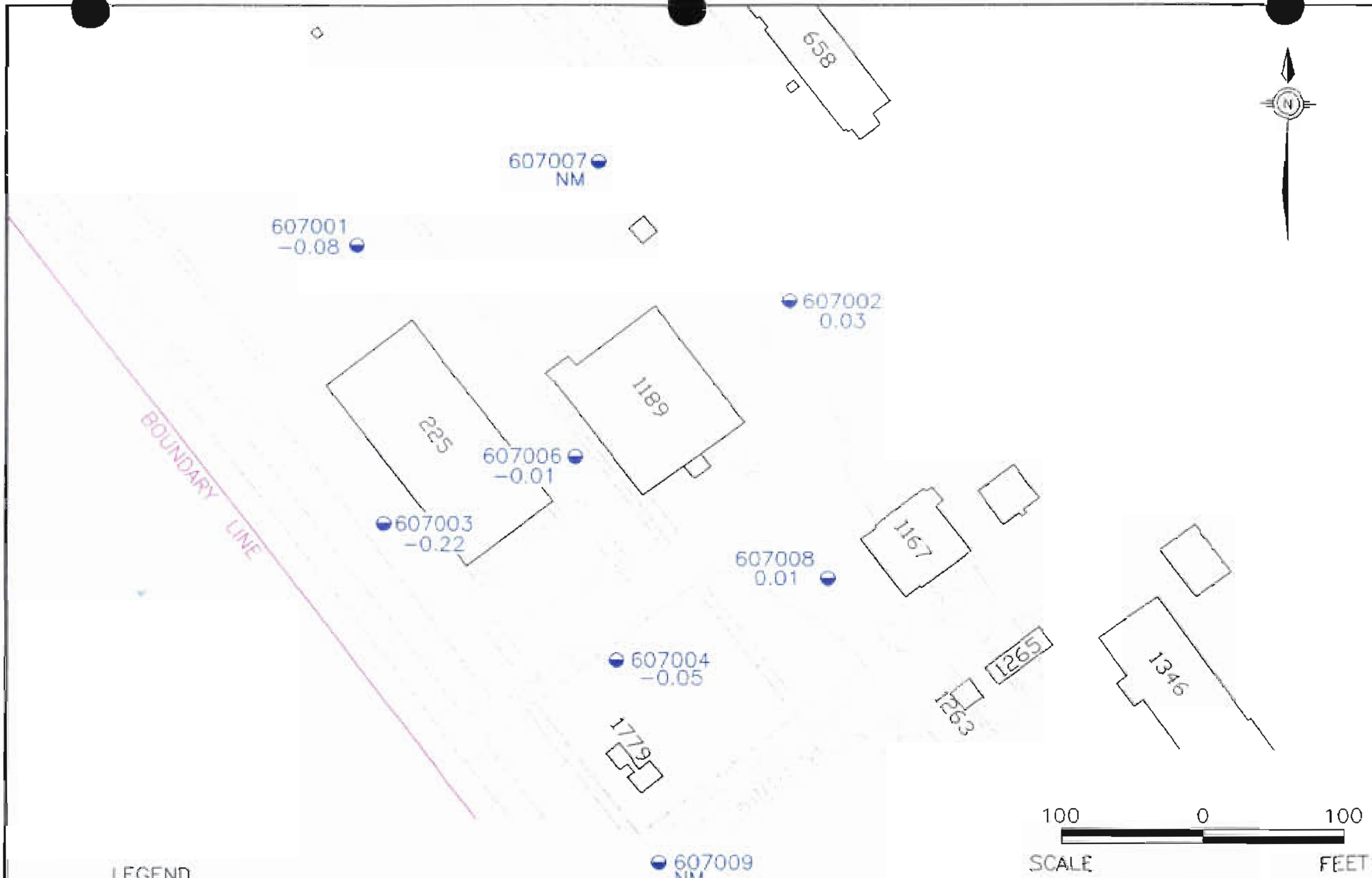
CHARLESTON, S.C.

FIGURE 10.4-11
INTERMEDIATE/DEEP
VERTICAL HYDRAULIC GRADIENT
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 11/12/97 | DWG NAME: 2906IDVH



LEGEND

- SHALLOW MONITORING WELL

NM — WATER LEVEL ELEVATION NOT MEASURED

NEGATIVE VALUE INDICATES A WATER LEVEL DROP FROM LOW TO HIGH TIDE

ZONE F
RCRA FACILITY INVESTIGATION REPORT
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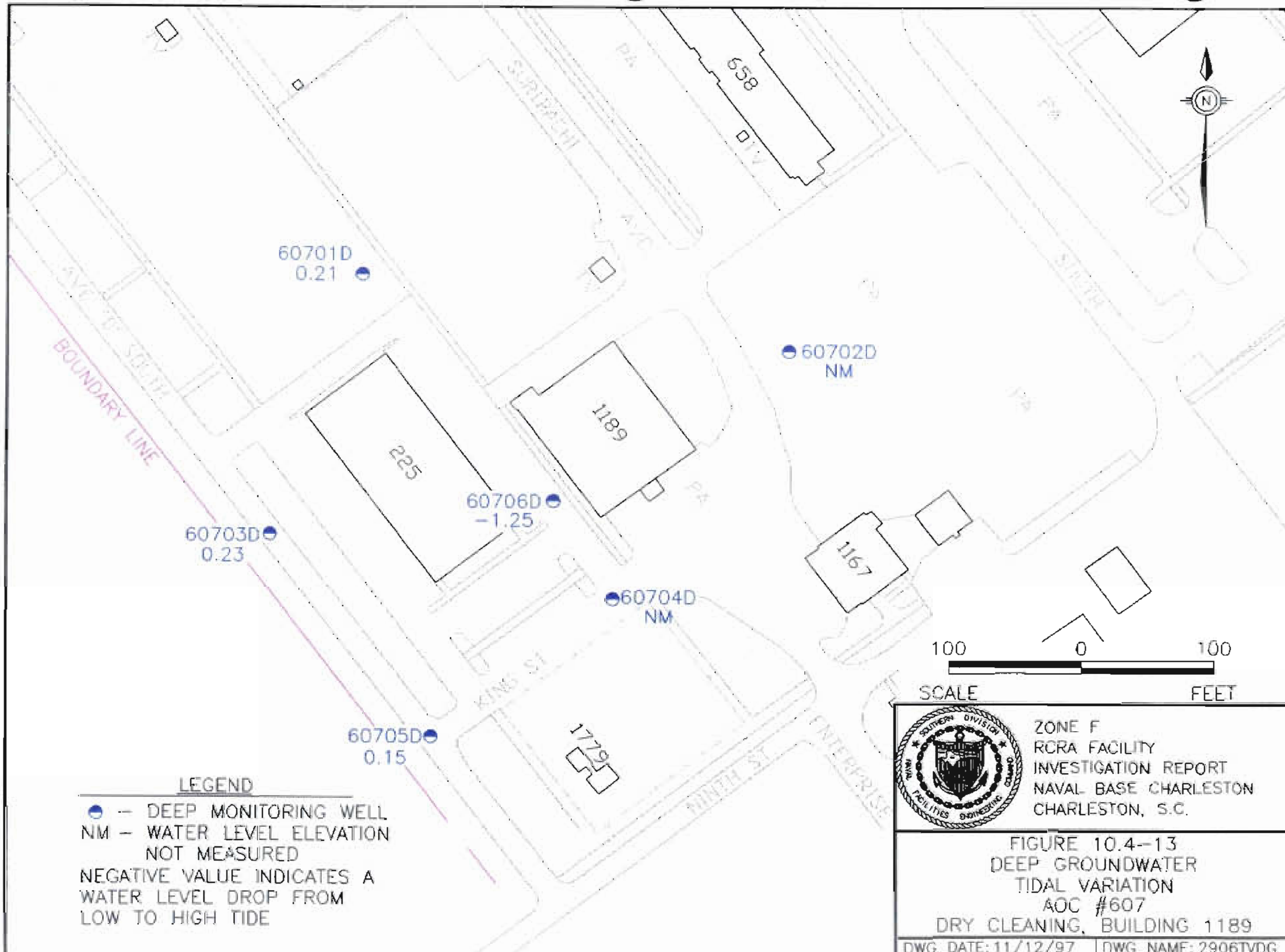
CHARLESTON, S.C.

FIGURE 10.4-12
SHALLOW GROUNDWATER TIDAL VARIATION
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 10/30/97 | DWG NAME: 2906SWTV



LEGEND

● – DEEP MONITORING WELL
NM – WATER LEVEL ELEVATION NOT MEASURED
NEGATIVE VALUE INDICATES A WATER LEVEL DROP FROM LOW TO HIGH TIDE

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

FIGURE 10.4-13
DEEP GROUNDWATER TIDAL VARIATION
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 11/12/97 | DWG NAME: 2906TVDG

10.4.2 Field Investigation Approach

The objective of the field investigation at AOC 607 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, sediment, and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions for the hollow stem auger procedures used for shallow well installation; the Rotasonic drilling procedures used for the onsite deep well; the DPT screening procedures used for soil and groundwater screening; sediment and 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 F.

10.4.3 DPT Screening Survey

The approved final RFI work plan called for a screening survey (DPT survey) in the AOC 607 area to identify the extent that soil and shallow groundwater may have been impacted by potential onsite contamination. Push sample points were spaced on 50- foot square grids, dependent on the layout of the site (buildings, obstructions, etc.). Interval soil samples were generally collected from 2- to- 4-feet bgs and 4- to 6-feet bgs. Analyzed by a mobile laboratory (the mobile laboratory used to screen AOC 607 DPT/CPT samples was able to provide DQO Level IV data, even though only DQO Level III was required). Groundwater samples were collected at nodes which yielded water. Dependent upon location within the site area, groundwater was collected at shallow, intermediate and deep sampling intervals. Intermediate and deeper samples were not collected where shallow zones were contaminated. The sampling grid over the site area was densified as necessary to determine the extent of contamination found through the screening process. A total of 59 samples were collected from 62 DPT screening locations as depicted in Figure 10.4-1. In all, 100 soil and 107 groundwater screening samples plus field QA/QC were collected during the DPT survey. These results were used to optimize placement of the discrete soil borings and monitoring wells proposed for this investigation. The analytical screening data is contained in Appendix D. Because this data was used for screening only and was presented in progress meeting, the results are not presented in the RFI text.

10.4.4 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing 12 soil borings within the AOC 607 area to confirm the presence of VOC soil contamination identified during site screening and also to analyse for metals and SVOA constituents. Upper and lower interval soil samples were proposed from each boring. Ten soil borings were advanced during the field investigation, as depicted in Figure 10.4-2. These were placed in accordance with the screening analyses, and as discussed and approved by the project team. Upper and lower interval samples were collected from nine borings, while one boring was sampled from the upper interval only. Samples 607SB001 through 607SB004 were collected through the floor of Building 1346 to investigate soil contamination beneath the building. In accordance with the approved final RFI work plan, soil samples were analyzed for metal, SVOA, and VOA constituents at DQO Level III. Table 10.4.1 summarizes the AOC 607 soil samples and analyses.

10.4.4.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.4.2. Inorganic analytical results for soil are summarized in Table 10.4.3. Table 10.4.4 summarizes all analytes detected in soil at AOC 607. Appendix D contains a complete analytical data report for all Zone F samples collected.

Table 10.4.1
AOC 607
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
607SB001	607SB00101	Upper	9/25/96	See note	
	607SB00102	Lower			
607SB002	607SB00201	Upper	9/25/96	See note	
	607SB00202	Lower			
607SB003	607SB00301	Upper	9/25/96	See note	
	607SB00302	Lower			
607SB004	607SB00401	Upper	9/25/96	See note	
	607SB00402	Lower			
607SB005	607SB00501	Upper	10/22/96	See note	
	607SB00502	Lower			
607SB006	607SB00601	Upper	10/22/96	See note	Lower sample not collected
607SB007	607SB00701	Upper	10/22/96	See note	
	607SB00702	Lower			
607SB008	607SB00801	Upper	10/22/96	See note	
	607SB00802	Lower			
607SB009	607SB00901	Upper	10/22/96	See note	
	607SB00902	Lower			
607SB010	607SB01001	Upper	10/22/96	See note	
	607SB01002	Lower			

Note:
SW-846 (metals, SVOAs, and VOAs) at DQO Level III.

Table 10.4.2
Zone F
AOC 607
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detection (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Volatiles Organic Compounds (Upper Interval - 10 Samples/Lower Interval -9- Samples) (μg/kg)						
1,2-Dichloroethene (total)	Upper	0/10	ND	ND	70000	0
	Lower	3/9	1 - 20	8	400	0
Acetone	Upper	0/10	ND	ND	780000	0
	Lower	1/9	1000	1000	16000[a]	0
Carbon disulfide	Upper	0/10	ND	ND	780000	0
	Lower	1/9	17	17	32000[a]	0
Methylene chloride	Upper	1/10	3	3	85000	0
	Lower	0/9	ND	ND	20[b]	0
Tetrachloroethene	Upper	4/10	1 - 220	89	12000	0
	Lower	4/9	10 - 710	199	60	1
Trichloroethene	Upper	1/10	2	2	58000	0
	Lower	4/9	2 - 23	9.25	60	0
Semivolatiles Organic Compounds (Upper Interval - 10 Samples/Lower Interval - 9 Samples) (μg/kg)						
Butylbenzylphthalate	Upper	1/10	58	58	1600000	0
	Lower	0/9	ND	ND	930000[d]	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
a	=	Calculated values correspond to a noncancer hazard quotient of 1.
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c	=	SSL for pH of 6.8.
d	=	Soil saturation concentration (C_{sat}).
*	=	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.
ND	=	Not detected.
NL	=	Not listed.
NA	=	Not applicable.

Table 10.4.3
Zone F
AOC 607
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
Inorganic (Upper Interval - 10 Samples Lower Interval - 9 Samples) (mg/kg)						
Aluminum	Upper	10/10	3230 - 18600	7429	7800	3
	Lower	9/9	4430 - 11000	8233.33	1000000	0
Antimony	Upper	3/10	0.58 - 1.8	1.19	3.1	0
	Lower	0/9	ND	ND	5	0
Arsenic	Upper	10/10	1.2 - 8.7	3.26	0.43	10
	Lower	9/9	2.3 - 7.1	4.15	29[b]	0
Barium	Upper	10/10	6.4 - 36	18.25	550	0
	Lower	9/9	10 - 78.6	23.61	1600[b]	0
Beryllium	Upper	4/10	0.28 - 0.92	0.56	0.15	4
	Lower	7/9	0.34 - 0.6	0.46	63[b]	0
Cadmium	Upper	2/10	.11 - .18	0.15	3.9	0
	Lower	0/9	ND	ND	8[b]	0
Calcium	Upper	10/10	271 - 15700	5510	NL	NA
	Lower	9/9	525 - 1420	1001.7	NL	NA
Chromium	Upper	10/10	3.7 - 26.9	9.36	39	0
	Lower	9/9	4.6 - 18.9	12.11	38[b]	0
Cobalt	Upper	10/10	0.43 - 45.7	7.20	470	0
	Lower	9/9	0.76 - 1.9	1.101	2000	0
Copper	Upper	10/10	0.79 - 21.5	5.04	310	0
	Lower	6/9	0.55 - 5.5	1.795	920	0

Table 10.4.3
Zone F
AOC 607
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.[a] (mg/kg)	Number of Samples Exceeding Reference
Iron	Upper	10/10	1250 - 20000	6403	2300	8
	Lower	9/9	3160 - 16000	10427.78	NL	NA
Lead	Upper	10/10	4.3 - 33.1	12.42	400[c]	0
	Lower	9/9	4.4 - 13.4	7.77	400[c]	0
Magnesium	Upper	10/10	176 - 2310	623.8	NL	NA
	Lower	9/9	230 - 1360	856.11	NL	NA
Manganese	Upper	10/10	5.8 - 279	59.12	180	1
	Lower	9/9	11.2 - 67.9	29.06	1100	0
Mercury	Upper	5/10	0.04 - .36	0.184	2.3	0
	Lower	1/9	0.06	0.06	2.0[b]	0
Nickel	Upper	10/10	0.84 - 10.4	3.874	160	0
	Lower	9/9	0.94 - 3.3	1.982	130[b]	0
Potassium	Upper	3/10	474 - 1050	705	NL	NA
	Lower	6/9	356 - 711	540.83	NL	NA
Selenium	Upper	3/10	0.38 - 0.65	0.49	39	0
	Lower	7/9	0.44 - 0.89	0.59	5[b]	0
Silver	Upper	2/10	0.83 - 0.95	0.89	39	0
	Lower	0/9	ND	ND	34[a,b]	0
Sodium	Upper	4/10	109 - 351	202	NL	NA
	Lower	5/9	80.1 - 734	267.22	NL	NA

Table 10.4.3
Zone F
AOC 607
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
Vanadium	Upper	10/10	2.8 - 41.8	13.59	55	0
	Lower	9/9	7.1 - 32	19.93	6000[a]	0
Zinc	Upper	10/10	4.1 - 76.4	26.7	2300	0
	Lower	9/9	4.9 - 26.7	10.9	12000[a,b]	0

Notes:

a = Calculated values correspond to a noncancer hazard quotient of 1.
b = SSL for pH of 6.8.
c = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA 1994a).
* = 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.
ND = Not detected.
NL = Not listed.
NA = Not applicable.

Table 10.4.4
AOC 607
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
Volatiles Organic Compounds (µg/kg)							
1,2-Dichloroethene (total)	607SB001	ND	70000	NA	3.0	400	NA
	607SB004	ND			20.0		
	607SB008	ND			1.0		
Acetone	607SB001	ND	780000	NA	1000.0	16000[a]	NA
Carbon disulfide	607SB007	ND	780000	NA	17.0	32000[a]	NA
Methylene chloride	607SB001	3.0	85000	NA	ND	20[b]	NA
Tetrachloroethene	607SB001	130.0	12000	NA	55.0	60	NA
	607SB002	5.0			21.0		
	607SB003	1.0			10.0		
	607SB004	220.0			710.0		
Trichloroethene	607SB001	ND	58000	NA	2.0	60	NA
	607SB002	ND			8.0		
	607SB003	ND			4.0		
	607SB004	2.0			23.0		

Table 10.4.4
AOC 607
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
Semivolatile Organic Compounds (μg/kg)							
Butylbenzylphthalate	607SB005	58.0	1600000	NA	ND	930000[c]	NA
Inorganics (mg/kg)							
Aluminum (Al)	607SB001	5990.0	7800.0	18500	6390.0	1000000	17100
	607SB002	3230.0			4430.0		
	607SB003	8590.0			6830.0		
	607SB004	6520.0			9050.0		
	607SB005	5590.0			11000.0		
	607SB006	9020.0			NT		
	607SB007	4930.0			9340.0		
	607SB008	**18600.0**			11000.0		
	607SB009	7730.0			6460.0		
	607SB010	4090.0			9600.0		
Antimony (Sb)	607SB005	0.580	3.1	0.79	ND	5	NL
	607SB007	1.8			ND		
	607SB010	1.2			ND		
Arsenic (As)	607SB001	2.6	0.43	19.9	2.3	29[c]	18.2
	607SB002	1.2			3.8		
	607SB003	2.8			2.6		
	607SB004	3.9			3.6		
	607SB005	3.3			4.5		
	607SB006	3.5			NT		
	607SB007	2.6			7.1		
	607SB008	8.7			4.4		
	607SB009	2.8			3.0		
	607SB010	1.2			6.1		

Table 10.4.4
AOC 607
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
Barium (Ba)	607SB001	13.3	550.0	61.5	15.0	1600[c]	51.8
	607SB002	6.4			10.0		
	607SB003	12.8			12.7		
	607SB004	11.5			18..7		
	607SB005	14.0			20.8		
	607SB006	18.1			NT		
	607SB007	25.6			18.4		
	607SB008	36.0			23.0		
	607SB009	24.5			78.6		
	607SB010	20.3			15.3		
Beryllium (Be)	607SB001	0.31	0.15	1.05	0.41	63[c]	1.20
	607SB002	ND			0.36		
	607SB003	ND			0.53		
	607SB004	0.28			0.34		
	607SB005	ND			0.44		
	607SB008	0.92			0.57		
	607SB009	0.71			0.60		
Cadmium (Cd)	607SB007	0.18	3.9	0.26	ND	8[c]	0.09
	607SB010	0.11			ND		

Table 10.4.4
AOC 607
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
Calcium (Ca)	607SB001	1490.0	NL	NL	717.0	NL	NL
	607SB002	1050.0			525.0		
	607SB003	271.0			948.0		
	607SB004	9680.0			736.0		
	607SB005	443.0			1420.0		
	607SB006	9720.0			NT		
	607SB007	15700.0			869.0		
	607SB008	10800.0			1350.0		
	607SB009	2060.0			1170.0		
	607SB010	3890.0			1280.0		
Chromium (Cr)	607SB001	6.5	39 VI 7800 III	34.8	6.4	38[c] (total)	32.2
	607SB002	3.7			4.8		
	607SB003	8.2			4.6		
	607SB004	8.7			12.5		
	607SB005	6.3			16.8		
	607SB006	14.1			NT		
	607SB007	7.3			14.5		
	607SB008	26.9			18.1		
	607SB009	6.8			12.4		
	607SB010	5.1			18.9		

Table 10.4.4
AOC 607
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)	607SB001	8.5	470.0	15.1	0.83	2000	6.85
	607SB002	1.1			0.76		
	607SB003	4.3			0.86		
	607SB004	45.7			1.5		
	607SB005	0.5			1.9		
	607SB006	3.0			NT		
	607SB007	1.4			0.9		
	607SB008	6.0			1.3		
	607SB009	1.1			0.76		
	607SB010	0.43			1.1		
Copper (Cu)	607SB001	3.7	310.0	48.2	1.7	920	30.4
	607SB002	1.0			1.4		
	607SB003	0.79			0.98		
	607SB004	4.3			0.64		
	607SB005	7.2			5.5		
	607SB006	1.3			NT		
	607SB007	6.1			ND		
	607SB008	21.5			0.55		
	607SB009	1.5			ND		
	607SB010	3.0			ND		

Table 10.4.4
AOC 607
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)	607SB001	**4050.0**	2300.0	NL	6640.0	NL	NL
	607SB002	1250.0			3840.0		
	607SB003	**7390.0**			3160.0		
	607SB004	**6060.0**			9710.0		
	607SB005	**4250.0**			12200.0		
	607SB006	**9240.0**			NT		
	607SB007	**3860.0**			16000.0		
	607SB008	**20000.0**			14900.0		
	607SB009	**5810.0**			11900.0		
	607SB010	2120.0			15500.0		
Lead(Pb)	607SB001	9.0	400.0[d]	180	4.4	400[d]	51.7
	607SB002	4.3			7.1		
	607SB003	5.3			4.9		
	607SB004	9.4			5.7		
	607SB005	13.9			13.4		
	607SB006	7.6			NT		
	607SB007	19.0			9.7		
	607SB008	33.1			8.7		
	607SB009	12.2			8.4		
	607SB010	10.4			7.7		

Table 10.4.4
AOC 607
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)	607SB001	374.0	NL	NL	445.0	NL	NL
	607SB002	176.0			312.0		
	607SB003	210.0			230.0		
	607SB004	848.0			628.0		
	607SB005	189.0			1250.0		
	607SB006	972.0			NT		
	607SB007	497.0			1220.0		
	607SB008	2310.0			1360.0		
	607SB009	436.0			1150.0		
	607SB010	226.0			1110.		
Manganese (Mn)	607SB001	33.2	180.0	307	30.9	1100	469
	607SB002	15.7			30.2		
	607SB003	5.8			30.4		
	607SB004	88.6			26.5		
	607SB005	68.9			67.9		
	607SB006	23.9			NT		
	607SB007	27.7			11.2		
	607SB008	279.0			22.0		
	607SB009	23.0			20.4		
	607SB010	25.4			22.1		
Mercury (Hg)	607SB004	0.17	2.3	0.62	ND	2[c]	0.23
	607SB005	0.36			0.06		
	607SB007	0.11			ND		
	607SB008	0.24			ND		
	607SB010	0.04			ND		

Table 10.4.4
AOC 607
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)	607SB001	3.1	160.0	12.6	2.2	130[c]	8.85
	607SB002	0.84			1.7		
	607SB003	1.3			2.3		
	607SB004	7.2			2.0		
	607SB005	10.4			3.3		
	607SB006	2.3			NT		
	607SB007	2.1			1.3		
	607SB008	8.0			2.3		
	607SB009	2.2			0.94		
	607SB010	1.3			1.8		
Potassium (K)	607SB004	591.0	NL	NL	426.0	NL	NL
	607SB005	ND			636.0		
	607SB006	474.0			NT		
	607SB007	ND			711.0		
	607SB008	1050.0			579.0		
	607SB009	ND			356.0		
	607SB010	ND			537.0		
Selenium (Se)	607SB001	ND	39	1.15	0.44	5[c]	1.24
	607SB004	ND			0.47		
	607SB005	ND			0.62		
	607SB006	0.65			NT		
	607SB007	ND			0.62		
	607SB008	0.44			0.62		
	607SB009	0.38			0.46		
	607SB010	ND			0.89		
Silver (Ag)	607SB001	0.95	39	1.85	ND	34[a,c]	NL
	607SB004	0.83			ND		

Table 10.4.4
AOC 607
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
Sodium (Na)	607SB005	ND	NL	NL	137.0	NL	NL
	607SB006	186.0			NT		
	607SB007	162.0			734.0		
	607SB008	351.0			281.0		
	607SB009	109.0			104.0		
	607SB010	ND			80.1		
Vanadium (V)	607SB001	9.9	55.0	48.9	11.9	6000[a]	49.4
	607SB002	2.8			7.3		
	607SB003	12.9			7.1		
	607SB004	11.4			20.4		
	607SB005	16.5			24.5		
	607SB006	17.2			NT		
	607SB007	8.3			22.0		
	607SB008	41.8			26.9		
	607SB009	10.5			27.3		
	607SB010	4.6			32.0		
Zinc (Zn)	607SB001	15.2	2300.0	198	7.1	12000[a,c]	84.2
	607SB002	7.7			7.7		
	607SB003	4.1			4.9		
	607SB004	17.6			7.1		
	607SB005	52.7			26.7		
	607SB006	13.2			NT		
	607SB007	40.8			11.5		
	607SB008	76.4			13.2		
	607SB009	10.3			7.4		
	607SB010	29.0			12.4		

were analyzed for metal, SVOA, and VOA constituents at DQO Level III. They were also analyzed for cyanides. One duplicate sample was collected Appendix IX analyses at DQO Level IV. The second round sample was analyzed for VOAs at DQO Level III. Table 10.4.5 summarizes the AOC 607 sediment samples and analyses.

Table 10.4.5
AOC 607
Sediment Samples and Analyses

Boring Location	Sample Identifier	Date Collected	Analyses	Remarks
607M0001	NA	NA	NA	Not Sampled
607M0002	607M000101	10/01/96	Note 1	
607M0003	607M000301	10/01/96	Note 1	
607M0004	607M000401 607N000401*	10/01/96	Notes 1/2*	
607M0005	607M000501	8/12/97	Note 3	Second-round sample

Notes:
1 = SW-846 (metals, cyanides, SVOAs, VOAs) Level III.
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanides; hex-chrome. Level IV.
3 = SW-846 (VOAs) Level III.
* = Duplicate sample.

10.4.5.1 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.4.6. Inorganic analytical results for sediment are summarized in Table 10.4.7. Table 10.4.8 presents a summary of all analytes detected in sediment at AOC 607. Appendix D is a complete analytical data report for all Zone F samples collected.

The following sections discuss sediment sample results in relation to detected soil parameters to offer an indication potential correlation. However, most AOC 607 is paved, limiting the potential for surface erosion and sediment transport from the immediate site area. Given that sediment

Table 10.4.8
AOC 607
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Benzoic acid	M0003	110.0
	M0004	48.0
Bis(2-Ethylhexyl)phthalate	M0002	3200.0
	M0003	980.0
	M0004	2800.0
Butylbenzylphthalate	M0004	155.0
Chrysene	M0002	2500.0
	M0003	55000.0
	M0004	3200.0
Di-n-octyl phthalate	M0002	170.0
	M0004	960.0
Dibenz(a,h)anthracene	M0002	240.0
	M0003	9100.0
	M0004	1200.0
Dibenzofuran	M0002	260.0
	M0003	7000.0
	M0004	485.0
Fluoranthene	M0002	3600.0
	M0003	130000.0
	M0004	6000.0
Fluorene	M0002	540.0
	M0003	27000.0
	M0004	975.0
Indeno(1,2,3-cd)pyrene	M0002	910.0
	M0003	16000.0
	M0004	2250.0
Naphthalene	M0002	230.0
	M0003	5900.0
	M0004	355.0
Phenanthrene	M0002	3200.0
	M0003	110000.0
	M0004	4250.0
Phenol	M0003	160.0
Pyrene	M0002	5300.0
	M0003	70000.0
	M0004	5950.0
Dioxins (ng/kg)		
Dioxin (2,3,7,8-TCDD TEQ[1])	M0004	2.4065

Table 10.4.8
AOC 607
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Lead(Pb)	M0002	70.9
	M0003	626.0
	M0004	100.95
Magnesium (Mg)	M0002	2770.0
	M0003	1010.0
	M0004	1650.0
Manganese (Mn)	M0002	120.0
	M0003	73.9
	M0004	110.5
Nickel (Ni)	M0002	21.4
	M0003	19.7
	M0004	4.95
Potassium (K)	M0002	349.0
	M0003	135.5
	M0004	467.0
Selenium (Se)	M0002	0.42
	M0003	0.74
Thallium (Tl)	M0003	0.79
Tin (Sn)	M0003	10.7
Vanadium (V)	M0002	306.0
	M0003	42.7
	M0004	13.85
Zinc (Zn)	M0002	255.0
	M0003	1380.0
	M0004	80.1

Notes:

NA	=	Not available
ND	=	Not detected.
NT	=	Not taken
µg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram
ng/kg	=	Nanograms per kilogram
1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)

samples were collected from engineered structures (storm catch basins, storm water culverts, etc.), this material is not true sediment generated in a native setting, and therefore, is not compared to reference concentrations or other criteria.

Volatile Organic Compounds in Sediment

Three VOCs, tetrachloroethene, trichloroethene, and vinyl chloride, were detected in AOC 607 sediment samples. Each of these VOCs, except vinyl chloride, was also detected in site soil samples. The highest sediment VOC concentration detected was 4.0 μg/kg of vinyl chloride.

Semivolatile Organic Compounds in Sediment

Twenty-seven SVOCs were detected in sediment samples. Of these SVOCs, only butylbenylphthalate was also detected in soil. The highest sediment SVOC concentrations was 130,000 μg/kg of fluoranthene.

Pesticides and PCBs in Sediment

A single concentration of the pesticide heptachlor was detected in the one duplicate sediment sample. No PCB concentrations were detected in AOC 607 sediment samples. Heptachlor was not detected in site soil.

Other Organic Compounds in Sediment

A single dioxin concentration (2,3,7,8-TCDD TEQ) was also detected in the duplicate sediment sample. Dioxin was not detected in site soil.

Inorganic Elements in Sediment

Metals were as commonly detected in sediment as they were in site soil. Twenty-two metals and cyanide were detected in sediment samples collected at AOC 607.

10.4.6 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of six shallow monitoring wells within the AOC 607 area to: (1) assess groundwater quality, (2) to confirm the nature and extent of any contamination identified during the screening survey, and (3) identify contaminants which may be migrating from the site in the shallow aquifer. Because three aquifer horizons were identified in the site area, eight shallow, five intermediate, and six deep wells were installed, in two phases, within the site area during the field investigation (Figure 10.4-2). All wells installed at AOC 607 included two-ft length screened intervals. Shallow wells were installed at approximately 10-ft bgs in the upper sand layer of the Wando Formation. Intermediate wells were installed at approximately 20-ft bgs. Deep wells were installed to about 30-ft bgs. In accordance with the approved final RFI work plan, groundwater samples from original wells were analyzed for limited specific constituents at DQO Level III. Subsequent phase wells were sampled for VOAs only, at DQO Level III. Two shallow well duplicate samples, and one deep well duplicate sample were collected for Appendix IX analyses at DQO Level IV. Table 10.4.9 summarizes the groundwater samples and analyses at this site.

Table 10.4.9
AOC 607
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
607001	Shallow	60700101	11/19/96	Note 1	
607002	Shallow	60700201*	11/19/96	Notes 1/2*	
607003	Shallow	60700301	11/19/96	Note 1	
607004	Shallow	60700401	11/19/96	Note 1	
607006	Shallow	60700601*	11/19/96	Notes 1/2*	Second-round sample
607007	Shallow	60700701	11/21/96	Note 1	
607008	Shallow	607008A1	4/30/97	Note 3	Second-round samples
607009	Shallow	607009A1	5/06/97	Note 3	
607011	Intermediate	60701I01	11/19/96	Note 1	

Table 10.4.9
AOC 607
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
60702I	Intermediate	60702I01	11/19/96	Note 1	
60703I	Intermediate	60703I01	11/19/96	Note 1	
60704I	Intermediate	60704I01	11/19/96	Note 1	
60706I	Intermediate	60706IA1	4/30/97	Note 3	Second-round samples
60701D	Deep	60701D01	11/21/96	Note 1	
60702D	Deep	60702D01*	11/20/96	Notes 1/2*	
60703D	Deep	60703D01	11/21/96	Note 1	
60704D	Deep	60704D01	11/21/96	Note 1	
607054D	Deep	607054D01	11/201/96	Note 1	
60706D	Deep	60706DA11	4/30/97	Note 3	Second-round samples

Notes:

1 = SW-846 (metals, pesticides/PCBs, SVOAs, VOAs); cyanides. Level III.
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanides; hex-chrome at DQO Level IV.
3 = SW-846 (VOAs) at DQO Level III.
* = Duplicate sample.

10.4.6.1 Nature of Contamination in Groundwater

Shallow wells 607001 through 607004, 607006, and 607006, intermediate wells 607001I through 607004I, and 607007I, and deep wells 607001D through 607005D, and 607007D, were installed initially. Shallow wells 607008 and 607009, and intermediate and deep wells 6007006I and 607006D, were installed to further evaluate site groundwater during later sampling events. Analytical results for shallow groundwater samples are summarized in Tables 10.4.10 and 10.4.11. Analytical results for intermediate groundwater samples are summarized in Tables 10.4.12 and 10.4.13. Deep groundwater analytical results are presented in Tables 10.4.14 and 10.4.15. Table 10.4.16 presents a summary of all analytes detected in groundwater at AOC 607.

Organics Detected in Groundwater

Shallow Well Samples

Several VOCs and SVOCs were detected in shallow groundwater samples. The tap water RBCs for five VOCs were exceeded during the initial groundwater samples at AOC 607. Concentrations of 1,1-dichloroethene, 1,2-dichloroethene (total), tetrachloroethene, trichloroethene, and vinyl chloride exceeded their respective RBCs. During initial sampling, only one SVOC, pentachlorophenol, exceeded its tap water RBC. Figures 10.4-16 through 10.4-20 show VOCs detected in shallow groundwater. Figure 10.4-21 shows the concentrations of pentachlorophenol in shallow groundwater.

Intermediate Well Samples

Four VOCs were detected in intermediate groundwater samples. The tap water RBCs for these four VOCs were exceeded during groundwater sampling at AOC 607. Concentrations of 1,1-dichloroethene, 1,2-dichloroethene (total), tetrachloroethene, and trichloroethene exceeded their respective tap water RBC. Figures 10.4-22 through 10.4-25 show VOCs concentration detected in intermediate groundwater samples.

Table 10.4.10
Zone F
AOC 607
Organic Analytical Results for Shallow 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
Volatile Organic Compounds (µg/L)							
1,1-Dichloroethene	Shallow	1/8	2.0	2.0	.044	7.0	1
1,2-Dichloroethene (total)	Shallow	2/8	120 - 840	480	5.5	70.0	2
Carbon Disulfide	Shallow	1/8	2.0 - 2.0	2.0	100	NL	0
Tetrachloroethene	Shallow	2/8	14.0 - 45000	2257	1.1	5.0	2
Toluene	Shallow	2/8	1.0 - 4.0	2.5	75	1000	0
Trichlorothene	Shallow	2/8	26 - 1300	663	1.6	5.0	2
Vinyl Chloride	Shallow	1/8	9.0	9.0	0.019	2.0	1
Semivolatile Organic Compounds (µg/L)							
Benzoic Acid	Shallow	2/7	1.0 - 1.0	1.0	15000	NL	0
Benzyl Alcohol	Shallow	1/7	2.0	2.0	1100	NL	0
Butylbenzylphtalate	Shallow	1/7	1.0	1.0	730	NL	0
Phentachlorophenol	Shallow	1/7	3.0	3.0	0.56	1.0	1

Notes:
NL = Not listed.
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA 1996[b]). MCLs/SMCLs from *Drinking Water Regulations Health Advisories* (USEPA 1996[a])

Table 10.4.11
Zone F
AOC 607
Inorganic Analytical Results for Shallow 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 (7 Shallow Samples) (μg/L)							
Aluminum	Shallow	7/7	66.9 - 7810	2059.1	3700	50	2
Antimony	Shallow	1/7	2.6	2.6	1.5	6	1
Arsenic	Shallow	5/7	3.0 - 75.2	24.2	0.045	50	5
Barium	Shallow	7/7	5.8 - 42.4	22.5	260	2000	0
Calcium	Shallow	7/7	4170 - 65800	32239	NL	NL	0
Chromium	Shallow	4/7	1.4 - 35.6	11.6	18	100	1
Cobalt	Shallow	2/7	2.6 - 9.9	6.3	220	NL	0
Copper	Shallow	3/7	.96 - 5.0	2.39	150	1000	0
Iron	Shallow	7/7	74.6 - 22000	6468	1100	300	5
Lead	Shallow	2/7	5.5 - 17.4	11.5	15	15	1
Magnesium	Shallow	7/7	1022.5 - 23900	14646	NL	NL	0
Manganese	Shallow	7/7	2.6 - 495	160	84	50	4
Nickel	Shallow	6/7	1.2 - 7.1	3.23	73	100	0
Potassium	Shallow	5/7	4660 - 26500	12364	NL	NL	0

Table 10.4.11
Zone F
AOC 607
Inorganic Analytical Results for Shallow 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
Selenium	Shallow	2/7	6.8 - 9.3	8.1	18	50	0
Sodium	Shallow	7/7	6570 - 478000	199810	NL	NL	0
Tin	Shallow	1/7	3.5	3.5	2200	NL	0
Vanadium	Shallow	2/7	12.0 - 90.4	51.2	26	NL	1
Zinc	Shallow	1/7	22.0	22.0	1100	5000	0

Notes:
NL = Not listed.
NA = Not applicable.
* = Tap water RBCs (THQ=0.1)(USEPA, 1996b) and MCLs/SMCLs (USEPA, 1996d) were used as reference concentrations.

Table 10.4.12
Zone F
AOC 607
Organic Analytical Results for Intermediate 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
Volatile Organic Compounds (μg/L)							
1,1-Dichloroethene	Intermediate	1/5	2.0	2.0	.044	7.0	0
1,2-Dichloroethene (total)	Intermediate	1/5	24.0	24.0	5.5	70.0	0
Tetrachloroethene	Intermediate	1/5	4100.0	4100.0	1.1	5.0	1
Trichlorothene	Intermediate	1/5	150.0	150.0	1.6	5.0	1

Notes:
NL = Not listed.
* = Tap water RBCs (THQ=0.1) and MCLs/SMCLs were used as reference concentrations.

Table 10.4.13
Zone F
AOC 607
Inorganic Analytical Results for Intermediate 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 (4 Intermediate Samples) (μg/L)							
Aluminum	Intermediate	2/4	371 - 2810	1591	3700	50	0
Arsenic	Intermediate	3/4	5.2 - 43.3	18.2	0.045	50	3
Barium	Intermediate	4/4	2.08 - 54.4	41.6	260	2000	0
Calcium	Intermediate	4/4	58600 - 220000	123900	NL	NL	0
Chromium	Intermediate	2/4	1.1 - 9.3	5.2	18	100	0
Cobalt	Intermediate	1/4	8.1	8.1	220	NL	0
Copper	Intermediate	1/4	1.0	1.0	150	1000	0
Iron	Intermediate	4/4	699 - 4870	2745	1100	300	2
Lead	Intermediate	1/4	2.1	2.1	15	15	0
Magnesium	Intermediate	4/4	6410 - 31900	16470	NL	NL	0
Manganese	Intermediate	4/4	164 - 1040	456	84	50	4
Nickel	Intermediate	4/4	0.98 - 6.1	3.2	73	100	0
Potassium	Intermediate	4/4	2500 - 8250	4855	NL	NL	0
Sodium	Intermediate	4/4	78400 - 405000	192100	NL	NL	0

Table 10.4.13
Zone F
AOC 607
Inorganic Analytical Results for Intermediate 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	Intermediate	1/4	8.3	8.3	26	NL	0

Notes:
NL = Not listed.
NA = Not applicable.
* = Tap water RBCs (THQ=0.1)(USEPA, 1996b) and MCLs/SMCLs (USEPA, 1996d) were used as reference concentrations.

Table 10.4.14
Zone F
AOC 607
Organic Analytical Results for Deep 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
Volatile Organic Compounds (μg/L)							
Carbon Disulfide	Deep	1/6	2.0	2.0	100	NL	0
Chloromethane	Deep	1/6	10.0	10.0	1.4	NL	1
Tetrachloroethene	Deep	1/6	3.0	3.0	1.1	5.0	0
Trichlorothene	Deep	1/6	2.0	2.0	1.6	5.0	0

Notes:
NL = Not listed.
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January - June 1996* (USEPA 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA 1996e) were used as reference concentrations.

Table 10.4.15
Zone F
AOC 607
Inorganic Analytical Results for Deep 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 (5 Deep Samples) (µg/L)							
Aluminum	Deep	5/5	204 - 4540	1799	3700	50	1
Arsenic	Deep	5/5	3.5 - 20.3	9.5	0.045	50	5
Barium	Deep	5/5	18.7 - 55.0	30.8	260	2000	0
Beryllium	Deep	1/5	0.46	0.46	0.016	4	1
Cadmium	Deep	1/5	0.60	0.60	1.8	5	0
Calcium	Deep	5/5	35800 - 201000	96260	NL	NL	0
Chromium	Deep	4/5	1.8 - 33.7	12.5	18	100	1
Cobalt	Deep	4/5	1.05 - 2.0	1.54	220	NL	0
Copper	Deep	3/5	1.2 - 8.3	4.6	150	1000	0
Iron	Deep	5/5	134 - 6960	2393	1100	300	3
Lead	Deep	4/5	18.7 - 99.7	62.8	15	15	4
Magnesium	Deep	5/5	7690 - 55700	30688	NL	NL	0
Manganese	Deep	5/5	51.9 - 185	124.8	84	50	3
Nickel	Deep	5/5	.92 - 17.4	6.34	73	100	0

Table 10.4.15
Zone F
AOC 607
Inorganic Analytical Results for Deep 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
Potassium	Deep	5/5	7550 - 18800	12890	NL	NL	0
Sodium	Deep	5/5	263000 - 401000	319600	NL	NL	0
Vanadium	Deep	4/5	3.5 - 12.3	6.26	26	NL	0
Zinc	Deep	1/5	43.3	43.3	1100	5000	0

Notes:
NL = Not listed.
NA = Not applicable.
* = Tap water RBCs (THQ=0.1)(USEPA, 1996b) and MCLs/SMCLs (USEPA, 1996e) were used as reference concentrations.

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Volatile Organic Compounds (µg/L)							
1,1-Dichloroethene	607006	**2.0**	**2.0**	ND	0.044	7.0	NA
	607061	NI	**2.0**	ND			
1,2-Dichloroethane (total)	607004	**120.0**	**57.0**	**70**	5.5	70.0	NA
	607006	**840.0**	**430.0**	**560**			
	607061	NI	**24.0**	**28**			
	607041	ND	ND	4			
1,1,2-Trichloroethane	607006	ND	**2.0**	ND	0.19	5.0	NA
Bromomethane	607006	ND	**2.0**	ND	0.87	NL	NA
Carbon disulfide	607007	2.0	ND	ND	100	NL	NA
	60705D	2.0	ND	ND			
Chloromethane	607006	ND	**6.0**	ND	1.4	NL	NA
	60701D	**10.0**	ND	ND			
Methylene chloride	607006	ND	1.0	ND	4.1	NL	NA
Tetrachloroethene	607006	**45000.0**	**17000.0**	**20000**	1.1	5.0	NA
	607008	NI	**14.0**	**9.0**			
	60704I	ND	1.0	ND			
	60706I	NI	**4100.0**	**8000**			
	60705D	**3.0**	ND	ND			
Toluene	607006	4.0	ND	ND	75	1000	NA
	607007	1.0	ND	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Trichloroethene	607004	**26.0**	**7.0**	**4.0**	1.6	5.0	NA
	607006	**1300.0**	**515.0**	**780**			
	60706I	NI	**150.0**	**150**			
	60701D	**2.0**	ND	ND			
Vinyl chloride	607004	ND	ND	**1.0**	0.019	2.0	NA
	607006	**9.0**	**14.5**	**20.0**			
Semivolatile Organic Compounds (µg/L)							
2-Chlorophenol	607004	ND	1.0	ND	18	NL	NA
Benzoic Acid	607004	1.0	ND	ND	15000	NL	NA
	607009	NI	1.0	ND			
Benzyl alcohol	607006	ND	ND	1.0	1100	NL	NA
	607008	NI		1.0			
	607009	NI	2.0	ND			
	607011	ND	ND	1.0			
Butylbenzylphthalate	607004	1.0	ND	ND	730	NL	NA
Di-n-butylphthalate	607006	ND	ND	1.0	370	NL	NA
	607007	ND	ND	1.0			
	60706I	NI	ND	1.0			
	60705D	ND	ND	1.0			
Pentachlorophenol	607003	**3.0**	ND	ND	0.56	NL	NA
Phenol	607001	ND	ND	3.0	2200	NL	NA
	60701I	ND	ND	4.0			
	60702I	ND	ND	2.0			
	60702D	ND	ND	1.0			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow/Deep Background
Inorganics (μG/L)							
Aluminum (Al)	607001	149.0	161.0	ND	3700	50	224/77.7
	607002	132.0	190.0	72.9			
	607003	306.0	70.4	273			
	607004	**4680.0**	13.5	ND			
	607006	1270.0	154.0	181.5			
	607007	66.9	21.1	661			
	607009	NI	**7810.0**	2820			
	60703I	2810.0	ND	ND			
	60704I	371.0	197.0	ND			
	60701D	**4540.0**	ND	ND			
	60702D	1470.0	2475.0	161			
	60703D	2550.0	758.0	1060			
	60704D	232.0	44.9	ND			
	60705D	204.0	69.0	166			
Antimony (Sb)	607006	ND	**3.9**	ND	1.5	6	NL
	607007	ND	**1.9**	ND			
	607009		**2.6**	ND			
	60704I	ND	**1.8**	ND			
	60703D	ND	**3.1**	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow/Deep Background
Arsenic (As)	607002	9.8	6.1	2.5	0.045	50	16.7/16.2
	607003	ND	3.3	5.0			
	607004	**75.2**	**48.3**	**72.7**			
	607006	3.0	ND	ND			
	607007	4.7	ND	14.8			
	607009	NI	**28.2**	**31.3**			
	60702I	**43.3**	**40.6**	**44.3**			
	60703I	6.0	3.7	7.2			
	60704I	5.2	4.2	9.5			
	60701D	11.3	4.6	6.1			
	60702D	8.2	6.9	7.45			
	60703D	**20.3**	15.9	**18.6**			
	60704D	4.3	3.0	2.6			
	60705D	3.5	ND	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Barium (Ba)	607001	20.0	18.4	19.1	260	2000	94.3/200
	607002	5.85	4.6	ND			
	607003	25.8	26.6	36.4			
	607004	29.5	1.8	ND			
	607006	20.9	12.15	10.75			
	607007	12.7	11.6	15.6			
	607008	NI	NT	4.9			
	607009	NI	42.4	27.5			
	60501I	38.8	33.0	31.6			
	60702I	54.4	49.4	54			
	60703I	52.5	32.9	32.2			
	60704I	20.8	22.4	21.0			
	60706I	NI	NT	69.6			
	60701D	55.0	32.7	30.6			
	60702D	30.85	40.25	24.7			
	60703D	26.6	19.8	22.5			
	60704D	18.7	20.3	19.1			
	60705D	22.7	18.0	15			
	60706D	NI	NT	17.1			
Beryllium (Be)	607003	ND	ND	0.24	0.016	4	0.66/0.46
	60704I	ND	ND	0.22			
	60701D	0.46	ND	ND			
Cadmium (Cd)	60701D	0.6	ND	ND	1.8	5	0.82/0.77
	60702D	ND	0.565	ND			
	60703D	ND	0.37	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow/Deep Background
Calcium (Ca)	607001	63000.0	64100.0	61100	NL	NL	NL
	607002	4170.0	1510.0	1020			
	607003	65800.0	35600.0	39300			
	607004	21800.0	20000.0	20600			
	607006	44500.0	26550.0	23800			
	607007	15700.0	12700.0	12500			
	607008	NI	NT	2310			
	607009	NI	10700.0	8500			
	60701I	111000.0	100000.0	94800			
	60702I	220000.0	206000.0	211000			
	60703I	106000.0	73700.0	75500			
	60704I	58600.0	56600.0	59500			
	60706I	NI	NT	210000			
	60701D	201000.0	103000.0	99900			
	60702D	108000.0	118500.0	88450			
	60703D	35800.0	19800.0	21500			
	60704D	75700.0	59900.0	58900			
	60705D	60800.0	50000.0	51600			
	60706D	NI	NT	70400			
Chromium (Cr)	607002	1.81	ND	1.4	18	100	2.05/1.31
	607003	ND	ND	1.4			
	607004	7.4	1.7	1.3			
	607006	1.4	ND	ND			
	607007	ND	ND	1.4			
	607009		**35.6**	**28.4**			
	60703I	9.3	ND	ND			
	60704I	1.1	1.1	ND			
	60701D	**33.7**	ND	1.2			
	60702D	4.0	7.05	1.0			
	60703D	10.5	4.1	3.4			
	60704D	1.8	1.2	ND			
	60705D	ND	1.1	1.1			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Cobalt (Co)	607003	ND	ND	2.3	220	NL	10.9/67
	607004	ND	1.4	1.5			
	607006	9.9	9.85	8.85			
	607007	2.6	2.0	2.3			
	607008	NI	NT	1.1			
	607009	NI	ND	1.9			
	60702I	8.1	8.4	7.8			
	60704I	ND	ND	0.9			
	60706I	NI	NT	8.2			
	60701D	2.0	ND	ND			
	60702D	1.05	1.85	ND			
	60703D	1.7	ND	1.1			
	60704D	1.4	ND	ND			
	60705D	ND	ND	0.74			
	60706D	NI	NT	0.69			
Copper (Cu)	607004	1.2	ND	ND	150	1000	NL
	607007	0.96	ND	1.6			
	607009		5.0	ND			
	60703I	1.0	ND	ND			
	60701D	8.3	ND	ND			
	60702D	1.2	ND	ND			
	60703D	4.2	7.0	2.3			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow/Deep Background
Iron (Fe)	607001	74.6	143.0	30.6	1100	300	NL
	607002	**1830.0**	**1320.0**	**880**			
	607003	408.0	379.0	999			
	607004	**22000.0**	**10400.0**	**15800**			
	607006	**4240.0**	**2250.0**	**2155**			
	607007	**7820.0**	**7710.0**	**6950**			
	607008	NI	NT	532			
	607009	NI	**8900.0**	**9530**			
	60701I	699.0	560.0	**1800**			
	60702I	**4870.0**	**4410.0**	**4650**			
	60703I	**4680.0**	578.0	803			
	60704I	729.0	624.0	624			
	60706I	NI	NT	**2650**			
	60701D	**6960.0**	32.4	65.5			
	60702D	**1600.0**	**2495.0**	194.5			
	60703D	**3030.0**	699.0	740			
	60704D	240.0	56.0	ND			
	60705D	134.0	47.2	ND			
Lead (Pb)	607004	5.5	ND	ND	15	15	NL
	607009	NI	**17.4**	ND			
	60703I	2.1	ND	ND			
	60701D	**70.8**	ND	ND			
	60702D	**99.7**	1.6	ND			
	60703D	**18.7**	ND	ND			
	60705D	**61.9**	ND	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow/Deep Background
Magnesium (Mg)	607001	17500	17700.0	16400	NL	NL	NL
	607002	1022.5	523.0	400			
	607003	6690.0	4850.0	5190			
	607004	22900.0	22900.0	22800			
	607006	9410.0	7100.0	6135			
	607007	23900.0	19900.0	16000			
	607008	NI	NT	359			
	607009	NI	21100.0	16300			
	607011	18300.0	16600.0	15300			
	607021	31900.0	30300.0	30300			
	607031	6410.0	4540.0	4560			
	607041	9270.0	9160.0	9030			
	607061	NI	NT	26100			
	60701D	55700.0	45800.0	43400			
	60702D	31250.0	31750.0	30700			
	60703D	7690.0	6350.0	7320			
	60704D	31900.0	27300.0	27700			
	60705D	26800.0	24200.0	24600			
	60706D	NI	NT	27600			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow/Deep Background
Manganese (Mn)	607001	2.6	1.7	0.89	84	50	2010/1256
	607002	53.5	19.4	11.4			
	607003	204.0	169.0	166			
	607004	208.0	194.0	212			
	607006	495.0	408.0	350.5			
	607007	120.0	109.0	191			
	607008	NI	NT	9.4			
	607009	NI	65.2	51.8			
	60701I	225.0	183.0	184			
	60702I	1040.0	1040.0	966			
	60703I	164.0	135.0	116			
	60704I	393.0	396.0	341			
	60706I	NI	NT	1750			
	60701D	185.0	68.2	86.4			
	60702D	179.0	179.5	70.55			
	60703D	51.9	17.5	32			
	60704D	128.0	123.0	66			
	60705D	80.3	58.2	19.6			
Mercury (Hg)	607002	ND	0.13	ND	1.1	2	NL
	607006	ND	0.1	0.14			
	607008	NI	NT	0.12			
	60702I	ND	0.17	ND			
	60704D	ND	ND	0.31			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Nickel (Ni)	607002	2.05	ND	1.2	73	100	5.55/61.1
	607003	1.2	ND	2.2			
	607004	2.1	ND	1.3			
	607006	4.3	3.4	ND			
	607007	2.6	1.3	2.1			
	607009	NI	7.1	ND			
	607011	0.98	ND	ND			
	60702I	6.1	5.5	5.6			
	60703I	3.3	ND	0.93			
	60704I	2.6	1.1	ND			
	60701D	17.4	0.72	1.3			
	60702D	2.5	3.9	1.65			
	60703D	6.8	4.9	3.2			
	60704D	2.1	1.3	ND			
	60705D	0.92	ND	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Potassium (K)	607001	6860.0	6510.0	6930	NL	NL	NL
	607002	ND	769.0	707			
	607003	ND	1190.0	1580			
	607004	12400.0	10600.0	13100			
	607006	4660.0	2600.0	3200			
	607007	11400.0	8890.0	11300			
	607008	NI	NT	856			
	607009	NI	26500.0	26200			
	607011	3440.0	2920.0	2730			
	607021	8250.0	7100.0	7800			
	607031	2500.0	1890.0	2210			
	607041	5230.0	4470.0	4810			
	607061	NI	NT	6160			
	60701D	18800.0	16500.0	16800			
	60702D	12300.0	11500.0	12250			
	60703D	7550.0	7120.0	8460			
	60704D	13400.0	11700.0	12900			
	60705D	12400.0	11300.0	12300			
	60706D	NI	NT	14100			
Selenium (Se)	607001	9.3	10.1	10.3	18	50	NL
	607004	6.8	ND	ND			
	607009	NI	NT	3.6			
	60703D	3.4	ND	ND			
Silver (Ag)	607061	NI	NT	1.3	18	100	NL
	60704D	1.2	ND	ND			

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Sodium (Na)	607001	6570.0	6430.0	8390	NL	NL	NL
	607002	61300.0	59800.0	48900			
	607003	23800.0	22200.0	19400			
	607004	246000.0	232000.0	248000			
	607006	144000.0	180500.0	168000			
	607007	439000.0	376000.0	447000			
	607008	NI	NT	43300			
	607009	NI	478000.0	390000			
	60701I	163000.0	153000.0	139000			
	60702I	405000.0	404000.0	398000			
	60703I	78400.0	79400.0	83500			
	60704I	122000.0	117000.0	124000			
	60706I	NI	NT	374000			
	60701D	401000.0	405000.0	370000			
	60702D	309000.0	261000.0	282000			
	60703D	340000.0	299000.0	291000			
	60704D	285000.0	295000.0	267000			
	60705D	263000.0	248000.0	239000			
	60706D			260000			
Thallium (Tl)	607001	ND	7.4	ND	0.29	2	5.58/8.18
	607003	ND	6.2	ND			
	607004	ND	ND	5.8			
	607006	ND	6.1	6.7			
	607011	ND	5.8	ND			
	60703D	ND	5.5	ND			
Tin (Sn)	607004	3.5	ND	ND	2200	NL	NL

Table 10.4.16
Zone F
AOC 607
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow/Deep Background
Vanadium (V)	607001	ND	1.4	ND	26	NL	1.58/1.13
	607004	12.0	ND	ND			
	607007	ND	ND	1.9			
	607008	NI	NT	1.2			
	607009	NI	**90.4**	**92.7**			
	60701I	ND	1.1	ND			
	60703I	8.3	ND	ND			
	60704I	ND	1.1	ND			
	60701D	25.6	1.8	ND			
	60702D	4.15	6.65	1.2			
	60703D	12.3	6.1	5.6			
	60704D	5.1	3.0	2.6			
	60705D	3.5	6.2	2.6			
	60706D	NI	NT	2.4			
Zinc (Zn)	607002	ND	10.7	6.9	1100	5000	NL
	607004	ND	ND	10.1			
	607006	ND	16.2	ND			
	607007	ND	ND	12.7			
	607009	NI	22.0	ND			
	60701D	43.3	9.4	6.9			
	60702D	ND	ND	15.65			
	60703D	ND	ND	10.0			

Notes:
NL = Not listed
NA = Not applicable
NT = Not taken
NI = Well not installed in initial phase
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January - June 1996* (USEPA 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health /advisories* (USEPA 1996e) were used as reference concentrations.
Bolded concentrations exceed both the RBC and the zone background.
All background reference values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background reference values for groundwater are based on two sampling rounds in two wells at each depth.
Well 607008, 607009, 60706I, and 60706D were installed during the second phase of well installation.

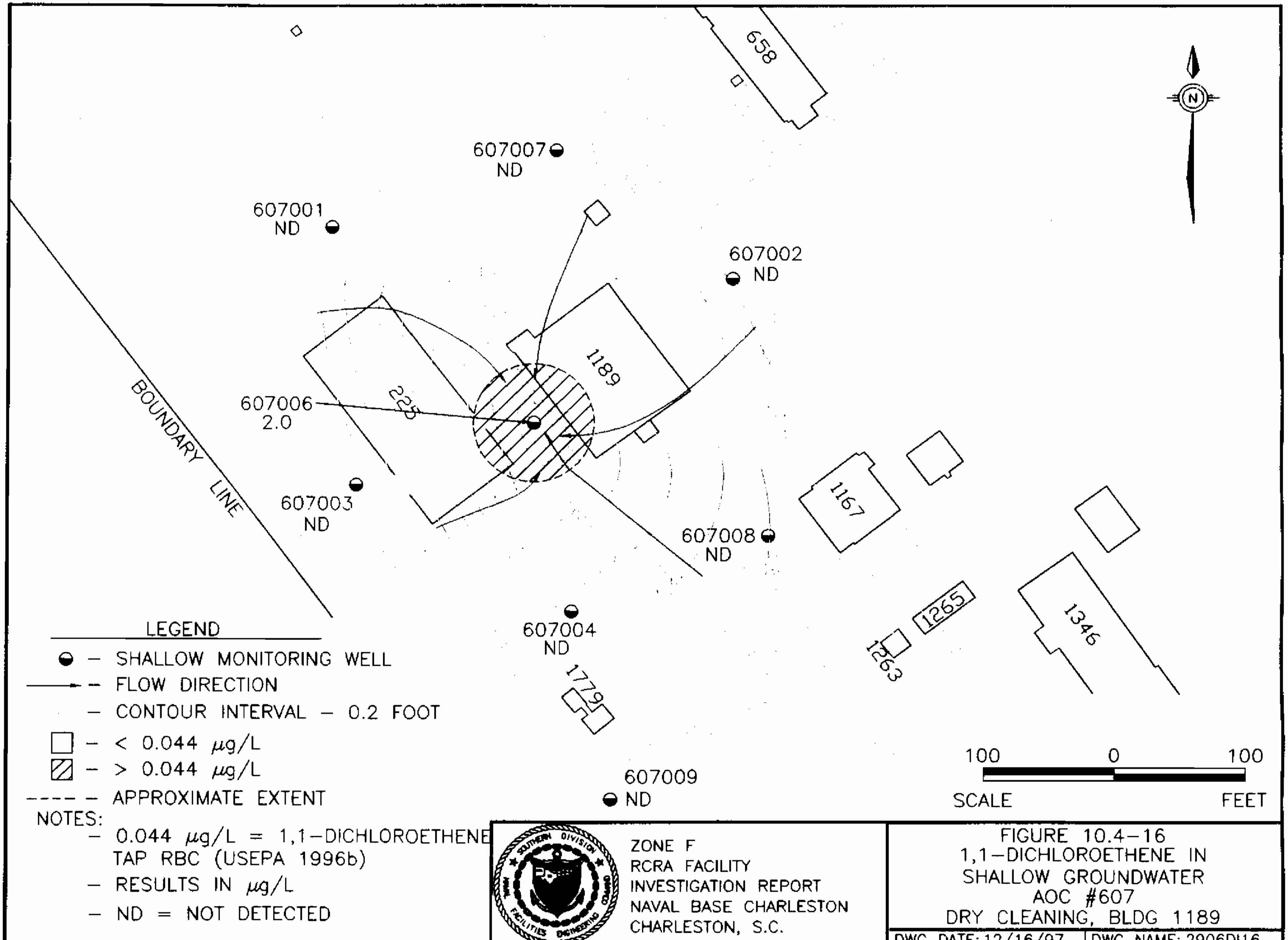


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FIGURE 10.4–16
1,1–DICHLOROETHENE IN
SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97	DWG NAME: 2906D116

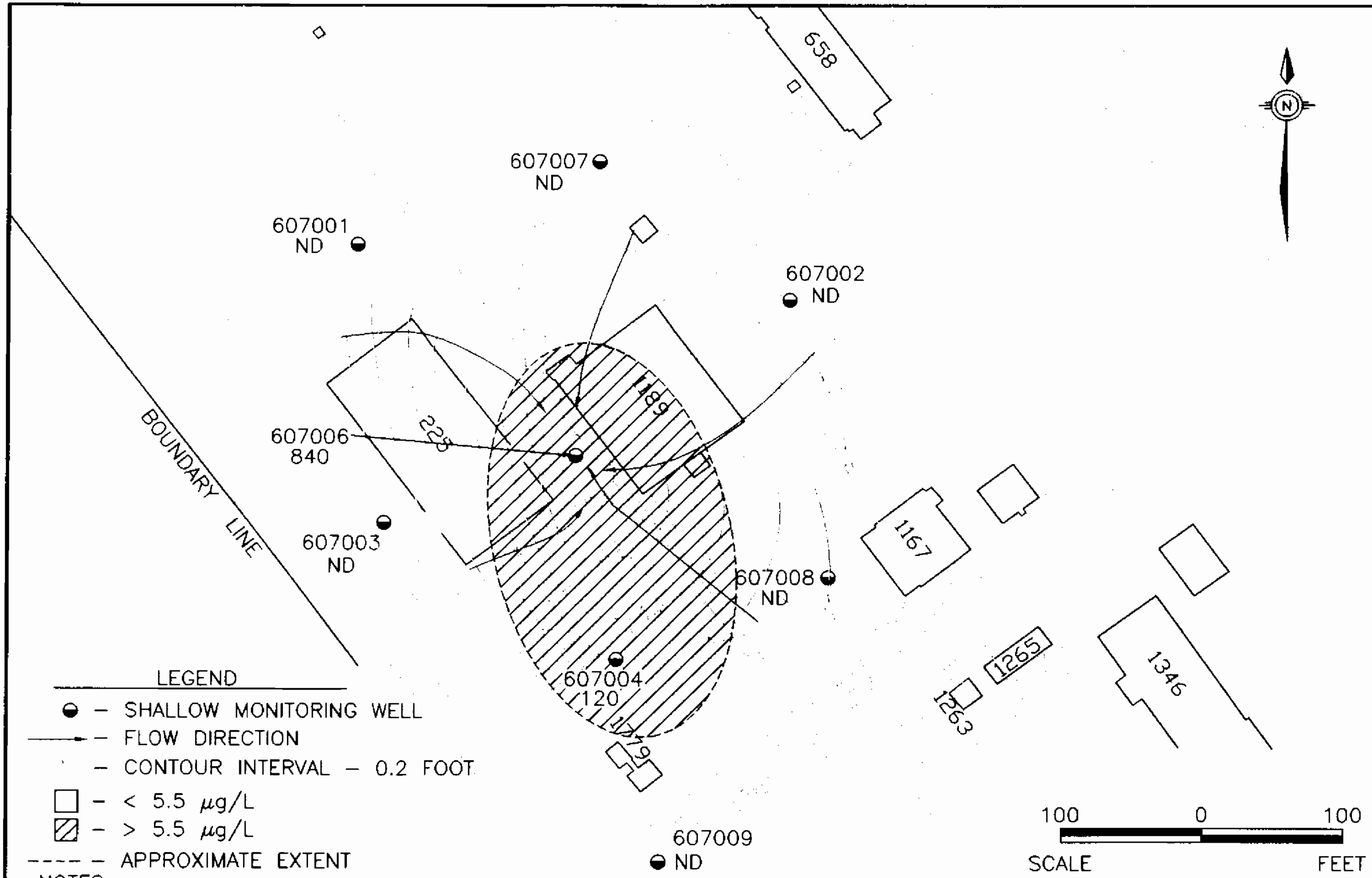

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FIGURE 10.4–17
1,2–DICHLOROETHENE IN
SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906DI17

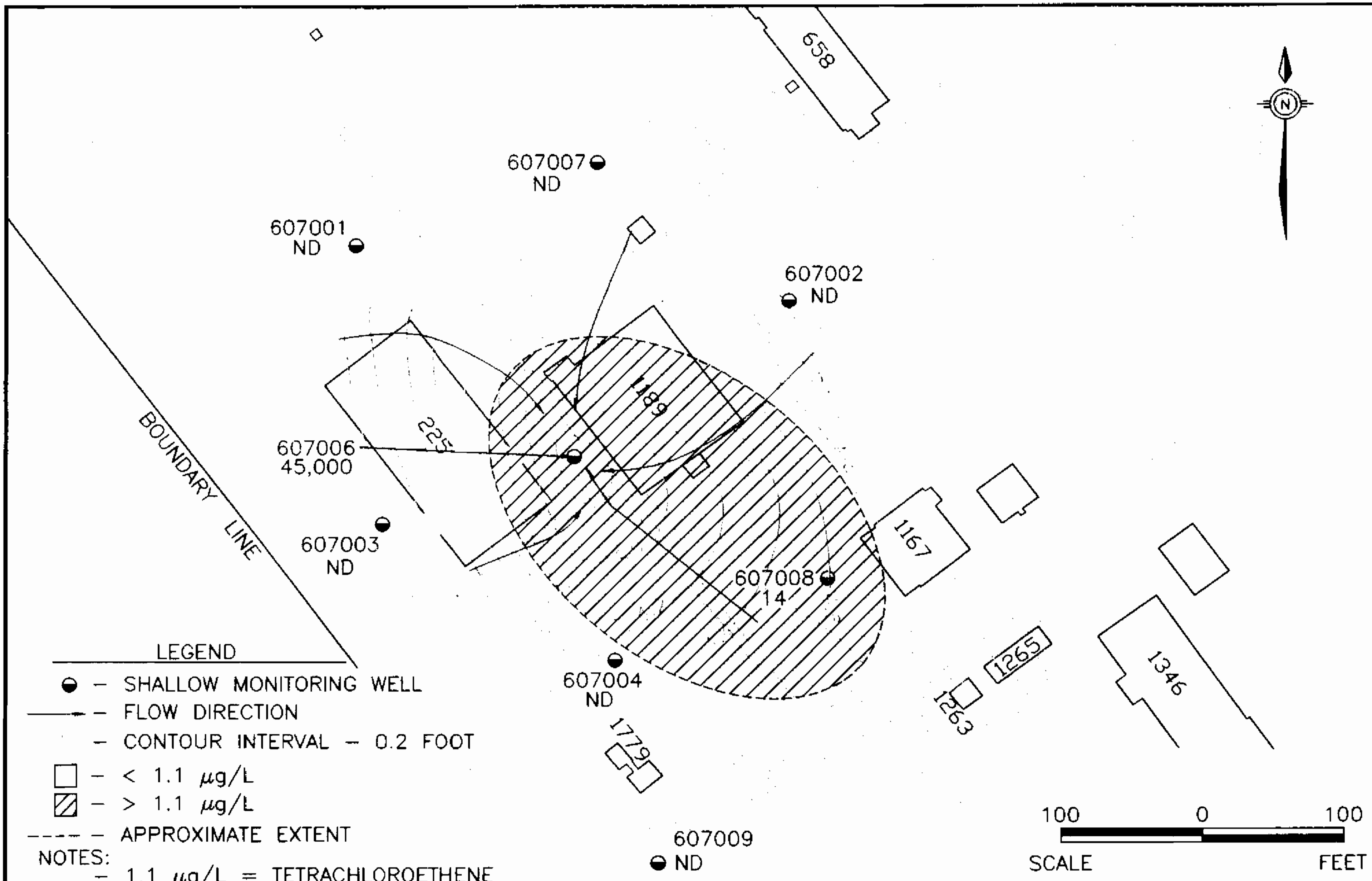

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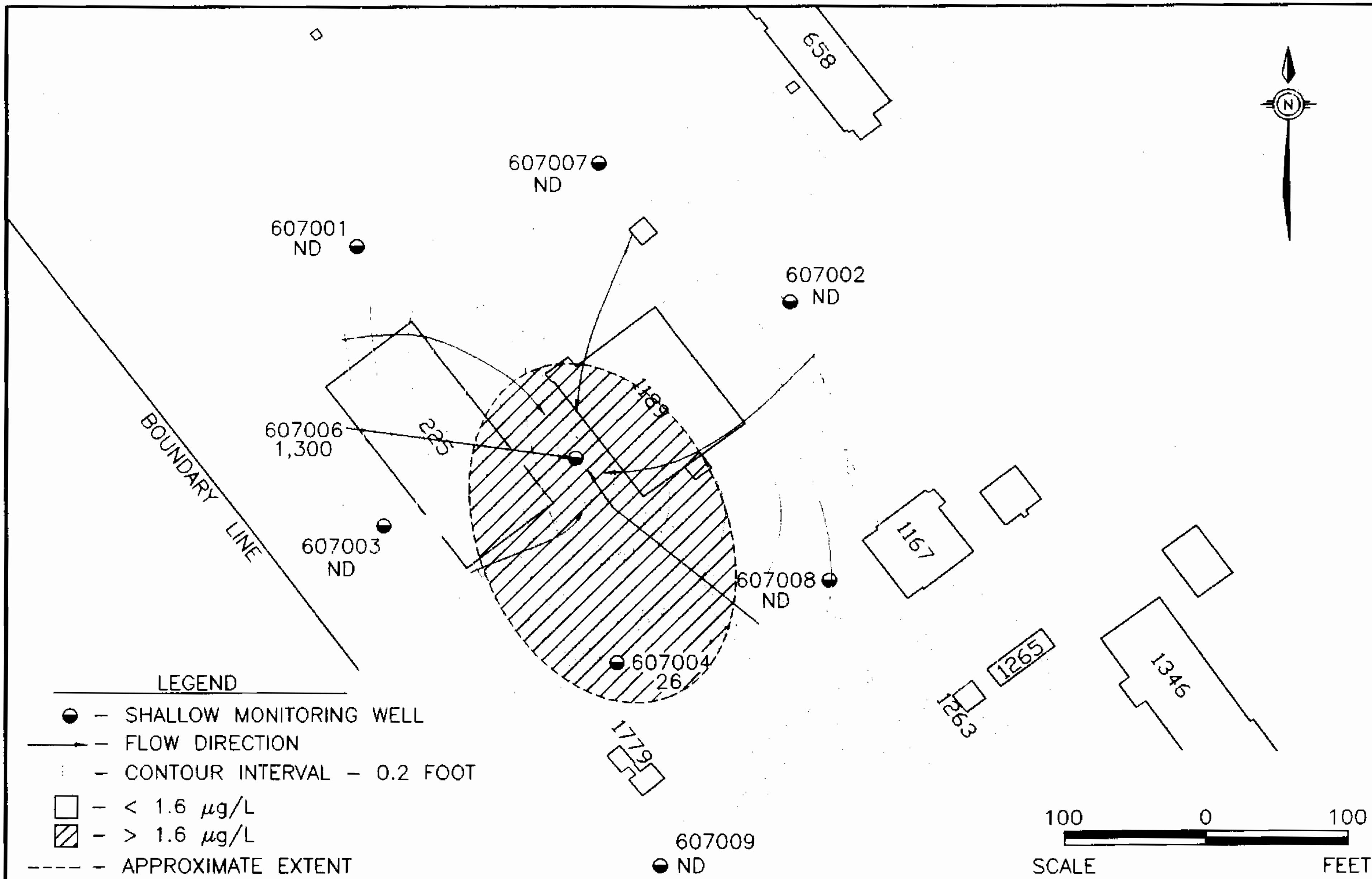
FIGURE 10.4–18
TETRACHLOROETHENE IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906TE18



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 1.6 µg/L
- > 1.6 µg/L
- APPROXIMATE EXTENT

NOTES:

- 1.6 µg/L = TRICHLOROETHENE TAP RBC (USEPA 1996b)
- RESULTS IN µg/L
- ND = NOT DETECTED

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FIGURE 10.4–19
TRICHLOROETHENE IN
SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906TR19

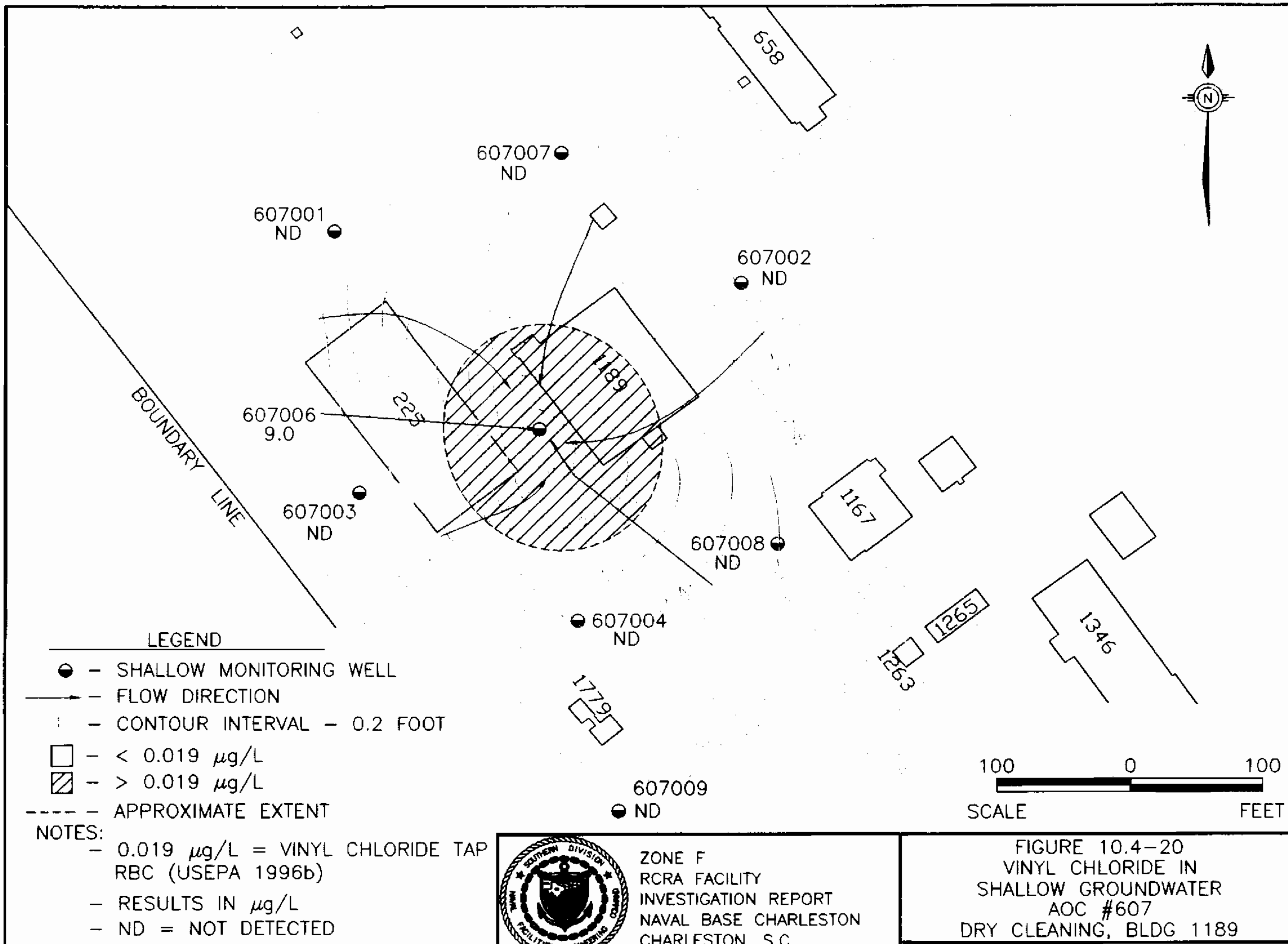

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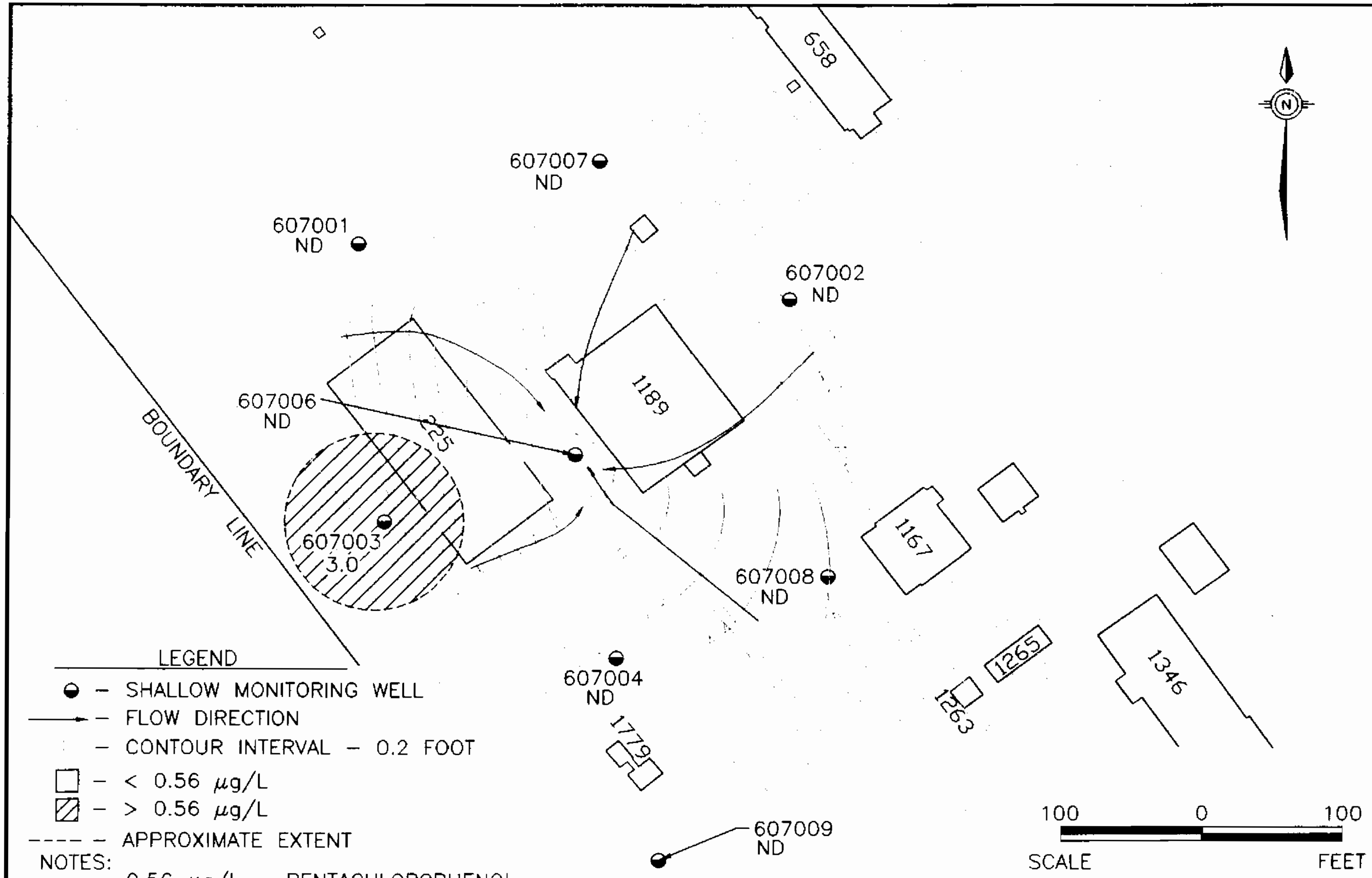
FIGURE 10.4–20
VINYL CHLORIDE IN
SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906VC20



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 0.56 μg/L
- > 0.56 μg/L
- APPROXIMATE EXTENT

NOTES:
- 0.56 μg/L = PENTACHLOROPHENOL TAP RBC (USEPA 1996b)
- RESULTS IN μg/L
- ND = NOT DETECTED

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FIGURE 10.4–21
PENTACHLOROPHENOL IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906PC21

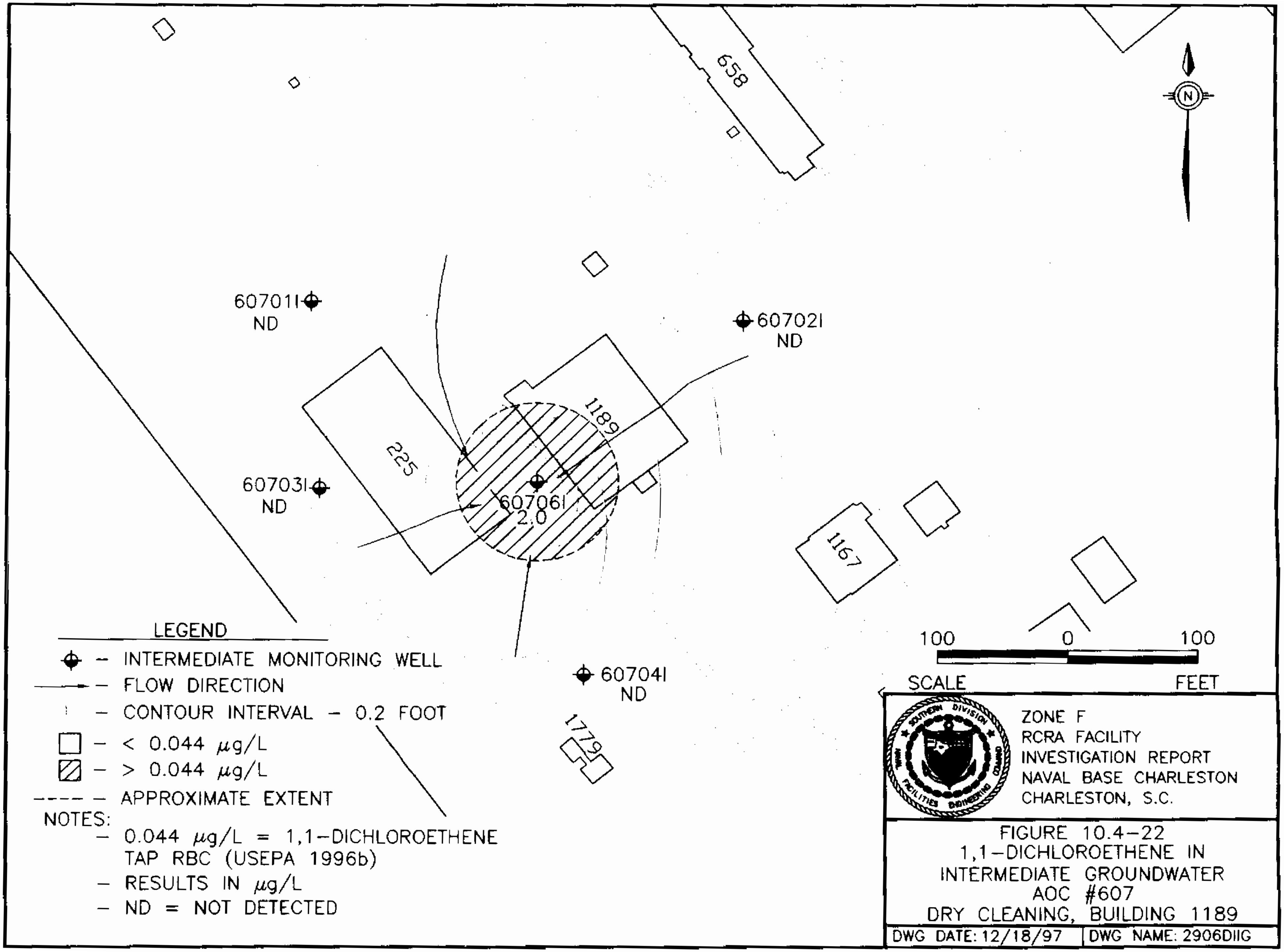

FIGURE 10.4–22
1,1–DICHLOROETHENE IN
INTERMEDIATE GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

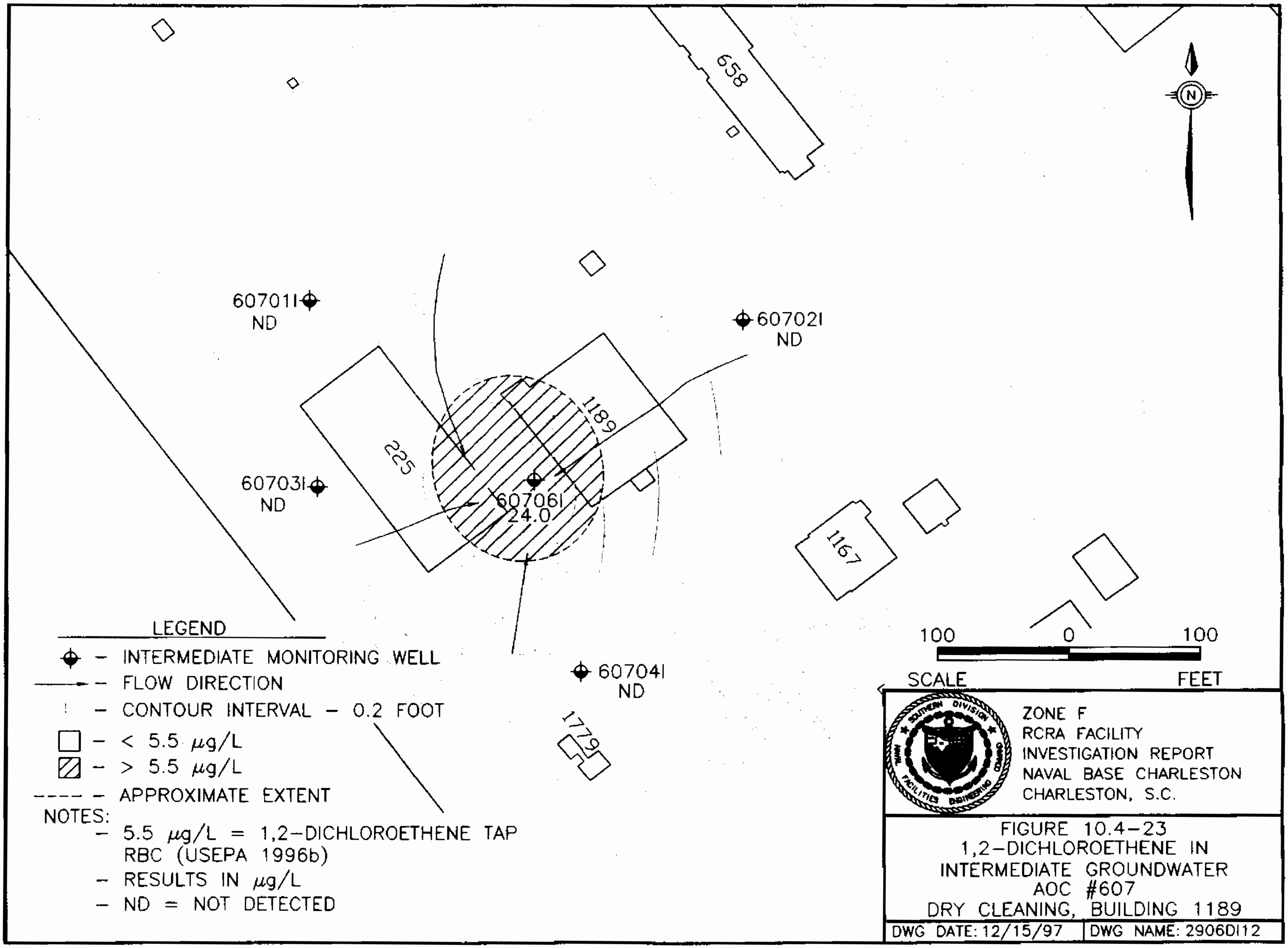

FIGURE 10.4–23
1,2–DICHLOROETHENE IN INTERMEDIATE GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

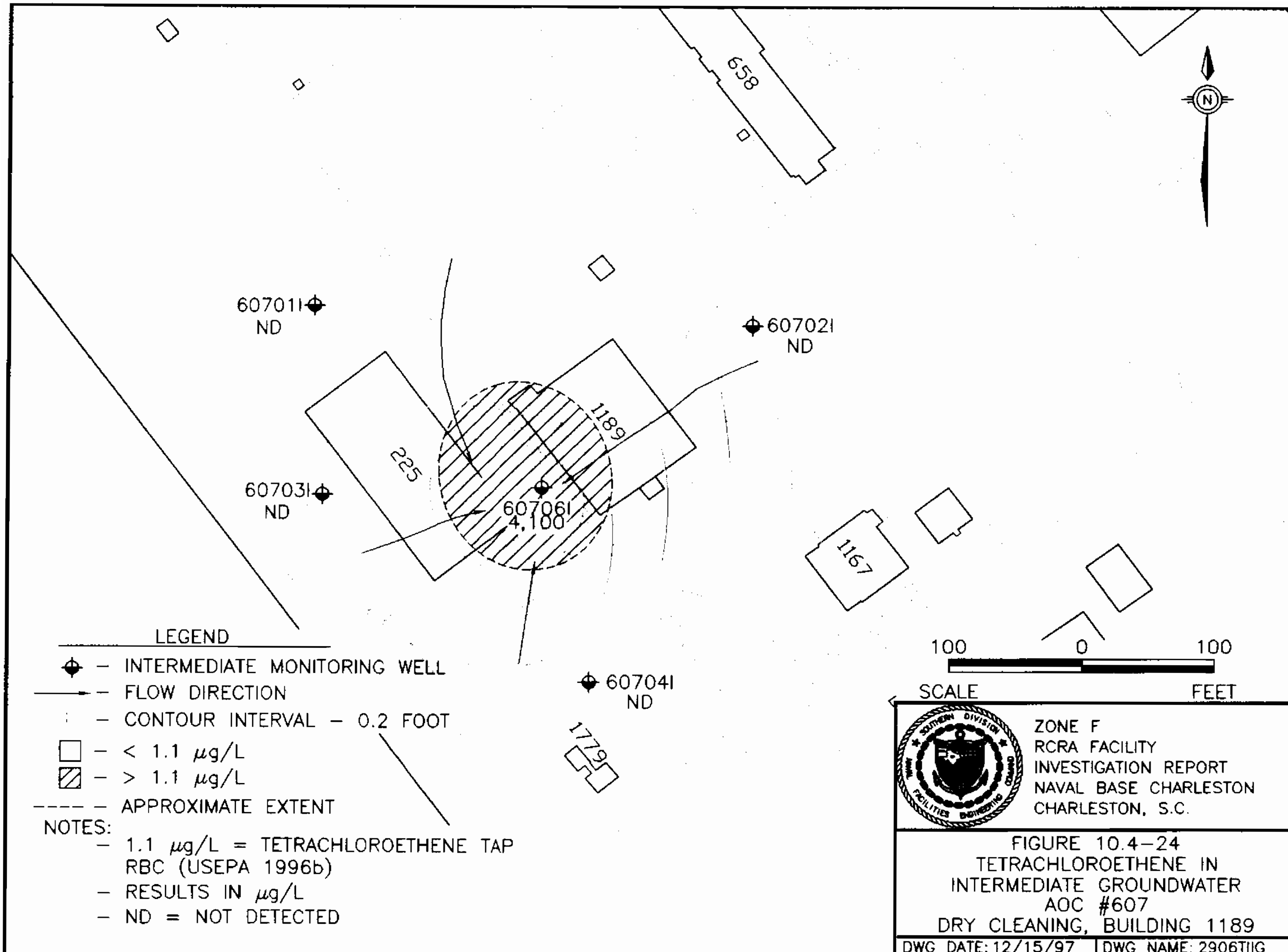
658
N
607011
ND
607021
ND
1189
225
607031
ND
607061
4,100
1167
607041
ND
1779
100
0
100
SCALE
FEET
LEGEND
– INTERMEDIATE MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.2 FOOT
– < 1.1 μg/L
– > 1.1 μg/L
– APPROXIMATE EXTENT
NOTES:
– 1.1 μg/L = TETRACHLOROETHENE TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
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FIGURE 10.4–24
TETRACHLOROETHENE IN
INTERMEDIATE GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189
DWG DATE: 12/15/97
DWG NAME: 2906TIIG

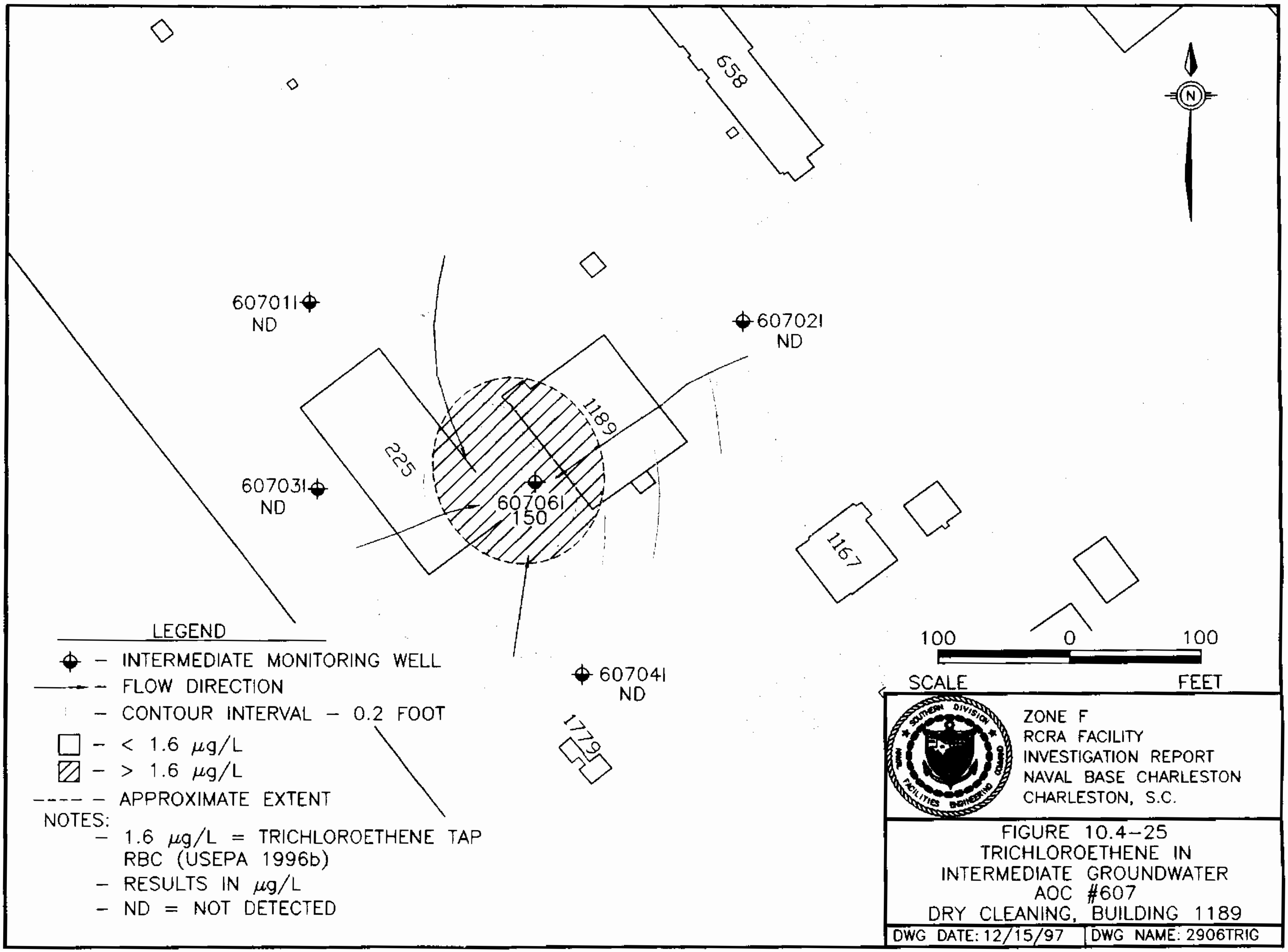


FIGURE 10.4–25
TRICHLOROETHENE IN
INTERMEDIATE GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97 | DWG NAME: 2906TRIG

Deep Well Samples

Four VOCs were detected in deep groundwater samples. The tap water RBCs for three VOCs were exceeded during groundwater sampling at AOC 607. Concentrations of chloromethane, tetrachloroethene, trichloroethene exceeded their respective tap water RBCs. Figure 10.4-26 through 10.4-28 show VOCs concentrations detected in deep groundwater samples.

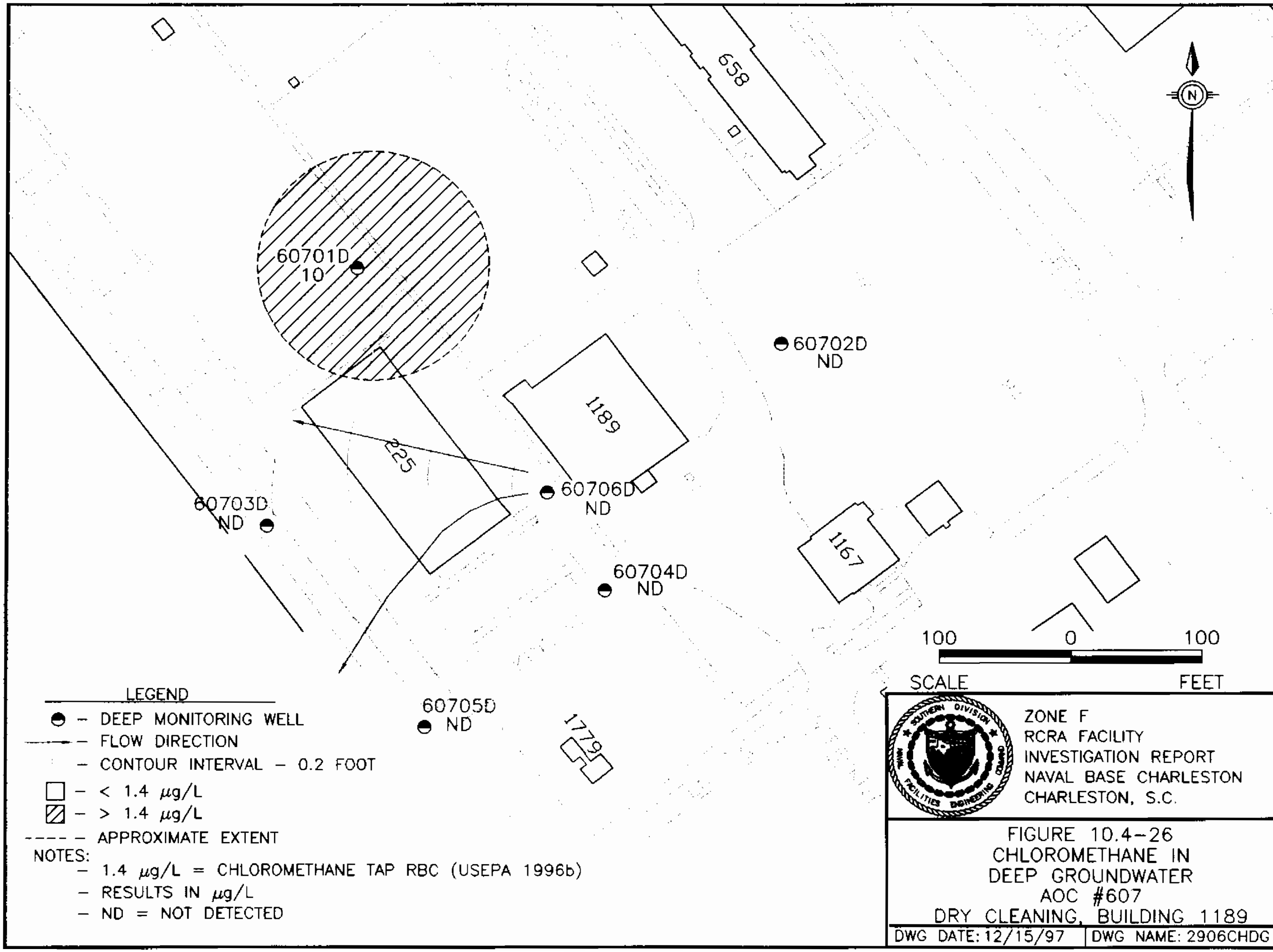
Inorganics Detected in Groundwater

Shallow Well Samples

Nineteen metals were detected in AOC 607 shallow groundwater samples. Aluminum, arsenic, chromium, and vanadium exceeded both their tap water RBCs and shallow groundwater background concentrations. Antimony, iron, and lead exceeded their tap water RBCs, but no background is available for these metals in Zone F groundwater. Figures 10.4-29 through 10.4-32 illustrate inorganics detected in shallow groundwater that exceeded both their respective tap water RBCs and background concentrations. Figures 10.4-33 and 10.4-34 show antimony and lead tap water RBC exceedences in shallow groundwater, respectively.

Intermediate Well Samples

Fifteen metals were detected in AOC 607 intermediate groundwater samples. Only arsenic exceeded both its tap water RBC and background concentration. Iron also exceeded its tap water RBC, but no background is available for iron in Zone F groundwater. Figure 10.4-35 shows the arsenic concentrations in intermediate groundwater.



LEGEND

- DEEP MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 1.4 μg/L
- > 1.4 μg/L
- APPROXIMATE EXTENT

NOTES:
- 1.4 μg/L = CHLOROMETHANE TAP RBC (USEPA 1996b)
- RESULTS IN μg/L
- ND = NOT DETECTED

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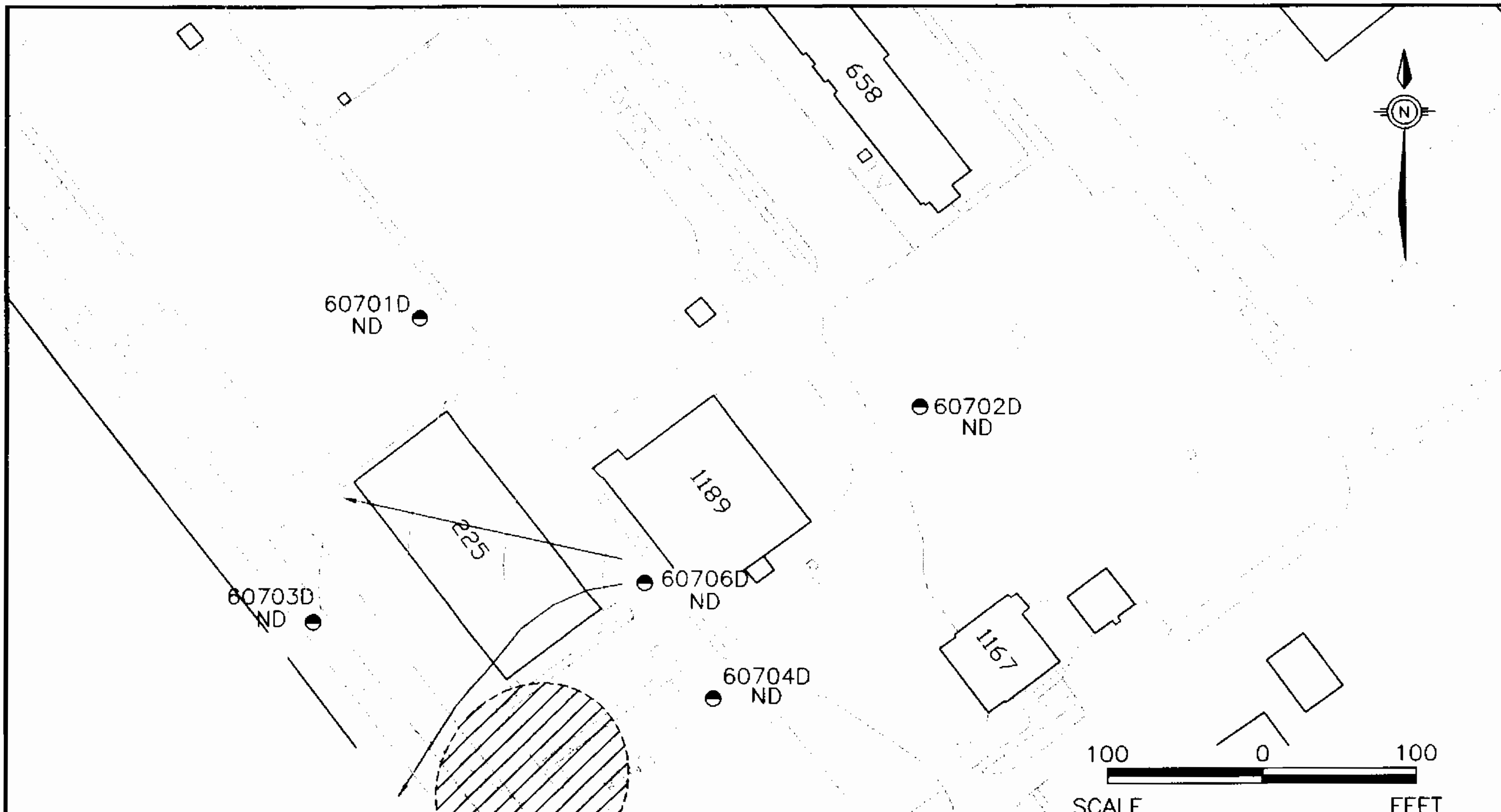
FIGURE 10.4–26
CHLOROMETHANE IN
DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97 | DWG NAME: 2906CHDG



LEGEND

- DEEP MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL - 0.2 FOOT
- < 1.1 $\mu g/L$
- > 1.1 $\mu g/L$
- APPROXIMATE EXTENT

NOTES:
- 1.1 $\mu g/L$ = TETRACHLOROETHENE TAP RBC (USEPA 1996b)
- RESULTS IN $\mu g/L$
- ND = NOT DETECTED

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FIGURE 10.4-27
TETRACHLOROETHENE IN
DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97	DWG NAME: 2906T607

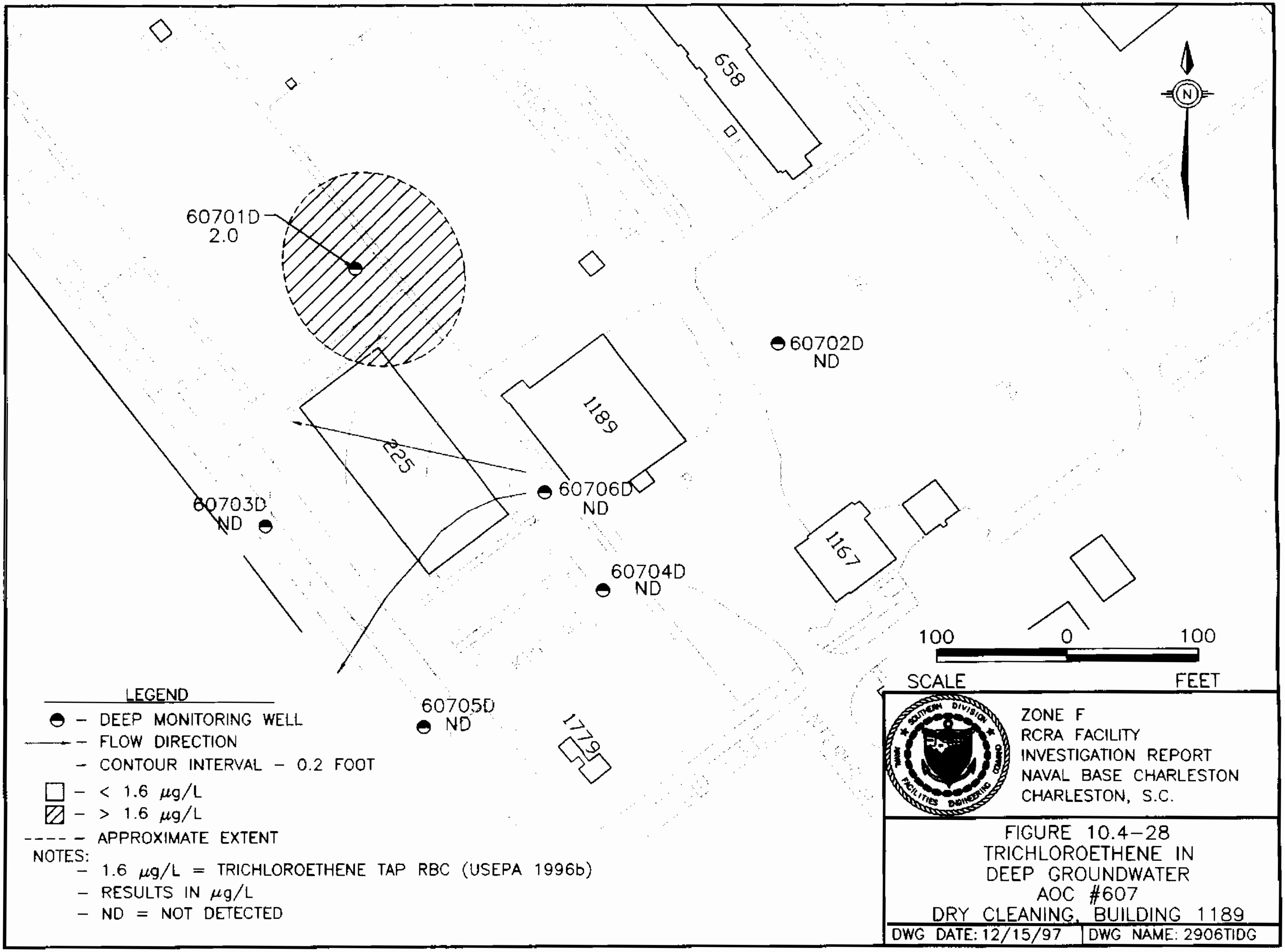
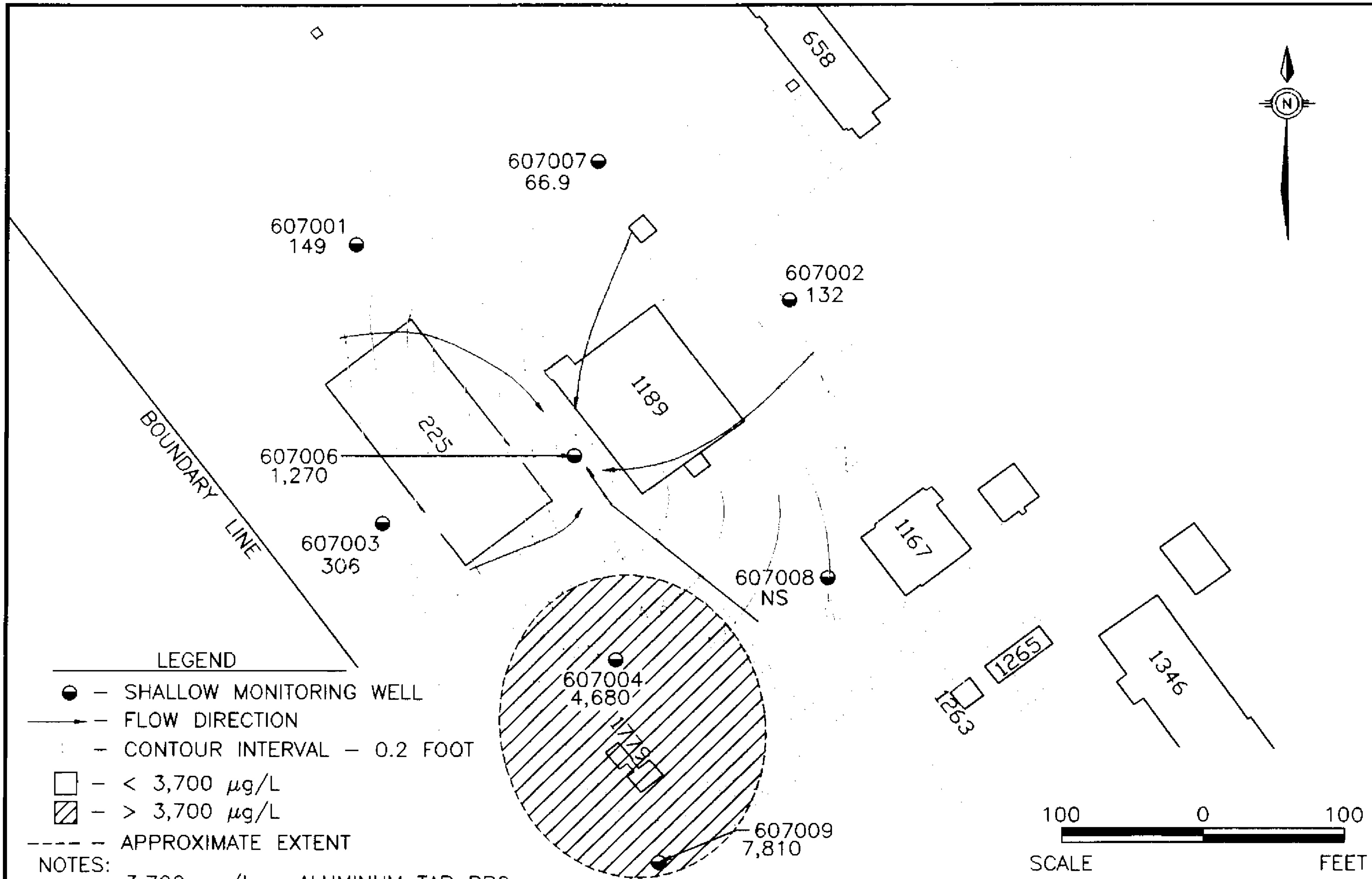


FIGURE 10.4-28
TRICHLOROETHENE IN
DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97 | DWG NAME: 2906TIDG



NOTES:
- 3,700 µg/L = ALUMINUM TAP RBC (USEPA 1996b)
- RESULTS IN µg/L
- ND = NOT DETECTED
- NS = WELL NOT SAMPLED FOR INORGANICS

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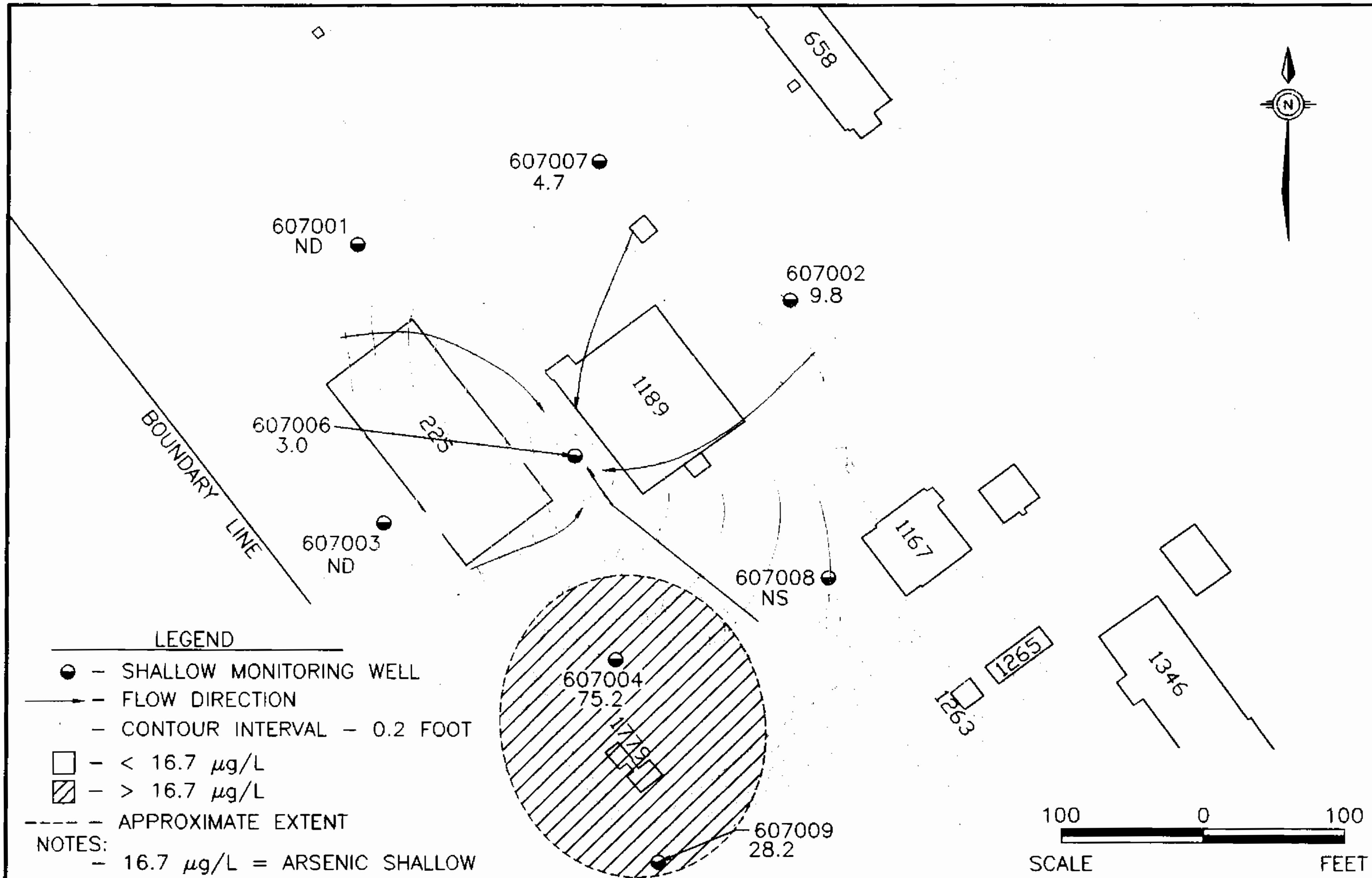
FIGURE 10.4–29
ALUMINUM IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906AL29



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL - 0.2 FOOT
- < 16.7 μg/L
- > 16.7 μg/L
- APPROXIMATE EXTENT

NOTES:
- 16.7 μg/L = ARSENIC SHALLOW BACKGROUND GROUNDWATER CONCENTRATION
- RESULTS IN μg/L
- ND = NOT DETECTED
- NS = WELL NOT SAMPLED FOR INORGANICS

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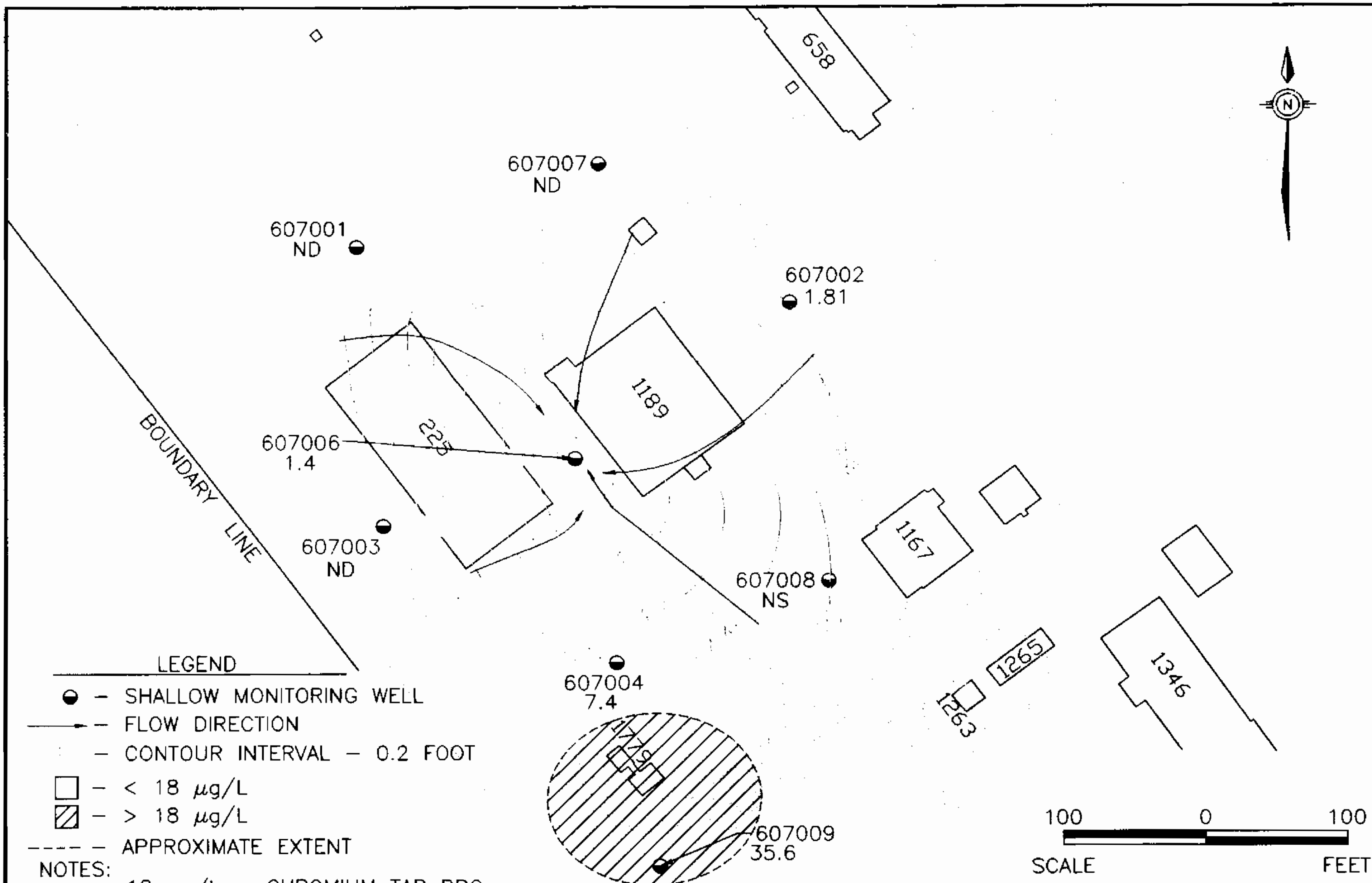
FIGURE 10.4-30
ARSENIC IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906AR30



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 18 μg/L
- > 18 μg/L
- APPROXIMATE EXTENT

NOTES:
- 18 μg/L = CHROMIUM TAP RBC (USEPA 1996b)
- RESULTS IN μg/L
- ND = NOT DETECTED
- NS = WELL NOT SAMPLED FOR INORGANICS

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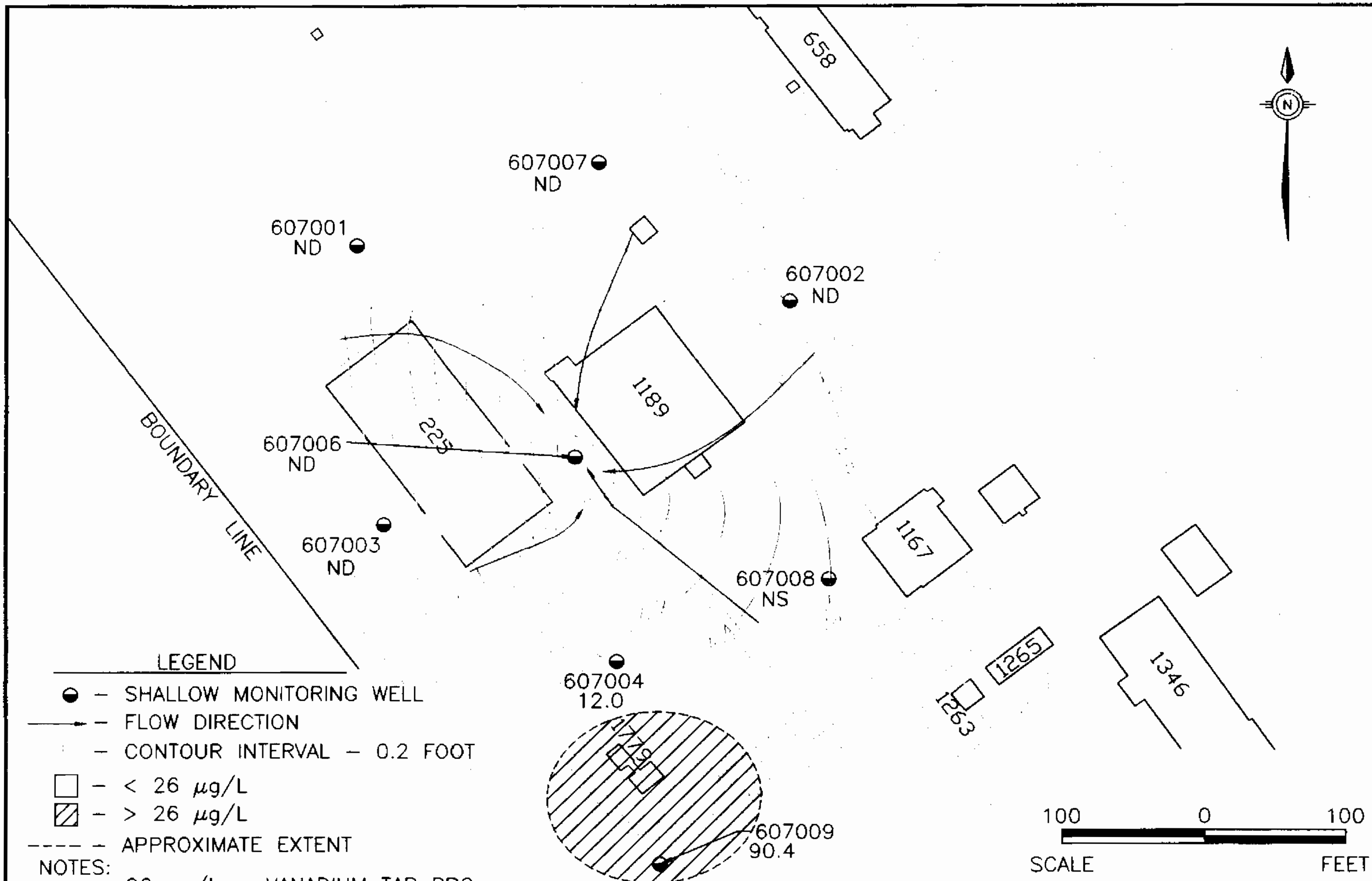
CHARLESTON, S.C.

FIGURE 10.4–31
CHROMIUM IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97	DWG NAME: 2906CH31



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 26 μg/L
- > 26 μg/L
- APPROXIMATE EXTENT

NOTES:
- 26 μg/L = VANADIUM TAP RBC (USEPA 1996b)
- RESULTS IN μg/L
- ND = NOT DETECTED
- NS = WELL NOT SAMPLED FOR INORGANICS

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FIGURE 10.4–32
VANADIUM IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97 | DWG NAME: 2906VA32

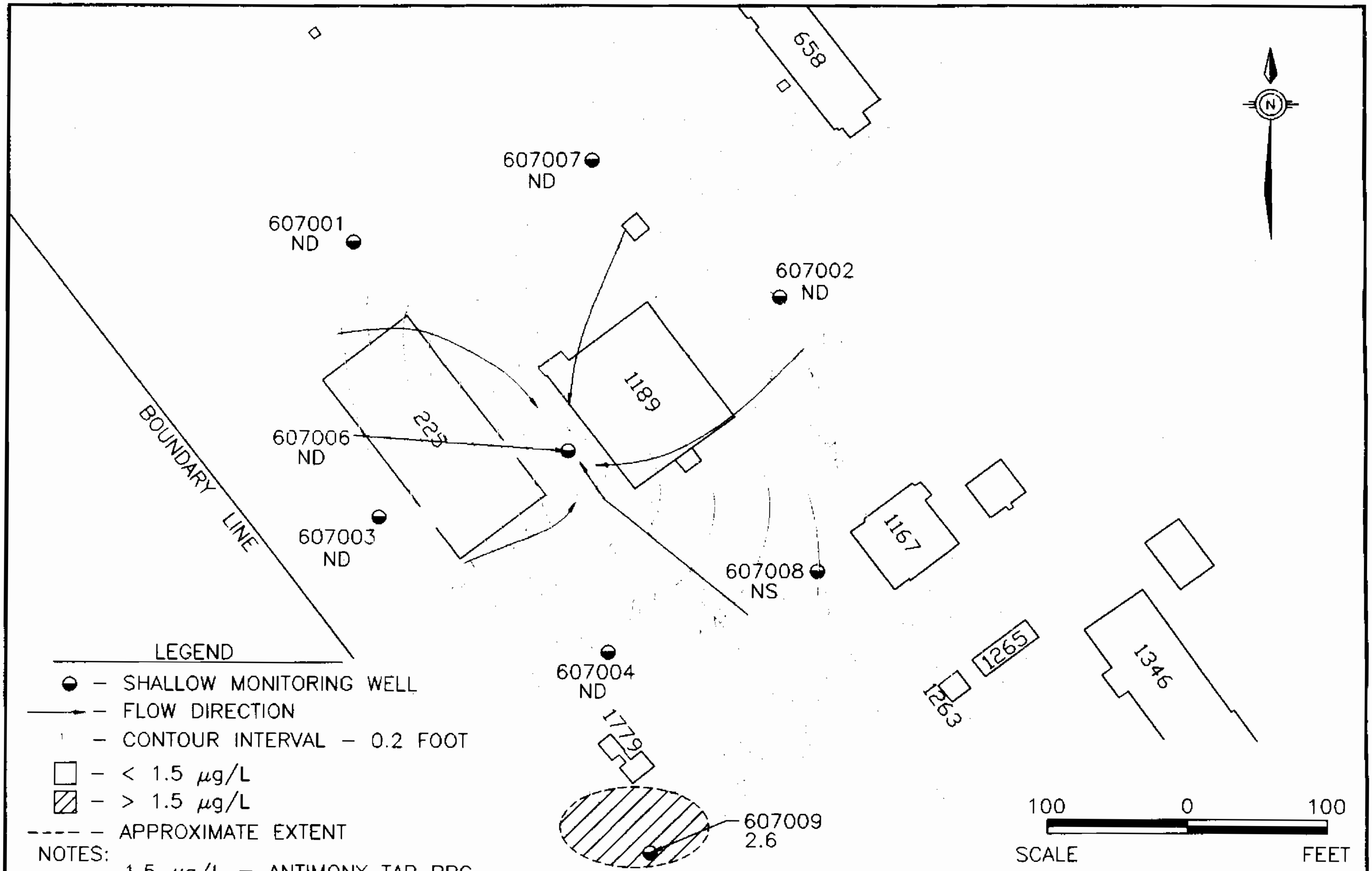

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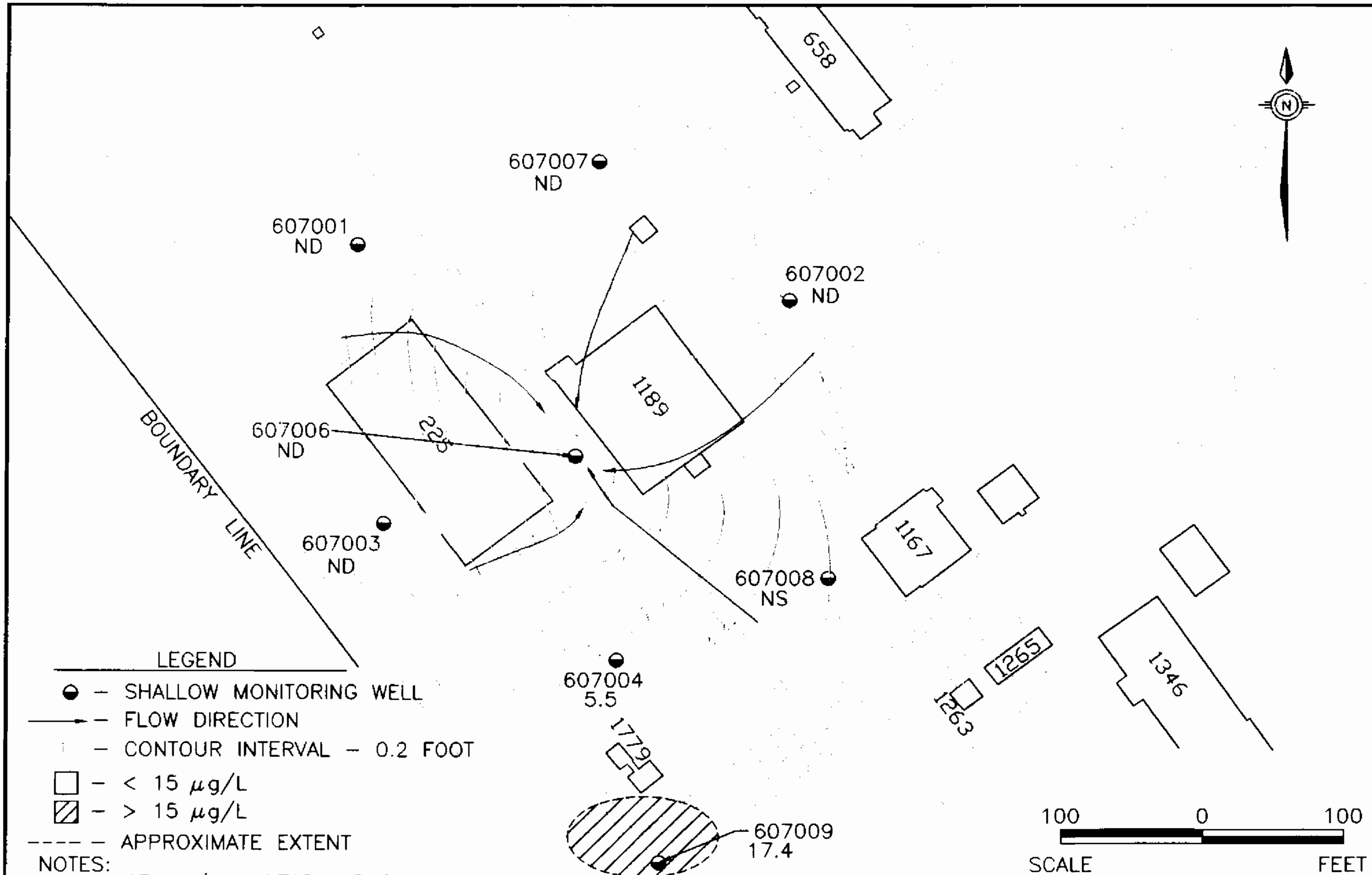
FIGURE 10.4–33
ANTIMONY IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/16/97	DWG NAME: 2906AN33



LEGEND

- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 15 µg/L
- > 15 µg/L
- APPROXIMATE EXTENT

NOTES:

- 15 µg/L = LEAD TAP RBC (USEPA 1996b)
- RESULTS IN µg/L
- ND = NOT DETECTED
- NS = WELL NOT SAMPLED FOR INORGANICS

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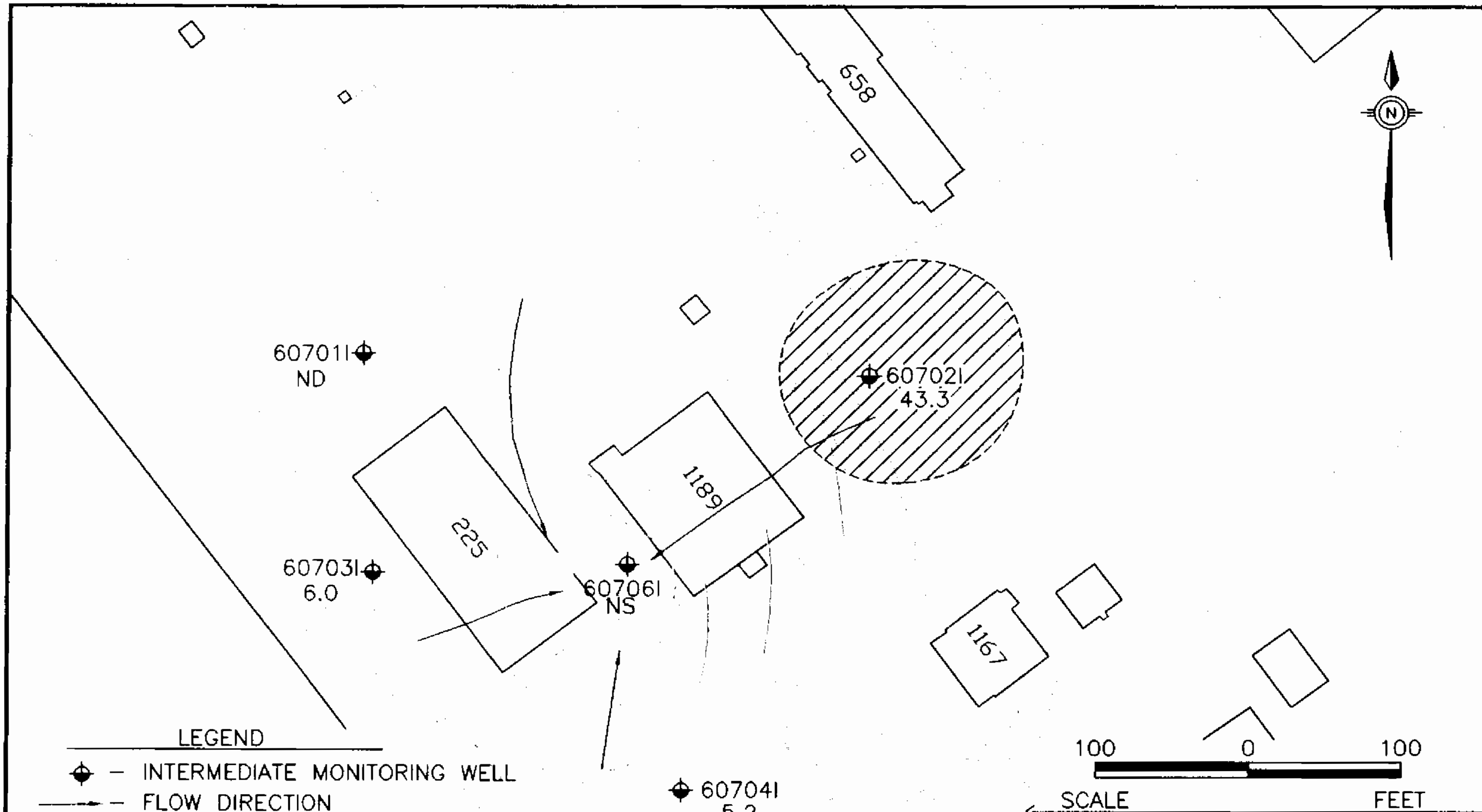
CHARLESTON, S.C.

FIGURE 10.4–34
LEAD IN SHALLOW GROUNDWATER
AOC #607
DRY CLEANING, BLDG 1189

DWG DATE: 12/18/97	DWG NAME: 2906LD34



LEGEND

- INTERMEDIATE MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 16.7 μg/L
- > 16.7 μg/L
- APPROXIMATE EXTENT

NOTES:
- 16.7 μg/L = ARSENIC SHALLOW BACKGROUND GROUNDWATER CONCENTRATION
- RESULTS IN μg/L
- ND = NOT DETECTED
- NS = WELL NOT SAMPLED FOR INORGANICS

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

FIGURE 10.4–35
ARSENIC IN INTERMEDIATE GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97	DWG NAME: 2906AIIG

Deep Well Samples

Eighteen metals were detected in AOC 607 deep groundwater samples. Concentrations of aluminum, arsenic and chromium exceed both their tap water RBCs and background concentrations. Iron and lead also exceeded their respective tap water RBCs, but no background is available for these metals in Zone F groundwater. Figures 10.4-36 through 10.4-38 show the inorganics in deep groundwater that exceeded both their tap water RBC and background concentrations. Figure 10.4-39 shows lead tap water RBC exceedances in deep groundwater.

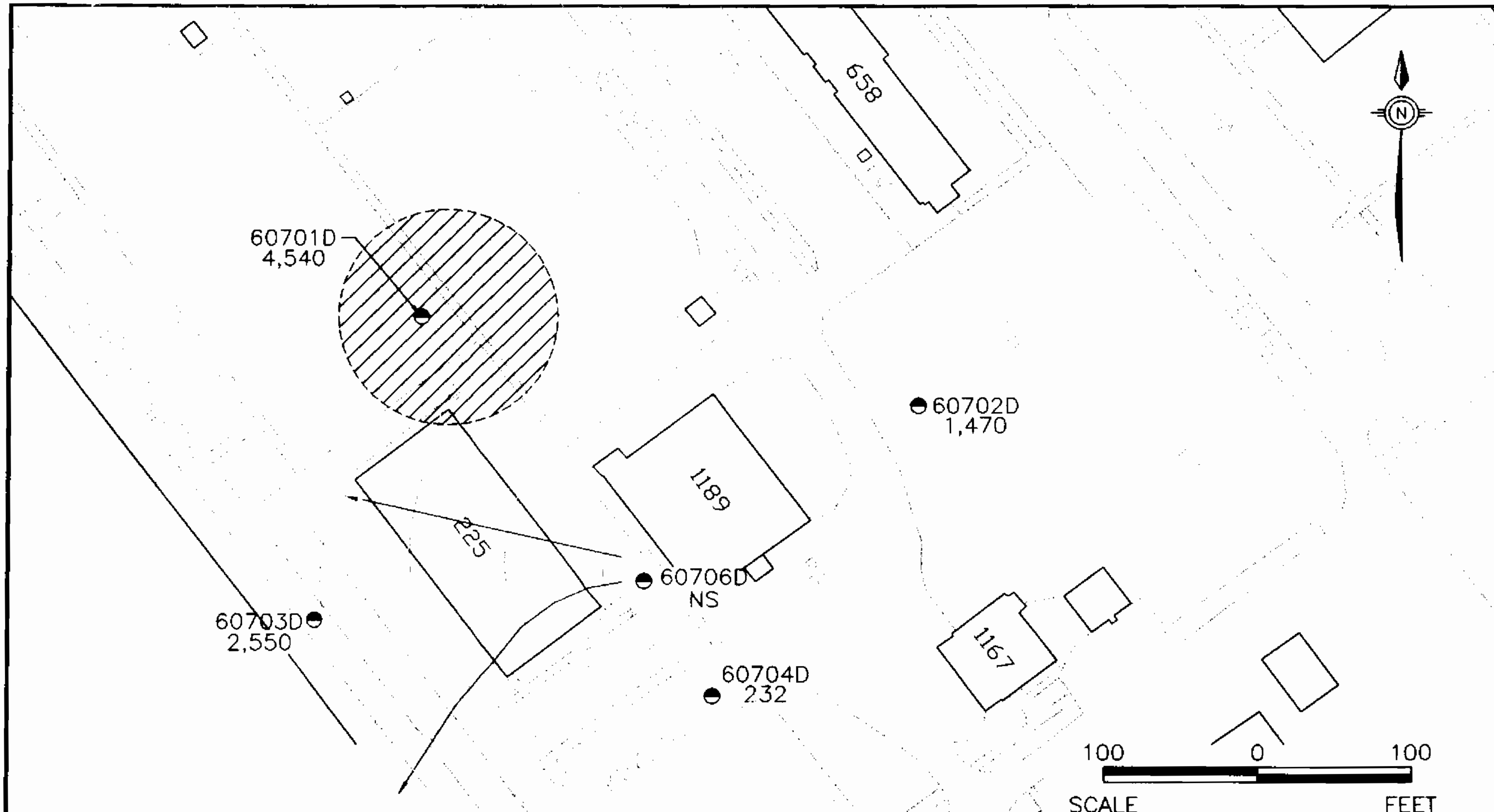
10.4.7 Fate and Transport Assessment for AOC 607

Environmental media sampled as part of the AOC 607 include surface soil, subsurface soil, shallow, intermediate and deep groundwater, and storm sewer sediment. Potential constituent migration pathways investigated for AOC 607 include soil-to-groundwater, groundwater-to-surface water, surface soil-to-sediment, and emission of volatiles from surface soil to air.

10.4.7.1 AOC 607 — Soil-to-Groundwater Cross-Media Transport

Table 10.4.17 compares maximum detected organic constituent 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).

No inorganics were detected in site soil at concentrations above their SSLs. One organic compound — PCE was detected in surface and subsurface soil at concentrations exceeding its SSL. Two locations, 607SB001 and 607SB004, exhibited concentrations of PCE greater than the SSL in surface soil, while only 607SB004 exhibited an exceedance in subsurface soil. Notably, at 607SB004 PCE exhibited a significant enrichment as a function of depth, a feature also common to detections



LEGEND

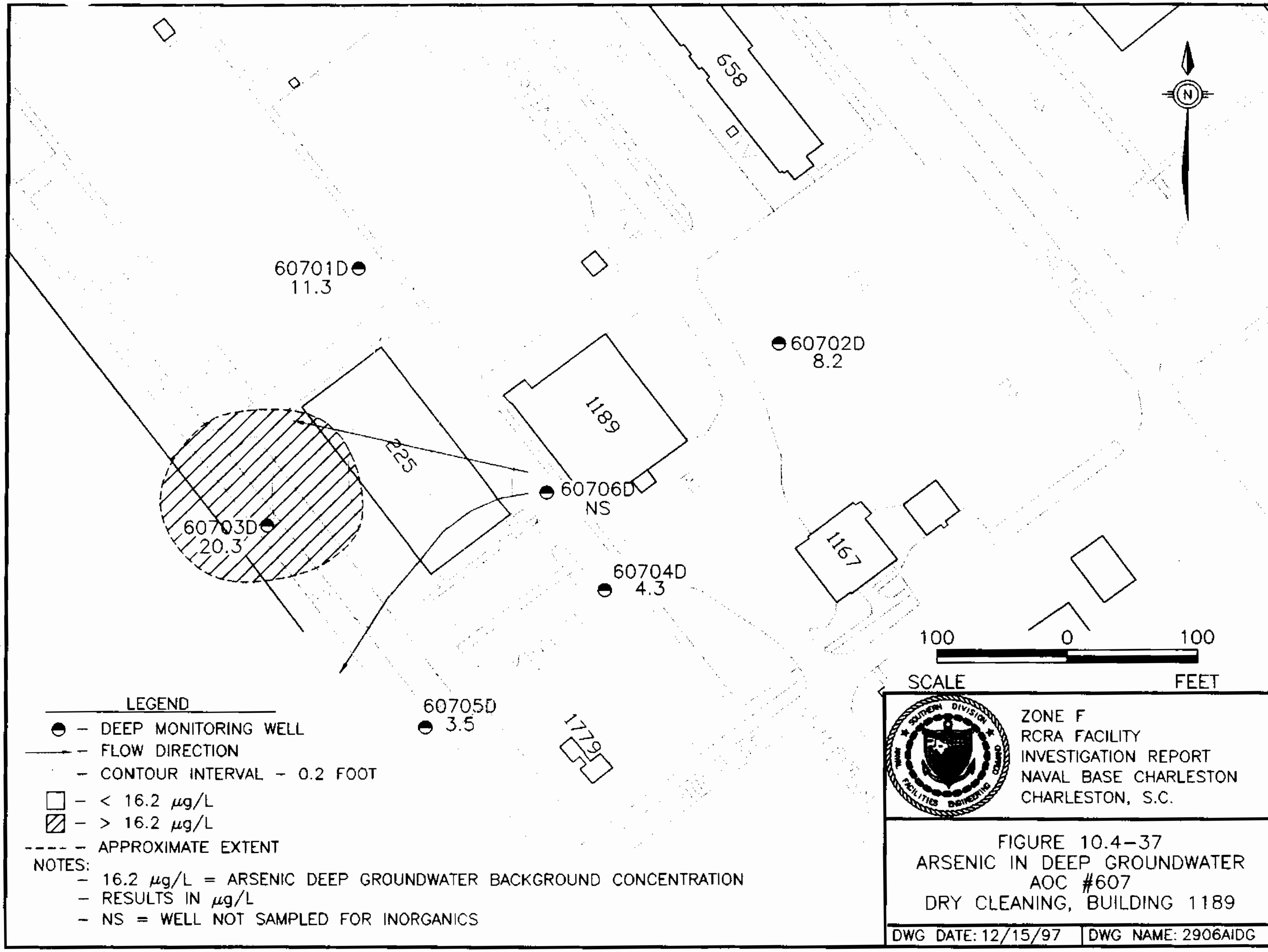
- DEEP MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL – 0.2 FOOT
- < 3,700 μg/L
- > 3,700 μg/L
- APPROXIMATE EXTENT

NOTES:
- 3,700 μg/L = TAP RBC FOR ALUMINUM (USEPA 1996b)
- RESULTS IN μg/L
- NS = WELL NOT SAMPLED FOR INORGANICS

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

FIGURE 10.4–36
ALUMINUM IN DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97 | DWG NAME: 2906A607



658
60701D
11.3
60702D
8.2
1189
225
60706D
NS
60703D
20.3
60704D
4.3
1167
60705D
3.5
1779
N
100
0
100
SCALE
FEET
LEGEND
– DEEP MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.2 FOOT
– < 16.2 μg/L
– > 16.2 μg/L
– APPROXIMATE EXTENT
NOTES:
– 16.2 μg/L = ARSENIC DEEP GROUNDWATER BACKGROUND CONCENTRATION
– RESULTS IN μg/L
– NS = WELL NOT SAMPLED FOR INORGANICS
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.4–37
ARSENIC IN DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189
DWG DATE: 12/15/97
DWG NAME: 2906AIDG

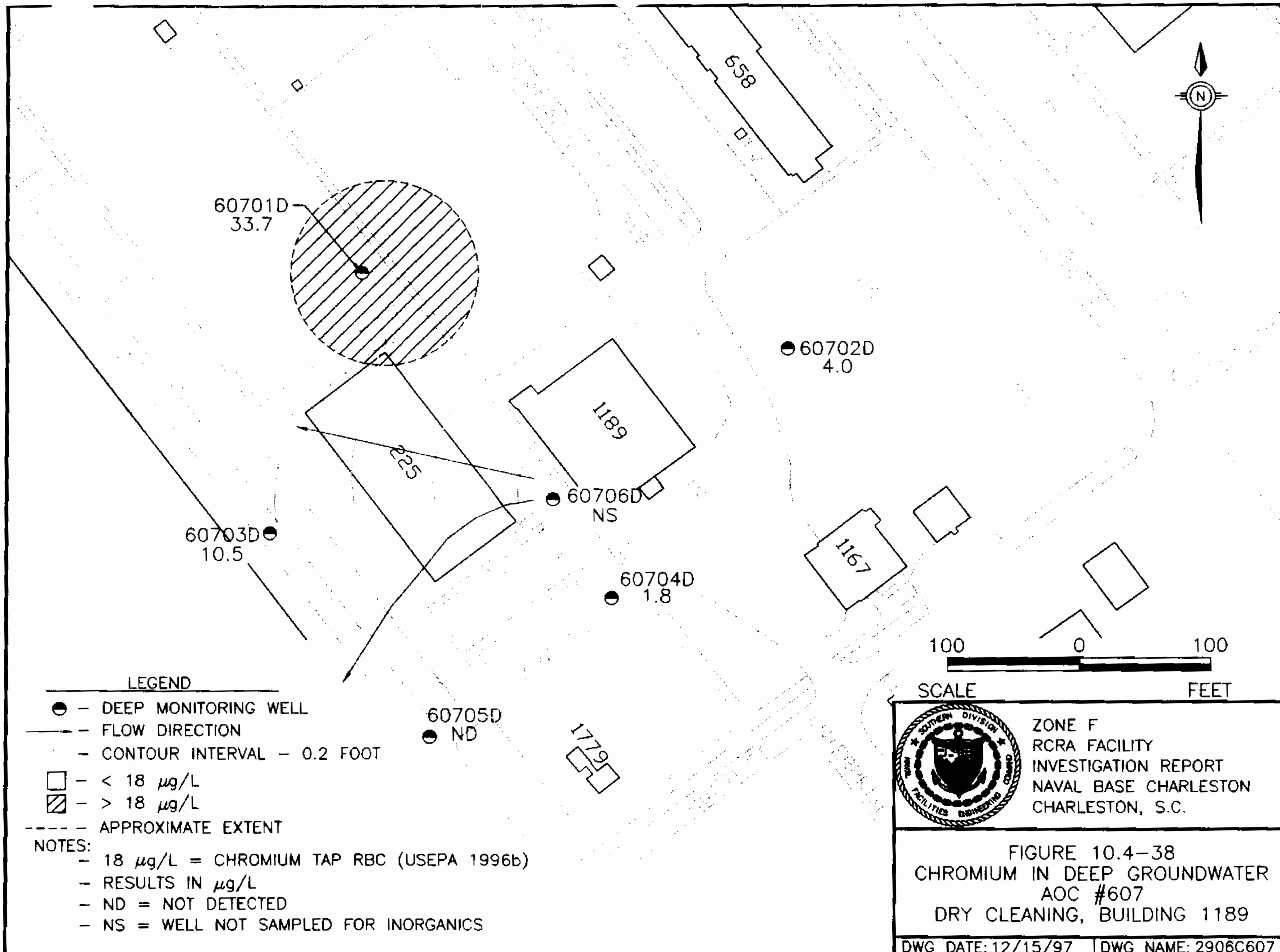


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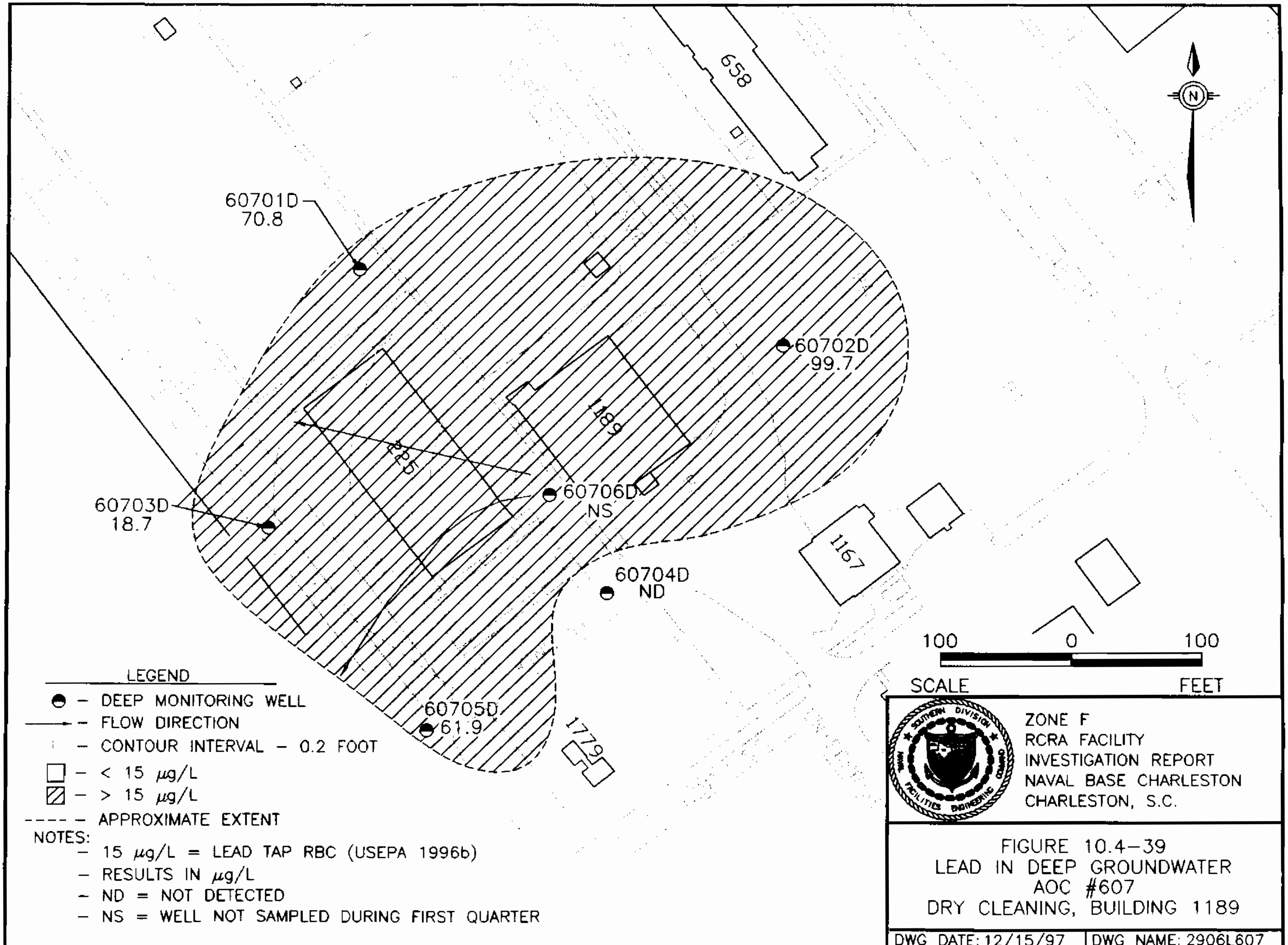
FIGURE 10.4–38
CHROMIUM IN DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97 | DWG NAME: 2906C607



ZONE F
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CHARLESTON, S.C.

FIGURE 10.4-39
LEAD IN DEEP GROUNDWATER
AOC #607
DRY CLEANING, BUILDING 1189

DWG DATE: 12/15/97 | DWG NAME: 2906L607

Table 10.4.17
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 607
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac 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												
Acetone	ND	1000	ND	ND	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	17	2	2	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chloromethane	ND	ND	ND	10	6.6	1.4	NA	UG/KG	UG/L	NO	YES	NO
1,1-Dichloroethene	ND	ND	2	ND	60	0.044	2240	UG/KG	UG/L	NO	YES	NO
1,2-Dichloroethene (total)	ND	20	840	ND	400	55	NA	UG/KG	UG/L	NO	YES	NO
Methylene chloride	3	ND	ND	ND	20	4.1	2560	UG/KG	UG/L	NO	NO	NO
Tetrachloroethene	220	710	45000	3	60	1.1	45	UG/KG	UG/L	YES	YES	YES
Toluene	ND	ND	4	ND	12000	750	37	UG/KG	UG/L	NO	NO	NO
Trichloroethene	2	23	1300	2	60	1.6	NA	UG/KG	UG/L	NO	YES	NO
Vinyl chloride	ND	ND	9	ND	10	0.019	NA	UG/KG	UG/L	NO	YES	NO
Semivolatile Organic Compounds												
Benzoic acid	ND	ND	1	ND	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzyl alcohol	ND	ND	2	ND	46200	11000	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	58	ND	1	ND	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	ND	ND	3	ND	30	0.56	7.9	UG/KG	UG/L	NO	YES	NO
Inorganic Compounds												
Aluminum	18600	11000	7810	4540	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	1.8	ND	2.6	ND	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	8.7	7.1	75.2	20.3	29	16.7	36	MG/KG	UG/L	NO	YES	YES
Barium	36	78.6	54.4	55	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.92	0.6	ND	0.46	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.18	ND	ND	0.6	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	26.9	18.9	35.6	33.7	38	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	45.7	1.9	9.9	2	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	21.5	5.5	5	8.3	920	1500	2.9	MG/KG	UG/L	NO	NO	YES
Cyanide	NA	NA	ND	ND	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	33.1	13.4	17.4	99.7	400	15	8.5	MG/KG	UG/L	NO	YES	YES
Manganese	279	67.9	1040	185	1100	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.36	0.06	ND	ND	2	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	10.4	3.3	7.1	17.4	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	0.65	0.89	9.3	3.4	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.95	ND	ND	1.2	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Tin	ND	ND	3.5	ND	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	41.8	32	90.4	25.6	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	76.4	26.7	22	43.3	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, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background reference value

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

of trichlorethene in site soil. The nature of soil contamination is consistent with past site activities, and the vertical distribution indicates that vertical migration of contaminants has occurred. This migration pattern is typical of surficial releases of PCE, a DNAPL with specific gravity greater than that of water. The lateral persistence of PCE exceedances in soil, however, is not fully delineated, so conclusions regarding residual mass would be conjectural at best. PCE was detected in site groundwater, thus validating the soil-to-groundwater pathway. However, the extent of groundwater contamination implies that the amount of residual mass posing a threat to groundwater may be small.

10.4.7.2 AOC 607 — Groundwater-to-Surface Water Cross-Media Transport

Table 10.4.17 also 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.

Seven organic compounds — 1,1 DCE, 1,2 DCE, PCE, TCE, chloromethane, vinyl chloride, and PCP — were detected in groundwater at concentrations above tap water RBCs. Additionally, PCE was present above saltwater screening criteria. All of these compounds were common to location 607006. 1,2 DCE, TCE, and vinyl chloride were also detected above screening levels at location 607004, while PCE was present above screening levels at locations 607008 and 607005 deep. PCP was above screening levels only at 607003 and only in the first quarter. 1,1 DCE, PCE, and TCE were present in intermediate groundwater at 607006. Temporally, at location 607006, the trend of organic concentrations was somewhat variable, which, given that the source activities had ceased, is likely reflective of climatological influence. Residual mass in soil can experience wide variation in contaminant flux due to infiltration of recharge and water table elevation changes, which is in turn reflected in groundwater concentrations. The primary contaminant from source activities is PCE, and evaluation of it can yield some insight into site conditions. In general, the concentration of PCE was greatly diminished from first to third quarter, a factor which suggests depletion of residual mass contribution. Additionally, with the exception of PCP, all of the cited compounds are degradation products of PCE and their presence indicates that breakdown through natural processes (presumably biological in nature) is occurring. The variable nature of the concentrations of these degradation products precludes a clear understanding of the breakdown rates; additional data pertinent to attenuation, as well as additional trend data is required to accurately define these. The presence of halogenated volatiles in groundwater is consistent with site activities and with soil contamination.

Three inorganics — arsenic, copper, and lead — were detected in groundwater at concentrations exceeding their respective screening levels. Arsenic exceeded its RBC and saltwater screening criteria at locations 607004, 607009, 60702I, and 60703D. Copper exceeded its surface water screening level in shallow groundwater at 607009, and in deep groundwater at 60701D and 60703D. Lead exceeded its RBC and saltwater screening level in shallow groundwater at 607009, and in deep groundwater at 60701D, 60702D, 60703D, and 60705D. All of the above cited exceedances were slight, within the same order of magnitude as the screening value. Temporally, concentration trends were not notable. These inorganics are inconsistent with AOC 607 activities as the source (their non-use in drycleaning procedures and their absence in soil). Additionally, their lateral and vertical occurrence is not correlative to organic contamination. The presence of copper and lead in deeper intervals, and their absence in corresponding shallow intervals, and the apparently ubiquitous presence of arsenic zone-wide, implies their association either with an upgradient source or with ambient conditions.

The presence of organics in site groundwater at significant concentrations provides that the groundwater migration pathway in essence does have merit. However, the risk-based pathway to receptors is invalid due to current non-use of the resource. The surface water migration pathway has merit also; however, the Cooper River (the nearest receptor) is 2000 feet to the northwest of the site. Attenuation of organics through retardation and mechanical dispersion, coupled with dilutional effects at the discharge zone, clearly limit the discharge at deleterious effects levels for ecological receptors. Additionally, site groundwater flow is clearly inconsistent with discharge to the Cooper River; therefore this pathway is not considered significant at this AOC. Migration of groundwater discharge to the storm sewer is valid, however, and point discharge of stormwater outfall should be considered as a pathway from this AOC. This mechanism is to be addressed for the Cooper River in the Zone L RFI.

10.4.7.3 AOC 607 - Soil-to-Sediment Cross Media Transport

Four sediment samples were collected from stormwater catch basins that drain the general site area. Table 10.4.6 summarize the analytes detected in sediment samples. The volatile organics found in common between the surface soil and sediment were PCE, TCE, and vinyl chloride - this constituent was detected in two sediment samples at about the same order of magnitude. For inorganics, nearly all of the constituents detected in soil samples were also detected in sediment samples at the site. Of 22 species present in surface soil 22 were also detected in sediment. This relationship establishes a link between surface soil and sediment, and implies either that surface soil is a source of these constituents in sediment, or at least contributes to the sediment load present in the stormwater drainage system.

10.4.7.4 AOC 607 — Soil-to-Air Cross-Media Transport

Table 10.4.18 lists the VOCs detected in surface soil samples collected at AOC 607 along with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at AOC 607. In addition, none of the VOCs was reported at a maximum concentration exceeding

Table 10.4.18
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone F: AOC 607
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Methylene chloride	3	13000	UG/KG	NO
Tetrachloroethene	220	11000	UG/KG	NO
Trichloroethene	2	5000	UG/KG	NO

* - 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

its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not valid at AOC 607.

10.4.7.5 AOC 607 — Fate and Transport Summary

The primary activity at AOC 607 was drycleaning; as such, any releases would have likely involved PCE. PCE was detected in soil above its screening level for protection of groundwater. It was primarily limited to location 607SB004, and exhibited enrichment as a function of depth. This is consistent with the dry cleaning building as a source, and with the vertical migration of PCE likely in product form. In groundwater, a number of organics (primarily limited to PCE and it's degradation products) were present above screening levels, thus substantiating the soil to groundwater pathway. These organics were primarily in the shallow zone in the vicinity of location 607006 and to a lesser extent 607004. None of the concentrations provide inferrable evidence that free product has entered the groundwater regime, indicating that vadose material has adsorbed the majority of potential release volumes. Temporally, the overall trend from first to third quarter samples is towards decreasing concentrations, possibly reflecting a biological attenuation mechanism and reduction of residual mass in soil. From second to third quarter samples trends are more variable. This variability may be a function of climatological effects defining flux into the system, and require more data to adequately address. The presence of some compounds, and particular PCE and TCE, in deeper groundwater provides evidence that vertical migration is occurring. Three inorganics were detected above their screening levels in groundwater; however, all were within an order of magnitude of their screening threshold values. Arsenic's zone-wide persistence, the lack of a surface source, and the absence of copper and lead in shallow intervals, indicates that these constituents are source upgradient or are indicative of ambient conditions. The risk-based pathway for groundwater is invalid due to non-use of the resource. The migration to surface water is invalidated due to inconsistency between the site flow directions and the direction of the Cooper River, the nearest receptor for such discharge. However, the pathway for groundwater discharge to storm sewer and subsequent discharge to the river is valid, and will be addressed in the Zone L RFI. The surface soil-to-air pathway is not considered significant at this site as no constituents were detected above their respective screening levels for this pathway.

10.4.8 Human Health Risk Assessment

10.4.8.1 Site Background and Investigative Approach

AOC 607 is the site of a former dry-cleaning facility at Building 1189 which more recently housed an industrial laundry facility. Building 1189 is currently vacant and the area surrounding it can be characterized as asphalt parking areas and roadways. Unpaved areas are located to the northeast and to the south of Building 1189.

Section 10.4.4 provides details of the soil sampling effort and Table 10.4.1 provides a soil sampling summary for the AOC 607 RFI. A total of 10 soil samples were collected from the upper interval as part of the RFI activities. All 10 samples were analyzed for VOCs, TAL metals, and SVOCs. An extensive DPT screening investigation, consisting of 59 samples collected from 62 DPT locations, was conducted at this site to identify areas of contamination. The ten surface soil samples collected during the RFI and 59 upper interval DPT soil samples were used to qualitatively assess the soil pathways.

Section 10.4.6 provides details of the groundwater sampling effort and provides details of the groundwater investigation for the AOC 607 RFI. The groundwater investigation at AOC 607 consisted of two phases of monitoring well installation. Data from the monitoring well investigation were used in the quantitative HHRA. A total of eight shallow, five intermediate, and six deep monitoring wells were installed. Groundwater data generated during the first quarter sampling events were quantitatively considered in the risk assessment. Data from subsequent quarterly sampling rounds and DPT investigations were used qualitatively to delineate plumes and define temporal trends.

10.4.8.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.4.19, aluminum was identified as a COPC for direct contact pathways. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out on the basis of background concentration comparisons. Additionally, vinyl chloride was identified as an indirect inhalation pathway COPC based on cross-media transfer mechanisms. Although fate and transport analysis did not identify any soil to air COPCs based on the extensive surface coverings found at AOC 607, the risk assessment added this pathway as a conservative measure.

Groundwater

As shown in Table 10.4.20, the COPCs identified in groundwater for this site include aluminum, antimony, arsenic, chloromethane, chromium, 1,1-dichloroethene, 1,2-dichloroethene (total), lead, pentachlorophenol, tetrachloroethene, trichloroethene, vanadium, and vinyl chloride. Beryllium and manganese were detected at concentrations exceeding their tap water RBCs and were eliminated from consideration in the HHRA based on direct comparison of their maximum concentrations to their background concentrations. There were too few background data for groundwater to perform Wilcoxon rank sum test analyses. As a result, this background comparison was not conducted for AOC 607 groundwater data.

Of the groundwater samples collected during the first quarter sampling event, hexavalent chromium analysis was performed on two duplicate samples from (607002 and 60702D). In each case, hexavalent chromium was not detected. Since there is uncertainty associated with the distribution of hexavalent and trivalent chromium in AOC 607 groundwater, based on two samples collected in the same general area, chromium was assumed to exist in the hexavalent state throughout this assessment as a conservative measure.

Table 10.4.19
Summary of Chemical Present in Site Samples
AOC 607, Surface Soil
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Reference	Units	Number Exceeding RBC	Ref.
Inorganics													
Aluminum (Al)	*	10	10	3230	18600	7429	NA	NA	7800	18500	mg/kg	3	1
Antimony (Sb)		3	10	0.58	1.8	1.19	0.33	0.39	3.1	0.79	mg/kg		2
Arsenic (As)		10	10	1.2	8.7	3.26	NA	NA	0.43	19.9	mg/kg	10	
Barium (Ba)		10	10	6.4	36	18.25	NA	NA	550	61.5	mg/kg		
Beryllium (Be)		4	10	0.28	0.92	0.56	0.09	0.21	0.15	1.05	mg/kg	4	
Cadmium (Cd)		2	10	0.11	0.18	0.15	0.04	0.05	3.9	0.26	mg/kg		
Calcium (Ca)	N	10	10	271	15700	5510	NA	NA	NA	NA	mg/kg		
Chromium (Cr)		10	10	3.7	26.9	9.36	NA	NA	39	34.8	mg/kg		
Cobalt (Co)		10	10	0.43	45.7	7.20	NA	NA	470	15.1	mg/kg		1
Copper (Cu)		10	10	0.79	21.5	5.04	NA	NA	310	48.2	mg/kg		
Iron (Fe)	N	10	10	1250	20000	6403	NA	NA	NA	NA	mg/kg		
Lead (Pb)		10	10	4.3	33.1	12.42	NA	NA	400	180	mg/kg		
Magnesium (Mg)	N	10	10	176	2310	624	NA	NA	NA	NA	mg/kg		
Manganese (Mn)		10	10	5.8	279	59.12	NA	NA	180	307	mg/kg	1	
Mercury (Hg)		5	10	0.04	0.36	0.18	0.04	0.04	2.3	0.62	mg/kg		
Nickel (Ni)		10	10	0.84	10.4	3.87	NA	NA	160	12.6	mg/kg		
Potassium (K)	N	3	10	474	1050	705	217	259	NA	NA	mg/kg		
Selenium (Se)		3	10	0.38	0.65	0.49	0.33	0.39	39	1.15	mg/kg		
Silver (Ag)		2	10	0.83	0.95	0.89	0.21	0.25	39	1.85	mg/kg		
Sodium (Na)	N	4	10	109	351	202	52.8	323	NA	NA	mg/kg		
Vanadium (V)		10	10	2.8	41.8	13.59	NA	NA	55	48.9	mg/kg		
Zinc (Zn)		10	10	4.1	76.4	26.7	NA	NA	2300	198	mg/kg		
Semivolatile Organics													
Butylbenzylphthalate		1	10	58	58	58	360	430	1600000	NA	ug/kg		
Volatile Organics													
Methylene chloride		1	11	3	3	3	1	6	85000	NA	ug/kg		
Tetrachloroethene		4	10	1	220	89	6	6	12000	NA	ug/kg		
Trichloroethene		1	10	2	2	2	1	6	58000	NA	ug/kg		
DPT Samples													
1,1-Dichloroethene		1	59	1.27	1.27	1.27	ND	ND	1100	NA	ug/kg		
cis-1,2-Dichloroethene		2	59	1.59	194	97.80	ND	ND	78000	NA	ug/kg		
trans-1,2-Dichloroethene		1	59	18.5	18.5	18.50	ND	ND	160000	NA	ug/kg		
Hexachlorobutadiene		1	59	1.2	1.2	1.20	ND	ND	8200	NA	ug/kg		
Methylene chloride		4	59	14.2	15.6	15.00	ND	ND	85000	NA	ug/kg		
Naphthalene		4	59	1.917	4.616	3.26	ND	ND	310000	NA	ug/kg		
Tetrachloroethene		3	59	1.974	12.4	8.46	ND	ND	12000	NA	ug/kg		
Toluene		5	59	1.38	2.65	2.05	ND	ND	1600000	NA	ug/kg		
1,2,3-Trichlorobenzene		4	59	1.937	3.104	2.31	ND	ND	78000	NA	ug/kg		
1,2,4-Trichlorobenzene		4	59	1.378	1.82	1.58	ND	ND	78000	NA	ug/kg		
Vinyl chloride	**	2	59	78.3	211	144.65	ND	ND	340	NA	ug/kg		
Xylene (m & p)		2	59	1.064	1.736	1.40	ND	ND	16000	NA	ug/kg		

* - Identified as a COPC
** - Identified as a COPC due to indirect inhalation
N - Essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
mg/kg - millgram per kilogram
ug/kg - microgram per kilogram
NA - Not applicable

Table 10.4.20
Summary of Chemicals Present in Site Samples
AOC 607- Combined Shallow, Intermediate, and Deep Groundwater
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations Residential RBC	Reference	Units	Number Exceeding RBC	Ref.
Inorganics													
Aluminum (Al)	*	14	16	66.9	7810	1899	29.4	115	3700	224	ug/L	3	10
Antimony (Sb)	*	1	16	2.6	2.6	3	2.3	5.7	1.5	NA	ug/L	1	
Arsenic (As)	*	13	16	3	75.2	17	2.5	2.5	0.045	16.7	ug/L	13	4
Barium (Ba)		16	16	5.85	55	30	NA	NA	260	200	ug/L		
Beryllium (Be)		1	16	0.46	0.46	0.46	0.3	0.63	0.016	0.66	ug/L	1	
Cadmium (Cd)		1	16	0.6	0.6	0.6	0.3	0.5	1.8	0.82	ug/L		
Calcium (Ca)	N	16	16	4170	220000	75161	NA	NA	NA	NA	ug/L		
Chromium (Cr)	*	10	16	1.1	35.6	11	0.8	0.8	18	2.05	ug/L	2	6
Cobalt (Co)		7	16	1.05	9.9	4	0.9	2.7	220	67	ug/L		
Copper (Cu)		7	16	0.96	8.3	3	0.6	0.6	150	NA	ug/L		
Iron (Fe)	N	16	16	74.6	22000	4263	NA	NA	NA	NA	ug/L		
Lead (Pb)	*	7	16	2.1	99.7	39	1.7	1.7	15	NA	ug/L	5	
Magnesium (Mg)	N	16	16	1022.5	55700	20109	NA	NA	NA	NA	ug/L		
Manganese (Mn)		16	16	2.6	1040	225	NA	NA	84	2010	ug/L	12	
Nickel (Ni)		15	16	0.92	17.4	4	0.8	0.8	73	61.1	ug/L		
Potassium (K)	N	14	16	2500	26500	10406	1600	1600	NA	NA	ug/L		
Selenium (Se)		3	16	3.4	9.3	7	2.8	3.4	18	NA	ug/L		
Silver (Ag)		1	16	1.2	1.2	1	1	1.9	18	2.7	ug/L		
Sodium (Na)	N	16	16	6570	478000	235317	NA	NA	NA	NA	ug/L		
Tin (Sn)		1	16	3.5	3.5	4	2.6	14	2200	NA	ug/L		
Vanadium (V)	*	8	16	3.5	90.4	20	0.5	2.8	26	1.58	ug/L	1	8
Zinc (Zn)		2	16	22	43.3	33	5.3	38.1	1100	NA	ug/L		
Semivolatile Organics													
Benzoic acid		2	16	1	1	1	50	50	15000	NA	ug/L		
Benzyl alcohol		1	16	2	2	2	10	10	1100	NA	ug/L		
Butylbenzylphthalate		1	16	1	1	1	10	18	730	NA	ug/L		
Pentachlorophenol	*	1	16	3	3	3	50	50	0.56	NA	ug/L	1	
Volatile Organics													
Carbon disulfide		2	19	2	2	2	5	5	100	NA	ug/L		
Chloromethane	*	1	19	10	10	10	10	10	1.4	NA	ug/L	1	
1,1-Dichloroethene	*	2	19	2	2	2	5	5	0.044	NA	ug/L	2	
1,2-Dichloroethene (total)	*	3	19	24	840	328	5	5	5.5	NA	ug/L	3	
Tetrachloroethene	*	4	19	3	45000	12279	5	7	1.1	NA	ug/L	4	
Toluene		2	19	1	4	3	5	5	75	NA	ug/L		
Trichloroethene	*	4	19	2	1300	370	5	5	1.6	NA	ug/L	4	
Vinyl chloride	*	1	19	9	9	9	10	10	0.019	NA	ug/L	1	

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
RBC - Risk-based concentration
ug/L - microgram per liter
NA - Not applicable
N - Essential nutrient

10.4.8.3 Exposure Assessment

Exposure Setting

AOC 607 is located along the west side of NAVBASE and is currently covered by either buildings, asphalt, or grass. The site is located within a moderately developed commercial/industrial area of NAVBASE and most surrounding parcels are occupied by buildings and/or service roads. Base reuse plans have indicate that the area surrounding AOC 607 could maintain its commercial/industrial setting or may be redeveloped as a recreational area. The surrounding area will either maintain its current features and/or entail relandscaping and additional construction.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, current trespassers, future recreational users, and hypothetical future site residents. With respect to soil, future site resident and future site worker (industrial) exposure scenarios were addressed in this risk assessment. 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 (much of the site is paved). Therefore, future worker assessment is considered to be conservatively representative of current site users. The future site resident scenario was built on the premise that existing buildings and pavement would be removed and replaced with yards and dwellings. Since redevelopment plans have not yet been finalized and recreational use is a redevelopment option, a recreational use scenario was qualitatively addressed by comparison to the residential use scenario. The current trespasser scenario was qualitatively addressed by comparison to the resident child scenario. In general, the residential scenario is a conservative estimate for the recreational and trespasser scenarios. As base redevelopment plans materialize, exposure scenarios can be refined to reflect proposed future uses.

Exposure Pathways

Exposure pathways for the future site workers are dermal contact with contaminated surface soil, incidental ingestion of surface soils, inhalation of volatiles emanating from surface and subsurface soils, ingestion of groundwater through potable use, and inhalation of VOCs resulting from domestic or process use of groundwater. The exposure pathways for future residential land use are the same as those for the future site worker. Uniform exposure was assumed for all sample locations. Table 10.4.21 presents the justification for exposure pathways assessed in this HHRA.

With respect to groundwater, since NAVBASE has readily available municipal water, it is highly unlikely that the aquifer will be used as a source of potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, a residential scenario and an industrial scenario were considered for AOC 607. Since there is no clear confining layer separating the shallow, intermediate, and deep aquifers, all groundwater data from the surficial aquifer were combined in evaluating the groundwater pathways.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for datasets consisting of at least 10 samples. Table 10.4.22 summarizes the statistical analysis performed on surface soil data and shows the 95% UCLs calculated for the soil COPCs. Vinyl chloride was the only soil-to-air COPC identified for AOC 607 and its EPC was based on both surface soil and subsurface soil data for this indirect exposure pathway. Surface (10) and subsurface (9) soil data from the RFI sampling effort and surface (10) and subsurface soil (7) from the DPT sampling effort were used to calculate a 95% UCL for vinyl chloride. These samples represent an area of approximately one-half acre. The EPC for vinyl chloride was set equal to its 95% UCL.

Table 10.4.21
Exposure Pathways Summary — AOC 607
NAVBASE — Zone F
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 and Trespassers	Air, Inhalation of gaseous contaminants emanating from soil	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This pathway is considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No (Qualified)	Groundwater is not currently used as a source of potable or non-residential water at AOC 607. Future land use assessment is considered to be conservatively representative of current receptors.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No (Qualified)	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 607. Future land use assessment is considered to be conservatively representative of current receptors.
	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), Site Worker, Recreational	Air, Inhalation of gaseous contaminants emanating from soil	Yes	Soil to air screening identified COPCs for this exposure route.
	Air, Inhalation of chemicals entrained in fugitive dust	No	No constituents were identified that would significantly contribute to risk via this route.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.

Table 10.4.21
Exposure Pathways Summary — AOC 607
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	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.

Table 10.2.22
Statistical Analysis of COPCs in Surface Soil
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

		Natural Log Transformed			UCL	MAX	EPC	
COPC	n	mean	SD	H-stat	(mg/kg)	(mg/kg)	(mg/kg)	
Aluminum	10	8.796	0.486	2.202	10623	18600	10623	UCL Used
Vinyl chloride*	36	1.228	1.527	3.065	0.024	0.211	0.024	UCL Used

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
* Identified as a COPC based on comparison of its maximum concentration in surface and subsurface soil to its soil-to-air SSL. Both surface and subsurface soil data collected during the RFI investigation and the CPT investigation were used to calculate EPC

Table 10.4.23 summarizes the determination of the groundwater EPC. Current EPA guidance favors the use of the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. The most concentrated area of the plume is defined separately for each COPC as summarized on Table 10.4.23. A plume of chlorinated solvents was defined using data generated from samples collected from monitoring wells 607006 and 60706I. The EPC is calculated as the arithmetic mean of first quarter data from these monitoring wells (considered the "most concentrated area" of the chlorinated solvent plume). All of the inorganic COPCs were ubiquitous in the surficial aquifer, and as a result, UCLs (or maximum concentrations if the UCLs were higher) were calculated to characterize their EPC. Chloromethane, pentachlorophenol, and vinyl chloride were only detected in one of the first quarter groundwater samples, and as a result, their only detected concentration was used as their respective EPCs.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with surface soils are shown in Tables 10.4.24 and 10.4.25, respectively. The CDIs for inhalation of VOCs emanating for surface and subsurface soil are shown in Table 10.4.26 and were calculated as follows. Since vinyl chloride was the only COPC identified for inhalation pathway and since there is no published reference dose, noncarcinogenic CDIs were not calculated.

Inhalation of VOCs Emanating from Soil:
Carcinogens:

$$CDI_{res} = \frac{C_S * IRadj * EF_{res} * 1/VF}{AT_C} \qquad CDI_w = \frac{C_S * IRa * EF_w * ED_w * 1/VF}{AT_C * BW_a}$$

Table 10.4.23
Determination of Groundwater EPCs
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

	Natural Log Transformed n	mean	Standard Deviation	95% UCL (mg/L)	Maximum Conc. (mg/L)	Average Conc. in Plume (mg/L)	EPC (mg/L)	
Aluminum (Al)	16	6.206	1.848	20.2	7.81	NA	7.81	Max Conc.
Antimony (Sb)	16	0.614	0.268	0.0022	0.0026	NA	0.0022	95% UCL
Arsenic (As)	16	1.920	1.238	0.04	0.0752	NA	0.04	95% UCL
Chloromethane	NA	NA	NA	NA	0.01	NA	0.01	Max Conc.
Chromium (Cr)	16	0.685	1.627	0.037	0.0356	NA	0.0356	Max Conc.
1,1-Dichloroethene	NA	NA	NA	NA	0.002	0.002	0.002	Mean in Plume
1,2-Dichloroethene (total)	NA	NA	NA	NA	0.84	0.432	0.432	Mean in Plume
Lead (Pb)	16	1.235	1.869	0.15	0.0997	NA	0.0997	Max Conc.
Pentachlorophenol	NA	NA	NA	NA	0.003	NA	0.003	Max Conc.
Tetrachloroethene	NA	NA	NA	NA	45	24.55	24.55	Mean in Plume
Trichloroethene	NA	NA	NA	NA	1.3	0.725	0.725	Mean in Plume
Vanadium (V)	16	0.850	1.821	0.087	0.0904	NA	0.087	95% UCL
Vinyl chloride	NA	NA	NA	NA	0.009	0.007	0.007	Mean in Plume

Table 10.4.24
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 607
NAVBASE - Charleston, Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Aluminum	1	10623	1.46E-02	1.36E-01	1.66E-02	5.20E-03	1.86E-03

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 10.4.25
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 607
NAVBASE - Charleston, Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Aluminum	10623	1	0.001	5.97E-04	1.97E-03	3.73E-04	4.26E-04	1.52E-04

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 10.4.26
Chronic Daily Intakes
Inhalation of Volatile Organic Compounds Eminating from Soil
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Vinyl Chloride	0.024	2.56E-06	7.16E-06	1.49E-06	1.83E-06	6.53E-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

Variable	**Description**
BW_a	Average adult body weight (70 kg)
ED_w	Adult exposure duration (25 yr)
EF_{res}	Residential exposure frequency (350 days/year)
EF_w	Worker exposure frequency (250 days/year)
IR_{adj}	Lifetime weighted average inhalation rate (11.66 m^3-yr/kg-day)
IR_a	Adult inhalation rate (20 m^3/day)
AT_C	Averaging time - carcinogen (25,550 days)
C_s	Chemical concentration in surface soil - EPC (mg/kg)
VF	Volatilization factor (2,568 m^3/kg)
F	Conversion factor (10^{-6} kg/mg)

The Volatilization factor was calculated as follows using USEPA Soil Screening Guidance (1996):

$$VF = \frac{Q/C*(3.14*D_A*T)^{1/2}*CF}{2*d*D_A}$$

Q/C	Source area/emission rate; one-half acre source, Charleston area (74.89 g/m^2-sec per kg/m^3)
D_A	Apparent diffusivity; calculated using Soil Screening Guidance defaults (0.02996 cm^2/sec)
CF	Conversion factor (1E-04 m^2/cm^2)

The CDIs for groundwater ingestion are presented in Table 10.4.27. The CDIs for inhalation of volatile organic compounds is assumed to be approximately equal to the CDI for ingestion as indicated in the Technical Memorandum Guidance on Estimating Exposure to VOCs while showering (USEPA/ORD, July 10, 1991).

10.4.8.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.4.28 presents toxicological information specific to each COPC identified at AOC 607. This information was used in the quantification of risk/hazard associated with soil and groundwater

Table 10.4.27
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
AOC 607
NAVBASE - Charleston, Zone F
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 Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Aluminum (Al)	7.81	2.14E-01	4.99E-01	1.18E-01	7.64E-02	2.73E-02
Antimony (Sb)	0.0022	6.03E-05	1.41E-04	3.32E-05	2.15E-05	7.69E-06
Arsenic (As)	0.04	1.10E-03	2.56E-03	6.03E-04	3.91E-04	1.40E-04
Chloromethane	0.01	2.74E-04	6.39E-04	1.51E-04	9.78E-05	3.49E-05
Chromium (Cr)	0.0356	9.75E-04	2.28E-03	5.36E-04	3.48E-04	1.24E-04
1,1-Dichloroethene	0.002	5.48E-05	1.28E-04	3.01E-05	1.96E-05	6.99E-06
1,2-Dichloroethene (total)	0.432	1.18E-02	2.76E-02	6.51E-03	4.23E-03	1.51E-03
Lead (Pb)	NA	NA	NA	NA	NA	NA
Pentachlorophenol	0.003	8.22E-05	1.92E-04	4.52E-05	2.94E-05	1.05E-05
Tetrachloroethene	24.55	6.73E-01	1.57E+00	3.70E-01	2.40E-01	8.58E-02
Trichloroethene	0.725	1.99E-02	4.63E-02	1.09E-02	7.09E-03	2.53E-03
Vanadium (V)	0.087	2.38E-03	5.56E-03	1.31E-03	8.51E-04	3.04E-04
Vinyl chloride	0.007	1.92E-04	4.47E-04	1.05E-04	6.85E-05	2.45E-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

Table 10.4.28
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 607
NAVBASE - Charleston, Zone F

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
ical	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
ichloroethene	0.009	a	M	liver lesions	1,000	NA		NA	NA	NA	0.6	a	0.175	a	C	kidney adenosarcoma
ichloroethene (total)	0.009	b	L	increased serum phosphatase	1,000	NA		NA	NA	NA	NA		NA		D	NA
ium	1	d	NA	NA	NA	NA		NA	NA	NA	NA		NA		NA	NA
ony	0.0004	a	L	whole body/blood increased mortality	1,000	NA		NA	NA	NA	NA		NA		D	NA
ic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
omethane	0.257		H	hepatotoxicity	300	0.257		H	hepatotoxicity	NA	0.012	b	0.0063	b	C	kidney tumors
mium III	1	a	L	NA	100/10	5.71E-07	e	NA	NA	NA	NA		NA	a	D	NA
mium VI	0.005	a	L	NA	500	NA		NA	NA	NA	NA		42	a	A	lung
	NA		NA	NA	NA	NA		NA	NA	NA	NA		NA		B2	various
chlorophenol	0.03	a	M	fetotoxicity	100	NA		NA	NA	NA	0.12	a	NA		B2	multiple tumor types
hloroethane	0.01	a	M/L	hepatotoxicity in mice, weight gain in rats	1,000	NA		NA	NA	NA	0.052	d	0.00203	d	NA	NA
oroethene	0.006	e	NA	NA	NA	NA		NA	NA	NA	NA		0.006	e	B2	forestomach tumors in mice
lium	0.007	a	NA	unclear	100	NA		NA	NA	NA	NA		NA		D	NA
chloride	NA		NA	NA	NA	NA		NA	NA	NA	1.9	b	0.3	b	A	hepatocellular carcinoma

= Integrated Risk Information System (IRIS)
= Health Effects Assessment Summary Tables (HEAST)
= HEAST alternative method
= EPA NCEA - Cincinnati (provisional)
= Withdrawn from IRIS/HEAST
= Information collected from IRIS, based on 2,4-dinitrotoluene and 2,6-dinitrotoluene mixture
= Information collected from EPA documents other than those listed above
= Not applicable or not available
= High confidence
= Low confidence
= Medium confidence

contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuromuscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen, et al., 1986) (Dreisbach, et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based SMCL for drinking water is 50 to 200 μg/L (USEPA, Office of Water).

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract, which is the target 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 bw/day, an uncertainty factor of 1000, and a modifying factor of 1 (IRIS).

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 RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. 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 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS, the basis for the classification is sufficient evidence from 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. The RBC for arsenic in tap water is 0.038 μg/L. 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.

Chloromethane is a clear, colorless gas that has a faintly sweet, non irritating odor at high levels in the air. A naturally occurring chemical, it is made in large amounts in the oceans and is produced by some plants and rotting wood and when such materials as grass, wood, charcoal, and coal burn. Chloromethane is also produced industrially, but most of it is destroyed during use. It is used mainly in the production of other chemicals such as silicones (72%), agricultural chemicals (8%), quaternary mines, and butyl rubber.

Case reports of humans exposed acutely to high concentrations of chloromethane have described severe neurological effects, sometimes followed by death. Effects on the cardiovascular system, liver, and kidney have also been described in the case reports of humans exposed for brief periods or for more prolonged periods occupationally (Gummart, 1961; McNally, 1946; Spevak et al., 1976). Numerous acute inhalation studies have identified the liver and kidney as target organs in rats and mice, the spleen in mice and dogs, and the testes and epididymides as target organs in rats. These studies have shown that species differences in susceptibility exist and that generally animals are more susceptible to relatively low exposures given continuously than to relatively high exposures given intermittently (ATSDR, 1990). USEPA has ranked chloromethane as a group C carcinogen (USEPA, 1993). Chloromethane has an oral SF as well as an inhalation SF that are 1.3E-02 and 6.3E-03, respectively (USEPA, 1996f).

Chromium exists in two stable, natural forms: trivalent (III) and hexavalent (VI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for both forms of chromium are 1.0 and 5E-03 (mg/kg-day). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a SFo of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

1,1-Dichloroethene is a volatile organic compound, primarily toxic to the liver, central nervous system, and kidneys. The mucous membrane, skin, lung, and cornea (irritation) are also affected. 1,1-Dichloroethene is more toxic than 1,2-Dichloroethene; this chlorinated compound is a USEPA group C carcinogen. The RfDo is 0.009 mg/kg-day, and the SFo and Sfi are 0.6 and 0.175 $(mg/kg\text{-}day)^{-1}$, respectively (Dreisbach, et al., 1987).

1,2-Dichloroethene is a halogenated hydrocarbon associated with toxicity to the mucous membrane, skin, lung, cornea (irritation), and liver. This compound is less toxic than its alkane counterparts, and is neither mutagenic nor carcinogenic. There is no USEPA carcinogenicity listing for this compound (Dreisbach et al., 1987). However, the RfDo has been set to 1E-02 mg/kg-day for the cis-isomer, and at 2E-02 mg/kg-day for the trans-isomer by USEPA (USEPA, 1996f and IRIS).

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. USEPA's OSWER has recommended a 1,000 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS, the classification is base on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate – sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

Tetrachloroethene (PCE) has been used as a solvent in industry and occurs as a volatile contaminant in other chlorinated hydrocarbons. PCE exposure can result in long-lasting narcosis with delayed onset and damage to the liver and kidneys. The principal manifestations of over-exposure to this halogenated hydrocarbon are jaundice and oliguria, and irritation of the eyes and nose, followed by headaches, nausea and coma. Cyanosis and central nervous system depression progressing to coma appear one to four hours after the short-term exposure. Liver and kidney damage after apparent recovery or after repeated exposures causes acute symptoms such as nausea, vomiting, abdominal pain, jaundice, oliguria and uremia. PCE exposure via the inhalation and/or skin absorption exposure pathways could result in headaches, tremor, dizziness, peripheral paresthesia, hypesthesia, or anesthesia. PCE is a carcinogen, but is currently under review by USEPA; it is currently classified as a B2-C carcinogen. The RfDo has been set to 0.01 mg/kg-day, and the SFo and SFi have been set to 0.052 and 0.00203 $(mg/kg\text{-}day)^{-1}$, respectively, by USEPA. As listed in IRIS, the critical effect of this chemical is hepatotoxicity in mice, weight gain in rats. The uncertainty factor was determined to be 1000 and the modifying factor was determined to be 1. (Dreisbach, et al., 1987).

Trichloroethene (TCE) is a mobile, volatile liquid which has the characteristic odor of chloroform. Inhalation, intravenous and subcutaneous routes are all viable exposure pathways for this compound. TCE is a strong skin and eye irritant that is relatively less toxic if ingested. Inhalation of high concentrations causes narcosis and anesthesia. This compound targets the liver and other organs. TCE is a B2 carcinogen, and the Sfo and SFi have been set by USEPA to 0.011 and 0.006 $(mg/kg\text{-}day)^{-1}$, respectively. USEPA also set the RfDo to 0.006 mg/kg-day (Dreisbach, et al., 1987).

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfDo set by USEPA is 0.007 mg/kg-day.

Vinyl chloride is a volatile organic that can cause Raynaud's Phenomenon or white finger disease. It has been shown to cause angiosarcoma, a cancer. It has been also been associated with reproductive dysfunction in men and women. The primary target organs for non-carcinogenic effects are the liver, kidney, and nervous system. This compound inhibits one of the main metabolic pathways of the body (a group of enzymes), and can influence the toxicity of other compounds because of this effect. Due to the carcinogenicity of this compound, USEPA classified vinyl chloride as a class A carcinogen and set the SFi and SFo to 0.3 and 1.9 $(mg/kg\text{-}day)^{-1}$, respectively (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

10.4.8.5 Risk Characterization

Surface Soil Pathways

Exposure to soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion, dermal contact, and inhalation exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.4.29 and 10.4.30 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively. Table 10.4.31 presents the carcinogenic risks and/or HQs associated with indirect exposure to VOCs emanating from surface and subsurface soil.

Table 10.4.29
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 607
NAVBASE - Charleston, Zone F
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
Aluminum	1	NA	0.015	0.14	ND	0.0019	ND
SUM Hazard Index/ILCR			0.01	0.1	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

Table 10. .4.30
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 607
NAVBASE - Charleston, Zone F
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 Worker adult Hazard Quotient	Future Worker adult ILCR
Aluminum	0.2	0.2	NA	0.0030	0.0098	ND	0.0021	ND
SUM Hazard Index/ILCR				0.003	0.01	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)

Table 10.4.31
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Volatile Organic Chemicals Eminating from Soil
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	Inhalation Rf Used (mg/kg-day)	Inhalation 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
Vinyl Chloride	NA	0.3	ND	ND	4.5E-07	ND	2.0E-07
SUM Hazard Index/ILCR			ND	ND	4E-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

Hypothetical Site Residents

The computed hazard index for the adult and child resident were 0.01 and 0.1, respectively, for the soil ingestion pathway. The computed hazard index for the adult and child dermal contact pathways were 0.003 and 0.01, respectively. The lifetime weighted average ILCR for the indirect inhalation pathway was calculated to be 4E-07. Results from the residential scenario are considered to be conservatively representative of the recreational and trespasser scenarios.

Hypothetical Site Workers

Hazard indices for the ingestion and dermal pathways were 0.002 and 0.002, respectively. The ILCR was calculated to be 2E-07 based on the indirect inhalation pathway.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and industrial scenarios. The groundwater exposure pathways were evaluated assuming that 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. Tables 10.4.32 and 10.4.33 present the risk and hazard for the exposure pathways.

Hypothetical Site Residents

For the ingestion and inhalation pathway, the lifetime weighted average ILCRs were computed to be 2E-02 and 9E-04, respectively. For the ingestion pathway the primary contributor was tetrachloroethene. Secondary contributors to the ingestion pathway include arsenic, chloromethane, 1,1-dichloroethene, pentachlorophenol, trichloroethene, and vinyl chloride. For the inhalation pathway, the primary contributors are tetrachloroethene, trichloroethene, and vinyl chloride, with a secondary contribution from 1,1-dichloroethene.

Table 10.4.32
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
AOC 607
Naval Base Charleston, Zone F
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
Aluminum (Al)	1	NA	0.21	0.50	ND	0.076	ND
Antimony (Sb)	0.0004	NA	0.15	0.35	ND	0.054	ND
Arsenic (As)	0.0003	1.5	3.7	8.5	9.0E-04	1.3	2.1E-04
Chloromethane	NA	0.013	ND	ND	2.0E-06	ND	4.5E-07
Chromium (Cr)	0.005	NA	0.20	0.46	ND	0.070	ND
1,1-Dichloroethene	0.009	0.6	0.0061	0.014	1.8E-05	0.0022	4.2E-06
1,2-Dichloroethene (total)	0.009	NA	1.3	3.1	ND	0.47	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Pentachlorophenol	0.03	0.12	0.0027	0.0064	5.4E-06	0.0010	1.3E-06
Tetrachloroethene	0.01	0.052	67	157	1.9E-02	24	4.5E-03
Trichloroethene	0.006	0.011	3	8	1.2E-04	1.2	2.8E-05
Vanadium (V)	0.007	NA	0.34	0.79	ND	0.12	ND
Vinyl chloride	NA	1.9	ND	ND	2.0E-04	ND	4.6E-05
SUM Hazard Index/ILCR			76	178	2E-02	27	5E-03

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 10.4.33
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants in Groundwater Resulting from Domestic Use
AOC 607
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Inhalation RfD Used (mg/kg-day)	Inhalation 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
Chloromethane	NA	0.0063	ND	ND	9.5E-07	ND	2.2E-07
1,1-Dichloroethene	0.009	0.175	0.0061	0.014	5.3E-06	0.0022	1.2E-06
1,2-Dichloroethene (total)	0.009	NA	1.3	3.1	ND	0.47	ND
Tetrachloroethene	0.01	0.00203	67	157	7.5E-04	24	1.7E-04
Trichloroethene	0.006	0.006	3.3	7.7	6.6E-05	1.2	1.5E-05
Vinyl chloride	NA	0.3	ND	ND	3.2E-05	ND	7.3E-06
SUM Hazard Index/ILCR			72	168	9E-04	26	2E-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

Hazard indices for the adult and child resident are 76 and 178, respectively, for the ingestion pathway and 72 and 168, respectively, for the inhalation pathway. The primary contributor to the ingestion pathway is tetrachloroethene. Secondary contributors to the ingestion pathway include aluminum, antimony, arsenic, chromium, 1,2-dichloroethene (total), trichloroethene, and vanadium. The primary contributor to the inhalation pathway is the tetrachloroethene with secondary contributions from 1,2-dichloroethene (total) and trichloroethene.

Hypothetical Site Workers

For the ingestion and inhalation pathways, the lifetime weighted average ILCRs were computed to be 5E-03 and 2E-04, respectively. The primary contributor to the ingestion pathway was tetrachloroethene. Secondary contributors to the ingestion pathway include arsenic, 1,1-dichloroethene, pentachlorophenol, trichloroethene, and vinyl chloride. For the inhalation pathway, the primary contributor was also tetrachloroethene with secondary contributions from 1,1-dichloroethene, trichloroethene, and vinyl chloride.

The ingestion and inhalation pathway hazard indices were computed to be 27 and 26, respectively. The primary contributor to the ingestion pathway was tetrachloroethene. Secondary contributors to the ingestion pathway include arsenic, 1,2-dichloroethene (total), trichloroethene, and vanadium. The primary contributor to the inhalation pathway was tetrachloroethene with secondary contributions from 1,1-dichloroethene and trichloroethene.

Lead Toxicity

Background

Currently, USEPA has not established an SF reference dose for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood levels as low as 10 μg/dL.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Uptake/Biokinetics Model (Version 0.99d) (Lead Model) to predict mean blood lead levels in children based on exposure to impacted environmental media. An alternative assessment was also provided using USEPA's *Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil* (December 1996) (Adult Lead Model) to evaluate health impact of lead under the more likely future industrial scenario. These models were used to assess the potential health effects of elevated lead levels reported in groundwater at AOC 607. Lead was detected 7 of 16 groundwater samples taken from AOC 607 monitoring wells during first quarter sampling. Both the maximum detected concentration (99.7 μg/L) and the mean detected concentration (39 μg/L) are above the TTAL of 15 μg/L.

Future Residential Scenario

Lead model default concentrations were used for exposure to air (0.1 Pb grams per cubic meter [g/m^3]) and maternal blood lead level (2.5 Pb per μg/dL). The maximum lead concentration (Table 10.4.23; 99.7 μg/L) was used as the input for drinking water and the maximum concentrations of lead in soil (Table 10.4.19; 33.1 mg/kg) was used as the input for soil and house dust. The Lead Model was run for a child ages 0-7 years using the inputs listed above. Table 10.4.34 presents the lead model output under these exposure conditions.

Figure 10.4-40 shows the probability percentage of blood lead levels for the hypothetical child receptor. Based on this model output the geometric mean blood concentrations is estimated to be 8.4 μg/dL, and the probability of blood lead concentration exceeding 10 μg/dL is 34%. USEPA generally considers that media concentrations resulting in probability percentage estimates of 5% or less sufficiently protect potential child receptors. As a result, groundwater lead would require

Table 10.4.34
Lead Model Results - Future Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

LEAD MODEL Version 0.99d
AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT
DRINKING WATER Conc: 99.70 ug Pb/L WATER Consumption: DEFAULT

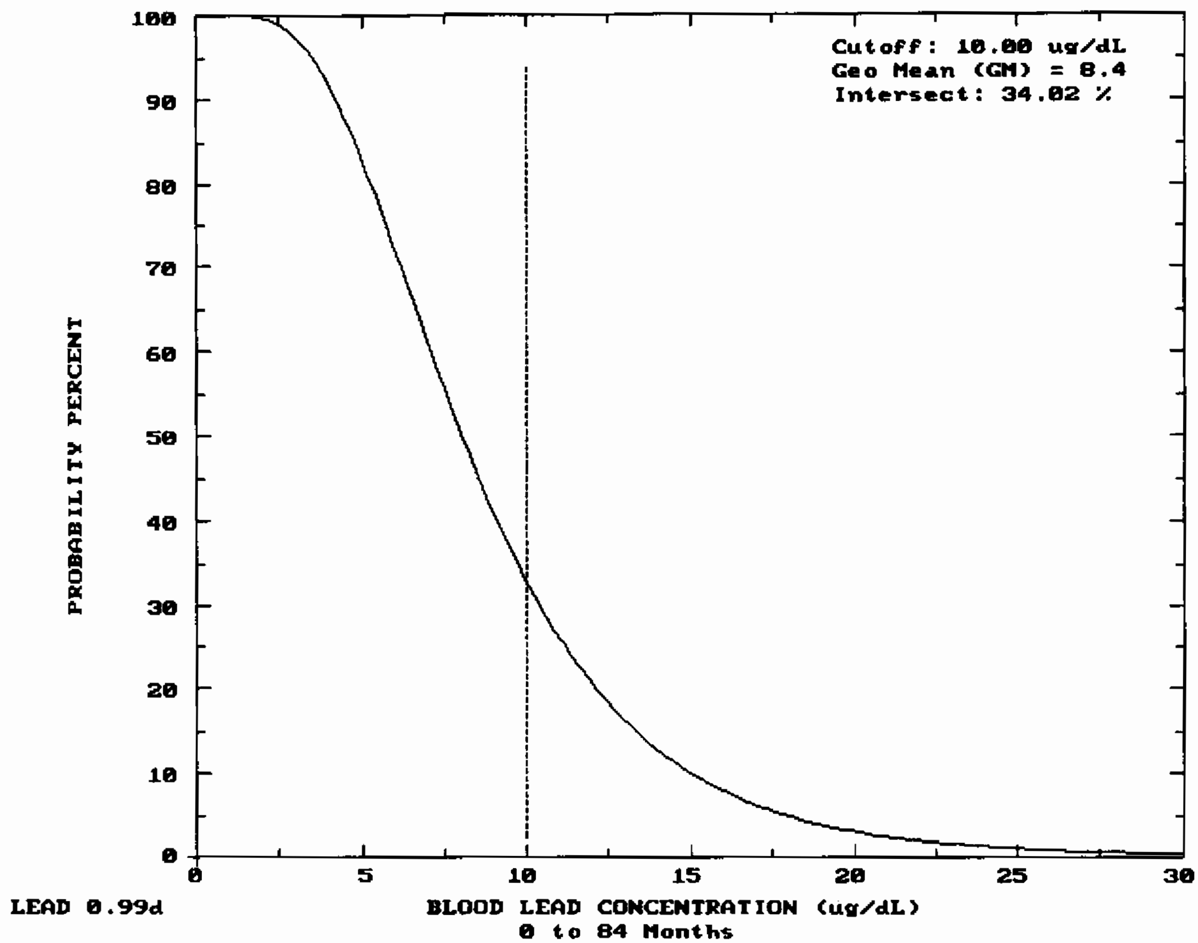
SOIL & DUST:
Soil: constant conc. Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT
PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model Maternal Blood Conc: 2.50 ug Pb/dL
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil/Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	8.0	15.00	4.28	2.32	8.38	0.00	0.02
1-2:	11.0	27.93	6.29	2.24	19.36	0.00	0.03
2-3:	10.8	29.73	6.45	2.58	20.64	0.00	0.06
3-4:	10.6	30.85	6.62	2.55	21.60	0.00	0.07
4-5:	10.1	30.73	5.05	2.53	23.08	0.00	0.07
5-6:	9.7	32.06	4.61	2.70	24.66	0.00	0.09
6-7:	9.1	32.83	4.39	3.01	25.33	0.00	0.09



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

FIGURE 10.4-40
PROBABILITY DISTRIBUTION OF BLOOD
LEAD LEVELS FOR CHILD 0-7 YEARS
RESIDENTIAL SCENARIO - AOC 607

corrective action under this hypothetical exposure scenario. The maximum detected concentration of lead detected in surface soil was below the action level of 400 mg/kg.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site. 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 in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.4.35 provides a summary of COCs identified in each medium based on contribution to cumulative ILCR or hazard index.

Surface Soils

Hypothetical Site Residents (future land use)

No soil pathway COCs were identified based on the residential scenario. Since the residential scenario is considered the most conservative exposure scenario, no soil pathway COCs would be expected under future recreational or current trespasser scenarios.

Hypothetical Site Workers (future land use)

No soil pathway COCs were identified based on the industrial pathway. Since current exposure to surface soil is limited in comparison to proposed future land use scenarios due to paved areas

Table 10.4.35
Summary of Risk and Hazard-based COCs
AOC 607
NAVBASE - Charleston, Zone F
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	Aluminum	0.015	0.14	ND	0.0019	ND				
	Dermal Contact	Aluminum	0.0030	0.0098	ND	0.0021	ND				
	Inhalation	Vinyl Chloride	ND	ND	4.5E-07	ND	2.0E-07				
Surface Soil Pathway Sum			0.02	0.1	4E-07	0.004	2E-07				
Groundwater Pathways	Ingestion	Aluminum (Al)	0.21	0.50	ND	0.076	ND	1			
		Antimony (Sb)	0.15	0.35	ND	0.054	ND	1			
		Arsenic (As)	3.7	8.5	9.0E-04	1.3	2.1E-04	1	2	3	4
		Chloromethane	ND	ND	2.0E-06	ND	4.5E-07		2		
		Chromium (Cr)	0.20	0.46	ND	0.070	ND	1			
		1,1-Dichloroethene	0.0061	0.014	1.8E-05	0.0022	4.2E-06		2		4
		1,2-Dichloroethene (total)	1.3	3.1	ND	0.47	ND	1		3	
		Lead (Pb)	ND	ND	ND	ND	ND				
		Pentachlorophenol	0.0027	0.0064	5.4E-06	0.0010	1.3E-06		2		4
		Tetrachloroethene	67	157	1.9E-02	24	4.5E-03	1	2	3	4
		Trichloroethene	3	8	1.2E-04	1.2	2.8E-05	1	2	3	4
		Vanadium (V)	0.34	0.79	ND	0.12	ND	1		3	
		Vinyl chloride	ND	ND	2.0E-04	ND	4.6E-05		2		4
	Inhalation	Chloromethane	ND	ND	9.5E-07	ND	2.2E-07				
		1,1-Dichloroethene	0.0061	0.014	5.3E-06	0.0022	1.2E-06		2		4
		1,2-Dichloroethene (total)	1.3	3.1	ND	0.47	ND	1		3	
		Tetrachloroethene	67	157	7.5E-04	24	1.7E-04	1	2	3	4
		Trichloroethene	3.3	7.7	6.6E-05	1.2	1.5E-05	1	2	3	4
		Vinyl chloride	ND	ND	3.2E-05	ND	7.3E-06		2		4
Groundwater Pathway Sum			148	346	2E-02	53	5E-03				
Sum of All Pathways			148	346	2E-02	53	5E-03				

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

and areas currently occupied by buildings, no soil pathway COCs would be expected under current industrial land use.

Groundwater

Hypothetical Site Residents (future land use)

Aluminum, antimony, arsenic, chromium, 1,2-dichloroethene, tetrachloroethene, trichloroethene, and vanadium were identified as groundwater COCs based on their contribution to cumulative hazard index. Arsenic, chloromethane, 1,1-dichloroethene, pentachlorophenol, tetrachloroethene, trichloroethene, and vinyl chloride were identified as COCs based on their contribution to cumulative ILCR. Lead was identified as a COC based on the outcome of the USEPA Lead Model.

Hypothetical Site Workers (future land use)

Arsenic, 1,2-dichloroethene, tetrachloroethene, trichloroethene, and vanadium were identified as groundwater COCs for this scenario based on their contribution to cumulative hazard index. Arsenic, 1,1-dichloroethene, pentachlorophenol, tetrachloroethene, trichloroethene, and vinyl chloride were identified as COCs based on their contribution to cumulative ILCR.

10.4.8.6 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 and SCDHEC 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. Current site workers are not exposed to site groundwater, nor is site groundwater used as a source of water for any purpose at this time. Without a completed exposure pathway, no risk or hazard is posed by the reported groundwater conditions.

Residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current base reuse plans call for the redevelopment of Zone F to either a commercial/industrial area or a recreational area. If the AOC 607 area were to be used as a residential site, the buildings would be demolished, asphalt surface removed, and the surface soil conditions would likely change dramatically. Consequently, exposure to current surface soil conditions 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. Residential site use is considered protective of both the recreational and trespasser scenarios.

Groundwater is not currently used at AOC 607 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone F. This system is planned to remain in operation under the current base reuse plan. As a result, groundwater would not be expected to be used as resource under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

A 95% UCL or maximum concentrations were applied as EPCs used to estimate risk and hazard for each soil COPC. As a result, it is unlikely that the EPC is exceeded by the true mean soil concentration for any soil COPC.

EPCs for the groundwater pathways were set equal to the arithmetic mean in the most concentrated area of the plume or the 95% UCL, both of which were calculated on first quarter sampling data with substitution of one-half of the SQL for nondetects. Since no distinct plume could be identified for any of the inorganic COPCs all of which were ubiquitous in the AOC 607 surficial aquifer, 95% UCLs were calculated to serve as EPCs. In some cases, data variability caused the 95% UCL to exceed the maximum detected concentration. In such cases, the maximum detected concentrations served as the EPC. Use of 95% UCLs and maximum concentrations as EPCs would tend to result in overestimation of risk and hazard associated with groundwater pathways. A plume of chlorinated solvents was identified just to the southwest of Building 1189. The most concentrated area of this plume was represented by monitoring wells 607006 and 60706I which reported significantly higher concentrations of 1,1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride than groundwater samples collected from other monitoring wells. In accordance with USEPA Region IV guidance, the EPCs for these chlorinated VOCs were calculated as the arithmetic mean of the data from these two monitoring wells. It is USEPA's contention that since most groundwater monitoring arrays are designed to identify fringes or uncontaminated areas of a plume, use of all of the groundwater data generated from such arrays would tend to underestimate the concentration in the plume. Chloromethane and pentachlorophenol were only detected in one first quarter groundwater sample in areas not related to the chlorinated VOC plume, and as a result, the sample detected concentrations served as their EPCs.

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.

Soil

A conservative screening process was used to identify COPCs for AOC 607. 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 the RBC (e.g. within 10% of their RBCs). Arsenic, beryllium, and manganese were detected at maximum concentrations exceeding their corresponding RBCs and were eliminated based on comparison to their corresponding background concentrations. Wilcoxon rank sum test analysis confirms that site concentrations of these inorganics were within background concentrations.

Although the future land use of AOC 607 is unknown, both the worker and residential exposure scenarios were assessed in this HHRA. Current base reuse plans call for development of Zone F into a commercial/industrial or recreational area. As previously discussed, it is likely that these scenarios would lead to overestimates of risk and/or hazard under any future use scenario.

Groundwater

None of the CPSSs screened and eliminated from formal assessment was reported at a concentration within approximately 10% of its RBC. Beryllium and manganese were eliminated from formal assessment based strictly upon comparison to background reference concentrations. Wilcoxon rank sum test analysis would not have yielded useful information due to the fact that their were too few background data points for groundwater.

Groundwater is not currently used as a potable water source at AOC 607, 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.

10.4.8.7 Risk Summary

The risk and hazard posed by contaminants at AOC 607 were assessed for the hypothetical site worker and the hypothetical future site resident under reasonable maximum exposure assumptions.

For surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Additionally, indirect inhalation exposure to VOCs emanating from soils was addressed. The ingestion and inhalation pathways were evaluated for shallow groundwater.

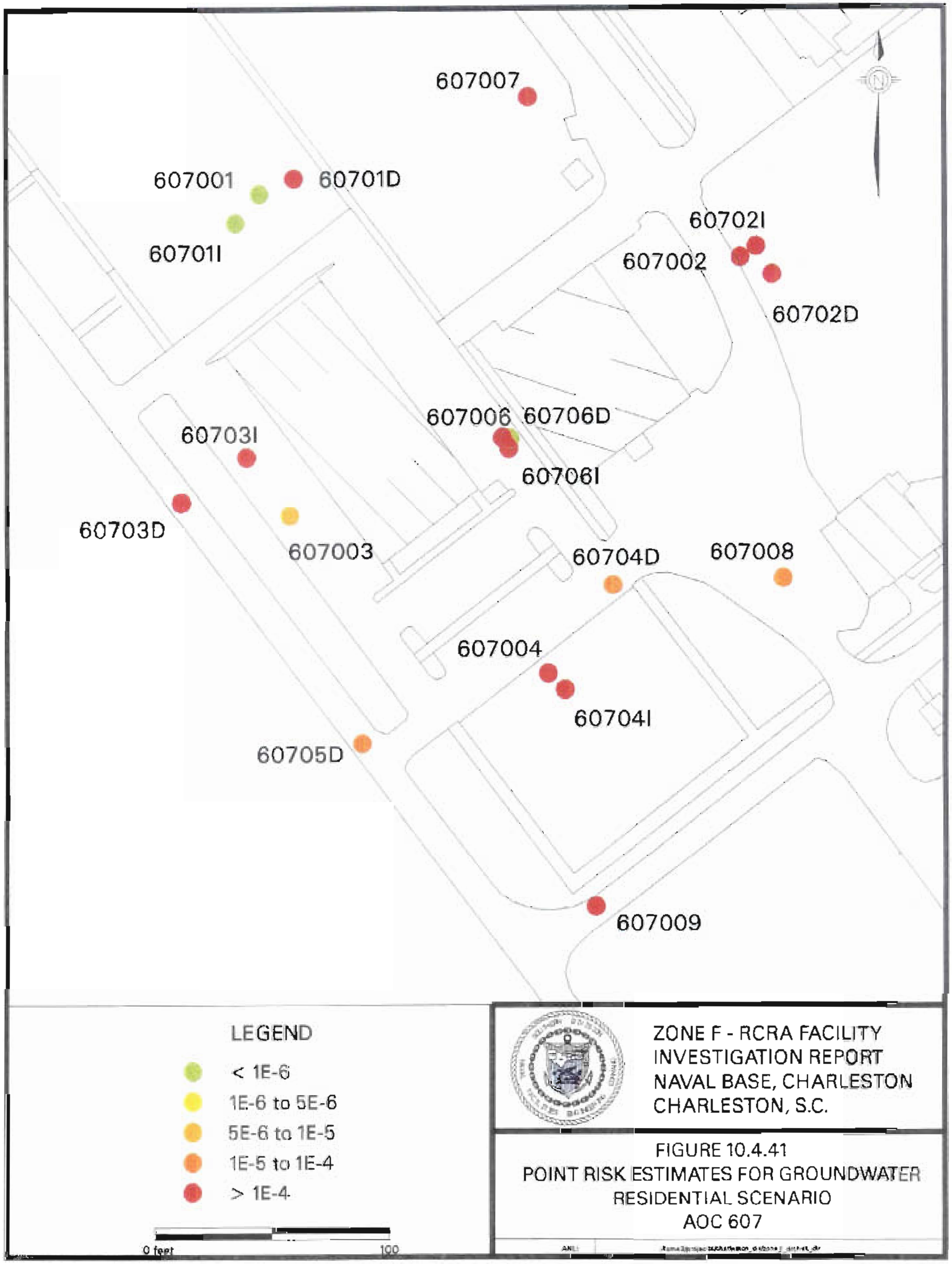
To add perspective to the AOC 607 HHRA point risk and hazard maps are presented below. Point risk maps are based on the unlikely assumption that potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions over the entire site rather than specific points. Risk maps are still useful because they allow the reader to visualize the contribution of risk or hazard index due to individual COCs.

Soil

Since no COCs were identified for AOC 607 soil pathways, risk maps are not warranted.

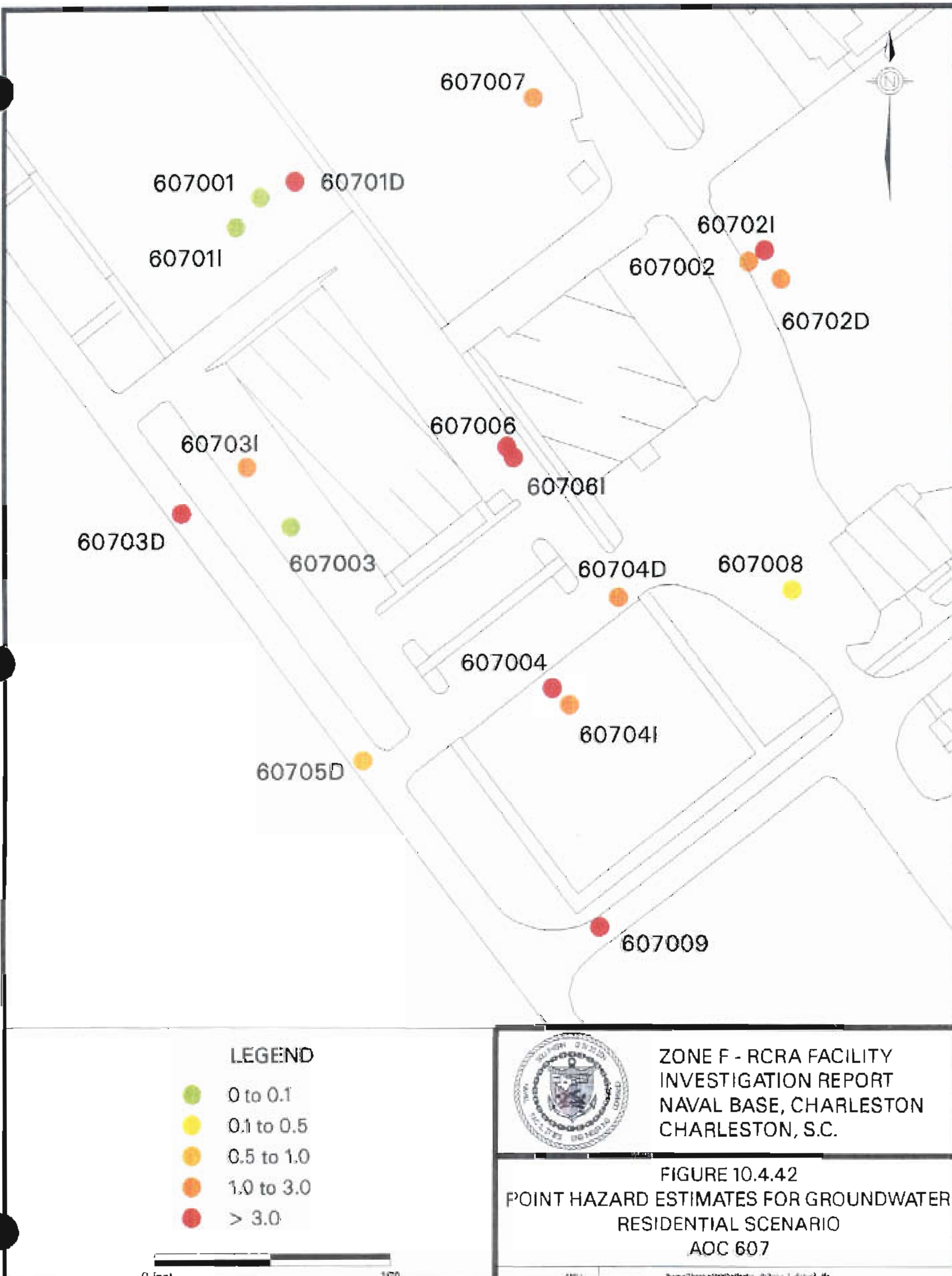
Groundwater

Figures 10.4-41 and 10.4-42 illustrate point risk and hazard for AOC 607 first quarter groundwater under a residential scenario. Table 10.4.36 details the individual contributors to risk and hazard at each monitoring well location. Concentrations arsenic in groundwater contributed to the most widespread occurrence of risk estimate in excess of 1E-06, accounting for nearly 100% of the risk projections in the samples collected from monitoring wells 60701D, 607002, 60702I, 60702D, 60703I, 60703D, 607004, 60704I, 60704D, 60705D, 607007, and 607009. Risk estimates related to arsenic concentrations ranged from 7E-05 (first quarter sample collected from 607006) to 2E-03 (first quarter sample collected from 607004). Concentrations of chlorinated VOCs in groundwater contribute nearly 100% of the risk projections associated with samples collected from monitoring wells 607006, 60706I, and 607008. Risk estimates related to chlorinated VOC concentrations ranged from 4E-02 (first quarter sample collected from 607006) to 3E-03 (first quarter sample



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

FIGURE 10.4.41
POINT RISK ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 607



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

FIGURE 10.4.42
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 607

Table 10.4.36
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Site	Location	Quarter	Parameter	Units	Concentration	Hazard Index	% HI	Risk (E-06)	% Risk
607	001	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	001	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	001	01	Aluminum (Al)	UG/L	149	0.0095	100.00	NA	
607	001	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	001	01	Arsenic (As)	UG/L	ND	NA		NA	
607	001	01	Chloromethane	UG/L	ND	NA		NA	
607	001	01	Chromium (Cr)	UG/L	ND	NA		NA	
607	001	01	Lead (Pb)	UG/L	ND	NA		NA	
607	001	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	001	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	001	01	Trichloroethene	UG/L	ND	NA		NA	
607	001	01	Vanadium (V)	UG/L	ND	NA		NA	
607	001	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			0.0095		NA	
607	01I	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	01I	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	01I	01	Aluminum (Al)	UG/L	ND	NA		NA	
607	01I	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	01I	01	Arsenic (As)	UG/L	ND	NA		NA	
607	01I	01	Chloromethane	UG/L	ND	NA		NA	
607	01I	01	Chromium (Cr)	UG/L	ND	NA		NA	
607	01I	01	Lead (Pb)	UG/L	ND	NA		NA	
607	01I	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	01I	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	01I	01	Trichloroethene	UG/L	ND	NA		NA	
607	01I	01	Vanadium (V)	UG/L	ND	NA		NA	
607	01I	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			NA		NA	
607	01D	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	01D	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	01D	01	Aluminum (Al)	UG/L	4540	0.2838	8.36	NA	
607	01D	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	01D	01	Arsenic (As)	UG/L	11.3	2.4043	70.81	251.1111	98.67
607	01D	01	Chloromethane	UG/L	10	NA		2.8705	1.13
607	01D	01	Chromium (Cr)	UG/L	33.7	0.4321	12.72	NA	
607	01D	01	Lead (Pb)	UG/L	70.8	NA		NA	
607	01D	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	01D	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	01D	01	Trichloroethene	UG/L	2	0.0426	1.25	0.5128	0.20
607	01D	01	Vanadium (V)	UG/L	25.6	0.2327	6.85	NA	
607	01D	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			3.3953		254.4944	
607	002	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	002	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	002	01	Aluminum (Al)	UG/L	132	0.0084	0.40	NA	
607	002	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	002	01	Arsenic (As)	UG/L	9.8	2.0883	98.51	218.6301	100.00
607	002	01	Chloromethane	UG/L	ND	NA		NA	

Table 10.4.36
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Site	Location	Quarter	Parameter	Units	Concentration	Hazard Index	% HI	Risk (E-06)	% Risk
607	002	01	Chromium (Cr)	UG/L	1.81	0.0231	1.09	NA	
607	002	01	Lead (Pb)	UG/L	ND	NA		NA	
607	002	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	002	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	002	01	Trichloroethene	UG/L	ND	NA		NA	
607	002	01	Vanadium (V)	UG/L	ND	NA		NA	
607	002	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			2.1199		218.6301	
607	02I	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	02I	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	02I	01	Aluminum (Al)	UG/L	ND	NA		NA	
607	02I	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	02I	01	Arsenic (As)	UG/L	43.3	9.2268	100.00	965.9883	100.00
607	02I	01	Chloromethane	UG/L	ND	NA		NA	
607	02I	01	Chromium (Cr)	UG/L	ND	NA		NA	
607	02I	01	Lead (Pb)	UG/L	ND	NA		NA	
607	02I	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	02I	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	02I	01	Trichloroethene	UG/L	ND	NA		NA	
607	02I	01	Vanadium (V)	UG/L	ND	NA		NA	
607	02I	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			9.2268		965.9883	
607	02D	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	02D	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	02D	01	Aluminum (Al)	UG/L	1470	0.0940	4.87	NA	
607	02D	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	02D	01	Arsenic (As)	UG/L	8.2	1.7473	90.52	182.9354	100.00
607	02D	01	Chloromethane	UG/L	ND	NA		NA	
607	02D	01	Chromium (Cr)	UG/L	4	0.0511	2.65	NA	
607	02D	01	Lead (Pb)	UG/L	99.7	NA		NA	
607	02D	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	02D	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	02D	01	Trichloroethene	UG/L	ND	NA		NA	
607	02D	01	Vanadium (V)	UG/L	4.15	0.0379	1.96	NA	
607	02D	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			1.9303		182.9354	
607	003	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	003	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	003	01	Aluminum (Al)	UG/L	306	0.0196	75.37	NA	
607	003	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	003	01	Arsenic (As)	UG/L	ND	NA		NA	
607	003	01	Chloromethane	UG/L	ND	NA		NA	
607	003	01	Chromium (Cr)	UG/L	ND	NA		NA	
607	003	01	Lead (Pb)	UG/L	ND	NA		NA	
607	003	01	Pentachlorophenol	UG/L	3	0.0064	24.63	5.3542	100.00
607	003	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	003	01	Trichloroethene	UG/L	ND	NA		NA	
607	003	01	Vanadium (V)	UG/L	ND	NA		NA	

Table 10.4.36
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Site	Location	Quarter	Parameter	Units	Concentration	Hazard Index	% HI	Risk (E-06)	% Risk
607	003	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			0.0260		5.3542	
607	03I	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	03I	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	03I	01	Aluminum (Al)	UG/L	2810	0.1796	10.87	NA	
607	03I	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	03I	01	Arsenic (As)	UG/L	6	1.2785	77.35	133.8552	100.00
607	03I	01	Chloromethane	UG/L	ND	NA		NA	
607	03I	01	Chromium (Cr)	UG/L	9.3	0.1189	7.19	NA	
607	03I	01	Lead (Pb)	UG/L	2.1	NA		NA	
607	03I	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	03I	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	03I	01	Trichloroethene	UG/L	ND	NA		NA	
607	03I	01	Vanadium (V)	UG/L	8.3	0.0758	4.59	NA	
607	03I	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			1.6529		133.8552	
607	03D	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	03D	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	03D	01	Aluminum (Al)	UG/L	2550	0.1630	3.44	NA	
607	03D	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	03D	01	Arsenic (As)	UG/L	20.3	4.3257	91.35	452.8767	100.00
607	03D	01	Chloromethane	UG/L	ND	NA		NA	
607	03D	01	Chromium (Cr)	UG/L	10.5	0.1342	2.84	NA	
607	03D	01	Lead (Pb)	UG/L	18.7	NA		NA	
607	03D	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	03D	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	03D	01	Trichloroethene	UG/L	ND	NA		NA	
607	03D	01	Vanadium (V)	UG/L	12.3	0.1123	2.37	NA	
607	03D	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			4.7353		452.8767	
607	004	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	004	01	1,2-Dichloroethene (total)	UG/L	120	1.7047	9.07	NA	
607	004	01	Aluminum (Al)	UG/L	4680	0.2992	1.59	NA	
607	004	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	004	01	Arsenic (As)	UG/L	75.2	16.0244	85.30	1677.6517	99.61
607	004	01	Chloromethane	UG/L	ND	NA		NA	
607	004	01	Chromium (Cr)	UG/L	7.4	0.0946	0.50	NA	
607	004	01	Lead (Pb)	UG/L	5.5	NA		NA	
607	004	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	004	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	004	01	Trichloroethene	UG/L	26	0.5540	2.95	6.5738	0.39
607	004	01	Vanadium (V)	UG/L	12	0.1096	0.58	NA	
607	004	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			18.7865		1684.2254	
607	04I	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	04I	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	04I	01	Aluminum (Al)	UG/L	371	0.0237	2.07	NA	

Table 10.4.36
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Site	Location	Quarter	Parameter	Units	Concentration	Hazard Index	% HI	Risk (E-06)	% Risk
607	04I	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	04I	01	Arsenic (As)	UG/L	5.2	1.1081	96.70	116.0078	100.00
607	04I	01	Chloromethane	UG/L	ND	NA		NA	
607	04I	01	Chromium (Cr)	UG/L	1.1	0.0141	1.23	NA	
607	04I	01	Lead (Pb)	UG/L	ND	NA		NA	
607	04I	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	04I	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	04I	01	Trichloroethene	UG/L	ND	NA		NA	
607	04I	01	Vanadium (V)	UG/L	ND	NA		NA	
607	04I	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			1.1458		116.0078	
607	04D	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	04D	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	04D	01	Aluminum (Al)	UG/L	232	0.0148	1.48	NA	
607	04D	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	04D	01	Arsenic (As)	UG/L	4.3	0.9163	91.56	95.9296	100.00
607	04D	01	Chloromethane	UG/L	ND	NA		NA	
607	04D	01	Chromium (Cr)	UG/L	1.8	0.0230	2.30	NA	
607	04D	01	Lead (Pb)	UG/L	ND	NA		NA	
607	04D	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	04D	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	04D	01	Trichloroethene	UG/L	ND	NA		NA	
607	04D	01	Vanadium (V)	UG/L	5.1	0.0466		NA	
607	04D	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			1.0007		95.9296	
607	05D	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	05D	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	05D	01	Aluminum (Al)	UG/L	204	0.0130	1.57	NA	
607	05D	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	05D	01	Arsenic (As)	UG/L	3.5	0.7458	89.95	78.0822	97.01
607	05D	01	Chloromethane	UG/L	ND	NA		NA	
607	05D	01	Chromium (Cr)	UG/L	ND	NA		NA	
607	05D	01	Lead (Pb)	UG/L	61.9	NA		NA	
607	05D	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	05D	01	Tetrachloroethene	UG/L	3	0.0384	4.63	2.4107	2.99
607	05D	01	Trichloroethene	UG/L	ND	NA		NA	
607	05D	01	Vanadium (V)	UG/L	3.5	0.0320	3.85	NA	
607	05D	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			0.8292		80.4929	
607	006	01	1,1-Dichloroethene	UG/L	2	0.0284	0.0046	23.0528	0.063
607	006	01	1,2-Dichloroethene (total)	UG/L	840	11.9330	1.94	NA	
607	006	01	Aluminum (Al)	UG/L	1270	0.0812	0.013	NA	
607	006	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	006	01	Arsenic (As)	UG/L	3	0.6393	0.10	66.9276	0.18
607	006	01	Chloromethane	UG/L	ND	NA		NA	
607	006	01	Chromium (Cr)	UG/L	1.4	0.0179	0.0029	NA	
607	006	01	Lead (Pb)	UG/L	ND	NA		NA	
607	006	01	Pentachlorophenol	UG/L	ND	NA		NA	

Table 10.4.36
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Site	Location	Quarter	Parameter	Units	Concentration	Hazard Index	% HI	Risk (E-06)	% Risk
607	006	01	Tetrachloroethene	UG/L	45000	575.3425	93.44	36160.9786	98.07
607	006	01	Trichloroethene	UG/L	1300	27.7017	4.50	328.6888	0.89
607	006	01	Vanadium (V)	UG/L	ND	NA		NA	
607	006	01	Vinyl chloride	UG/L	9	NA		294.4814	0.80
			Total			615.7439		36874.1293	
607	06I	01	1,1-Dichloroethene	UG/L	2	0.0284	0.05	23.0528	0.69
607	06I	01	1,2-Dichloroethene (total)	UG/L	24	0.3409	0.61	NA	
607	06I	01	Chloromethane	UG/L	ND	NA		NA	
607	06I	01	Tetrachloroethene	UG/L	4100	52.4201	93.63	3294.6669	98.18
607	06I	01	Trichloroethene	UG/L	150	3.1963	5.71	37.9256	1.13
607	06I	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			55.9858		3355.6454	
607	06D	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	06D	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	06D	01	Chloromethane	UG/L	ND	NA		NA	
607	06D	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	06D	01	Trichloroethene	UG/L	ND	NA		NA	
607	06D	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			NA		NA	
607	007	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	007	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	007	01	Aluminum (Al)	UG/L	66.9	0.0043	0.43	NA	
607	007	01	Antimony (Sb)	UG/L	ND	NA		NA	
607	007	01	Arsenic (As)	UG/L	4.7	1.0015	99.57	104.8532	100.00
607	007	01	Chloromethane	UG/L	ND	NA		NA	
607	007	01	Chromium (Cr)	UG/L	ND	NA		NA	
607	007	01	Lead (Pb)	UG/L	ND	NA		NA	
607	007	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	007	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	007	01	Trichloroethene	UG/L	ND	NA		NA	
607	007	01	Vanadium (V)	UG/L	ND	NA		NA	
607	007	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			1.0058		104.8532	
607	008	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	008	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	008	01	Chloromethane	UG/L	ND	NA		NA	
607	008	01	Tetrachloroethene	UG/L	14	0.1790	100.00	11.2501	100.00
607	008	01	Trichloroethene	UG/L	ND	NA		NA	
607	008	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			0.1790		11.2501	
607	009	01	1,1-Dichloroethene	UG/L	ND	NA		NA	
607	009	01	1,2-Dichloroethene (total)	UG/L	ND	NA		NA	
607	009	01	Aluminum (Al)	UG/L	7810	0.4993	6.09	NA	
607	009	01	Antimony (Sb)	UG/L	2.6	0.4155	5.06	NA	
607	009	01	Arsenic (As)	UG/L	28.2	6.0091	73.24	629.1194	100.00
607	009	01	Chloromethane	UG/L	ND	NA		NA	

Table 10.4.36
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 607
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Site	Location	Quarter	Parameter	Units	Concentration	Hazard Index	% HI	Risk (E-06)	% Risk
607	009	01	Chromium (Cr)	UG/L	35.6	0.4552	5.55	NA	
607	009	01	Lead (Pb)	UG/L	17.4	NA		NA	
607	009	01	Pentachlorophenol	UG/L	ND	NA		NA	
607	009	01	Tetrachloroethene	UG/L	ND	NA		NA	
607	009	01	Trichloroethene	UG/L	ND	NA		NA	
607	009	01	Vanadium (V)	UG/L	90.4	0.8256	10.06	NA	
607	009	01	Vinyl chloride	UG/L	ND	NA		NA	
			Total			8.2047		629.1194	

collected from 60706I). Pentachlorophenol was the sole contributor to the risk projection of 5E-06, associated with the first quarter sample collected from monitoring well 607003.

As with risk, concentrations of arsenic accounted for the most widespread occurrence of hazard index estimates above unity. Aluminum, antimony, chromium (assumed to be hexavalent), and vanadium were minor contributors to hazard index projections for AOC 607 groundwater. Groundwater samples collected from monitoring wells 607004, 607006, and 60706I reported concentrations of chlorinated VOCs which were associated with hazard indices above unity.

10.4.8.8 Remedial Goal Options

Soil

No soil COCs were identified for AOC 607, and as a result, no RGOs were calculated.

Groundwater

Shallow groundwater RGOs based on site residents and site workers are shown in Table 10.4.37. For carcinogens, RGOs were based on the lifetime weighted average site resident and adult site worker, respectively. Hazard-based RGOs were calculated based on either the hypothetical child resident or the adult site worker.

10.4.9 Corrective Measures Considerations

For AOC 607, the upper and lower soil intervals and shallow, intermediate, and deep groundwater were investigated. A total of 10 soil samples were collected from the upper and 9 soil samples were collected from the lower intervals, with nine of the ten samples collected beneath an asphalt or concrete pavement, or inside a building. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process was identified for the shallow, intermediate, and deep groundwater. However, residential use of the site is not

Table 10.4.37
Remedial Goal Options Groundwater
AOC 607
NAVBASE - Charleston, Zone F
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
Aluminum (Al)	NA	1	7.81	1.6	16	47	ND	ND	ND	0.224	NA
Antimony (Sb)	NA	0.0004	0.0022	0.00063	0.0063	0.019	ND	ND	ND	NA	0.006
Arsenic (As)	1.5	0.0003	0.04	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.0167	0.05
Chloromethane	0.013	NA	0.01	ND	ND	ND	0.0034	0.034	0.34	NA	NA
Chromium (Cr)	NA	0.005	0.0356	0.0078	0.078	0.23	ND	ND	ND	0.00205	0.1
1,1-Dichloroethene	0.6	0.009	0.002	0.000065	0.00065	0.0019	0.00011	0.0011	0.011	NA	0.007
1,2-Dichloroethene (total)	NA	0.009	0.432	0.00027	0.0027	0.0081	0.00058	0.0058	0.058	NA	NA
Lead (Pb)	NA	NA	0.0997	ND	ND	ND	ND	ND	ND	NA	15
Pentachlorophenol	0.12	0.03	0.003	0.047	0.47	1.4	0.00055	0.0055	0.055	NA	0.001
Tetrachloroethene	0.052	0.01	24.55	0.016	0.16	0.47	0.0013	0.013	0.13	NA	0.005
Trichloroethene	0.011	0.006	0.725	0.00041	0.0041	0.012	0.00074	0.0074	0.074	NA	0.005
Vanadium (V)	NA	0.007	0.087	0.011	0.11	0.33	ND	ND	ND	0.00158	10
Vinyl chloride	1.9	NA	0.007	ND	ND	ND	0.000030	0.00030	0.0030	NA	NA

Worker-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
Aluminum (Al)	NA	1	7.81	10.2	102	307	ND	ND	ND	0.224	NA
Antimony (Sb)	NA	0.0004	0.0022	0.0041	0.041	0.12	ND	ND	ND	NA	0.006
Arsenic (As)	1.5	0.0003	0.04	0.0031	0.031	0.092	0.00019	0.0019	0.019	0.0167	0.05
Chloromethane	0.013	NA	0.01	ND	ND	ND	0.015	0.15	1.5	NA	NA
Chromium (Cr)	NA	0.005	0.0356	0.051	0.51	1.5	ND	ND	ND	0.00205	0.1
1,1-Dichloroethene	0.6	0.009	0.002	0.046	0.46	1.4	0.00037	0.0037	0.037	NA	0.007
1,2-Dichloroethene (total)	NA	0.009	0.432	0.046	0.46	1.4	ND	ND	ND	NA	NA
Lead (Pb)	NA	NA	0.0997	ND	ND	ND	ND	ND	ND	NA	15
Pentachlorophenol	0.12	0.03	0.003	0.31	3.1	9.2	0.0024	0.024	0.24	NA	0.001
Tetrachloroethene	0.052	0.01	24.55	0.051	0.51	1.5	0.0053	0.053	0.53	NA	0.005
Trichloroethene	0.011	0.006	0.725	0.031	0.31	0.92	0.017	0.17	1.7	NA	0.005
Vanadium (V)	NA	0.007	0.087	0.072	0.72	2.1	ND	ND	ND	0.00158	10
Vinyl chloride	1.9	NA	0.007	ND	ND	ND	0.00013	0.0013	0.013	NA	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

expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is paved with asphalt.

No compounds were identified as COCs in the upper soil interval.

Numerous COCs were identified in the groundwater for AOC 607. Chloromethane, 1,1-dichloroethene, 1,2-dichloroethene, pentachlorophenol, tetrachloroethene, trichloroethene, vinyl chloride, arsenic, lead, and vanadium were identified in either the shallow, intermediate, or deep groundwater at AOC 607. The groundwater pathway cumulative residential exposure risk is 2E-02 and cumulative HI is 346 (resident child). The residential exposure risk and HI exceed USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI.

Residential RGOs for groundwater set for arsenic, chloromethane, 1,1-dichloroethene, 1,2-dichlorethene (total), pentachlorophenol, tetrachloroethene, trichloroethene, and vinyl chloride were 0.000044, 0.0034, 0.00011, 0.00058, 0.00055, 0.0013, 0.00074, and 0.000030 mg/L, respectively, based on a target risk of 1E-06. Hazard-based RGOs for groundwater for lead and vanadium were 0.015, and 0.11 mg/L, respectively, based on a target HI of 1. Potential corrective measures, in addition to no further action for shallow, intermediate and deep groundwater, and respective COCs, are presented in Table 10.4.38. Corrective measures are described in Section 9.

Table 10.4.38
Potential Corrective Measures for AOC 607

Medium	Compounds	Potential Corrective Measures
Shallow Groundwater	Arsenic, 1,1-dichloroethene, 1,2-dichloroethene (total), lead, pentachlorophenol, tetrachloroethene, trichloroethene, vanadium, vinyl chloride	a) No Action b) Intrinsic remediation and monitoring c) In-situ, chemical, biological, and physical treatment d) Ex-situ, chemical and physical treatment
Intermediate Groundwater	Arsenic, 1,1-dichloroethene, tetrachloroethene, trichloroethene	a) No Action b) Intrinsic remediation and monitoring c) In-situ, chemical, biological, and physical treatment d) Ex-situ, chemical and physical treatment
Deep Groundwater	Arsenic, chloromethane, lead, tetrachloroethene	a) No Action b) Intrinsic remediation and monitoring c) In-situ, chemical, biological, and physical treatment d) Ex-situ, chemical and physical treatment