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DRAFT ZONE E RESOURCE CONSERVATION AND RECOVERY FACILITY INVESTIGATION REPORT VOLUME IV OF XV SECTIONS 10.1- TO 10.25 CNC CHARLESTON SC
11/1/1997
ENSAFE

DRAFT ZONE E
RCRA FACILITY INVESTIGATION REPORT
NAVBASE CHARLESTON

VOLUME IV OF XV
SECTIONS 10.10 to 10.25

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Prepared for:

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Southern Division
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10.13 SWMU 100, Satellite Accumulation Area, Building 218

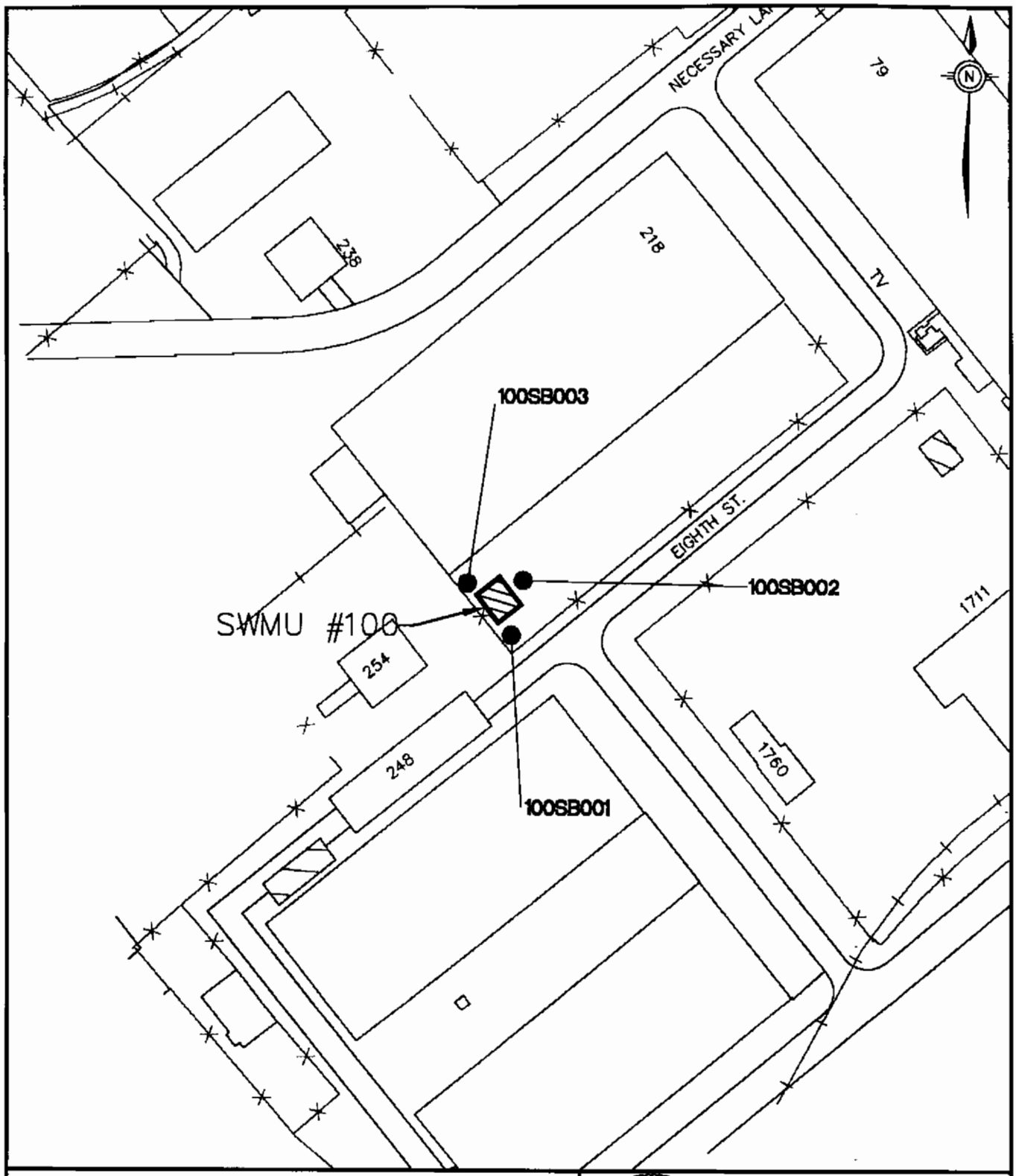
SWMU 100, SAA 63, is a less-than-90 day accumulation area located adjacent to Building 218. The operation dates of the SAA are not known. The unit consists of closed 55-gallon drums accumulated on an asphalt-paved area. This unit has no containment structures.

Materials of concern at SWMU 100 include metals, paints, epoxies, solvents, used blasting grit, and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure. The subsurface utility distribution system (including storm and sanitary sewers) in this area has acted as a conduit for moving any product or waste released within Zone E, and thus could expose personnel working on any of these subsurface systems, as well as providing a contaminant route to the Cooper River, which borders Zone E along its northeastern side.

To fulfill the RFI objectives for SWMU 100, soil and groundwater samples were collected in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether contamination resulted from onsite activities.

10.13.1 Soil Sampling and Analysis

Soil was sampled in one round at SWMU 100 from the locations shown in Figure 10.13.1. The *Final Zone E RFI Work Plan* proposed collecting two soil samples from the upper interval and two from the lower interval. Soil samples were also collected at both intervals for the shallow monitoring well location proposed at this site. All proposed samples were collected and submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. No duplicate samples were collected at SWMU 100. Table 10.13.1.1 summarizes soil sampling at SWMU 100.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.13.1
SOIL BORING LOCATIONS
SWMU#100
BUILDING 218
SAA

DWG DATE: 09/02/97 | DWG NAME: 10-13-1

Table 10.13.1.1
SWMU 100
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	3	3	Standard Suite[a], organotins	Standard Suite[a], organotins	None
Lower	3	3	Standard Suite[a], organotins	Standard Suite[a], organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCB

10.13.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.13.2.1. Inorganic analytical results for soil are summarized in Table 10.13.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.13.2.1
SWMU 100
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Acetone	Upper	1/3	16	16	20,000,000	0
	Lower	3/3	24.0 - 130	63.7	NA	NA
2-Butanone (MEK)	Lower	3/3	6.00 - 20.0	10.7	NA	NA
1,1-Dichloroethane	Lower	1/3	2	2	NA	NA

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.13.2.2
SWMU 100
Inorganic Detections for Soil (mg/kg)

Element	Sampling Interval	Freq. of] Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	3/3	4,580 - 6,780	5,310	100,000	26,600	0
	Lower	3/3	16,800 - 24,800	20,200	NA	41,100	NA
Antimony (Sb)	Lower	3/3	0.760 - 1.000	0.863	NA	1.60	NA
Arsenic (As)	Upper	3/3	1.50 - 2.30	1.80	3.80	23.9	0
	Lower	3/3	10.8 - 23.6	17.6	NA	19.9	NA
Barium (Ba)	Upper	3/3	7.10 - 21.0	12.5	14,000	130	0
	Lower	3/3	24.7 - 50.7	38.6	NA	94.1	NA
Beryllium (Be)	Upper	1/3	0.300	0.300	1.30	1.70	0
	Lower	3/3	0.900 - 1.60	1.23	NA	2.71	NA
Cadmium (Cd)	Lower	1/3	0.410	0.410	NA	0.960	NA
Calcium (Ca)	Upper	3/3	1,180 - 27,400	10,200	NA	NA	NA
	Lower	3/3	10,300 - 108,000	49,600	NA	NA	NA
Chromium (Cr)	Upper	3/3	4.70 - 13.4	7.63	1,000	94.6	0
	Lower	3/3	38.6 - 53.8	46.9	NA	75.2	NA
Cobalt (Co)	Upper	3/3	0.240 - 3.10	1.98	12,000	19.0	0
	Lower	3/3	3.20 - 8.30	6.30	NA	14.9	NA
Copper (Cu)	Upper	3/3	0.770 - 5.30	2.69	8,200	66.0	0
	Lower	3/3	22.6 - 47.1	34.7	NA	152	NA
Cyanide (CN)	Upper	1/3	0.560	0.560	4,100	0.500	0
	Lower	1/3	2.90	2.90	NA	NA	NA
Iron (Fe)	Upper	3/3	3,570 - 4,900	4,130	61,000	NA	0
	Lower	3/3	13,500 - 39,000	27,800	NA	NA	NA
Lead (Pb)	Upper	3/3	3.50 - 16.7	8.20	1,300	265	0
	Lower	3/3	33.2 - 64.0	47.3	NA	173	NA
Magnesium (Mg)	Upper	3/3	124 - 759	343	NA	NA	NA
	Lower	3/3	3,980 - 8,070	5,360	NA	NA	NA

Table 10.13.2.2
SWMU 100
Inorganic Detections for Soil (mg/kg)

Element	Sampling Interval	Freq. of] Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Manganese (Mn)	Upper	3/3	6.80 - 44.7	20.2	4,700	302	0
	Lower	3/3	218 - 348	279	NA	881	NA
Mercury (Hg)	Upper	1/3	0.0600	0.0600	61.0	2.60	0
	Lower	3/3	0.0700 - 0.470	0.273	NA	1.59	NA
Nickel (Ni)	Upper	3/3	1.40 - 5.50	3.17	4,100	77.1	0
	Lower	3/3	15.5 - 19.4	18.0	NA	57.0	NA
Potassium (K)	Upper	1/3	617	617	NA	NA	NA
	Lower	3/3	2,110 - 3,590	2,780	NA	NA	NA
Selenium (Se)	Upper	1/3	0.770	0.770	1,000	1.70	0
	Lower	3/3	1.60 - 2.60	2.20	NA	2.40	NA
Sodium (Na)	Upper	1/3	300	300	NA	NA	NA
	Lower	3/3	374 - 756	617	NA	NA	NA
Vanadium (V)	Upper	3/3	6.40 - 12.6	8.60	1,400	94.3	0
	Lower	3/3	42.7 - 79.8	61.2	NA	155	NA
Zinc (Zn)	Upper	3/3	4.50 - 21.5	11.8	61,000	827	0
	Lower	3/3	81.2 - 191	133	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Three VOCs were detected in soil samples collected at SWMU 100. One detection occurred in the upper interval and seven in the lower interval. No VOC was detected above its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

No SVOCs were detected in soil samples collected at SWMU 100.

Pesticides and PCBs in Soil

No pesticides or PCBs were detected in soil samples collected at SWMU 100.

Other Organic Compounds in Soil

No other organic compounds were detected in soil samples collected at SWMU 100.

Inorganic Elements in Soil

Twenty-two metals were detected in soil samples collected at SWMU 100. Forty-eight detections occurred in the upper interval and 62 in the lower interval. No metals exceeded both their respective industrial RBC and background RC in the upper interval. One metal — arsenic — exceeded both its respective SSL and background RC in the lower interval.

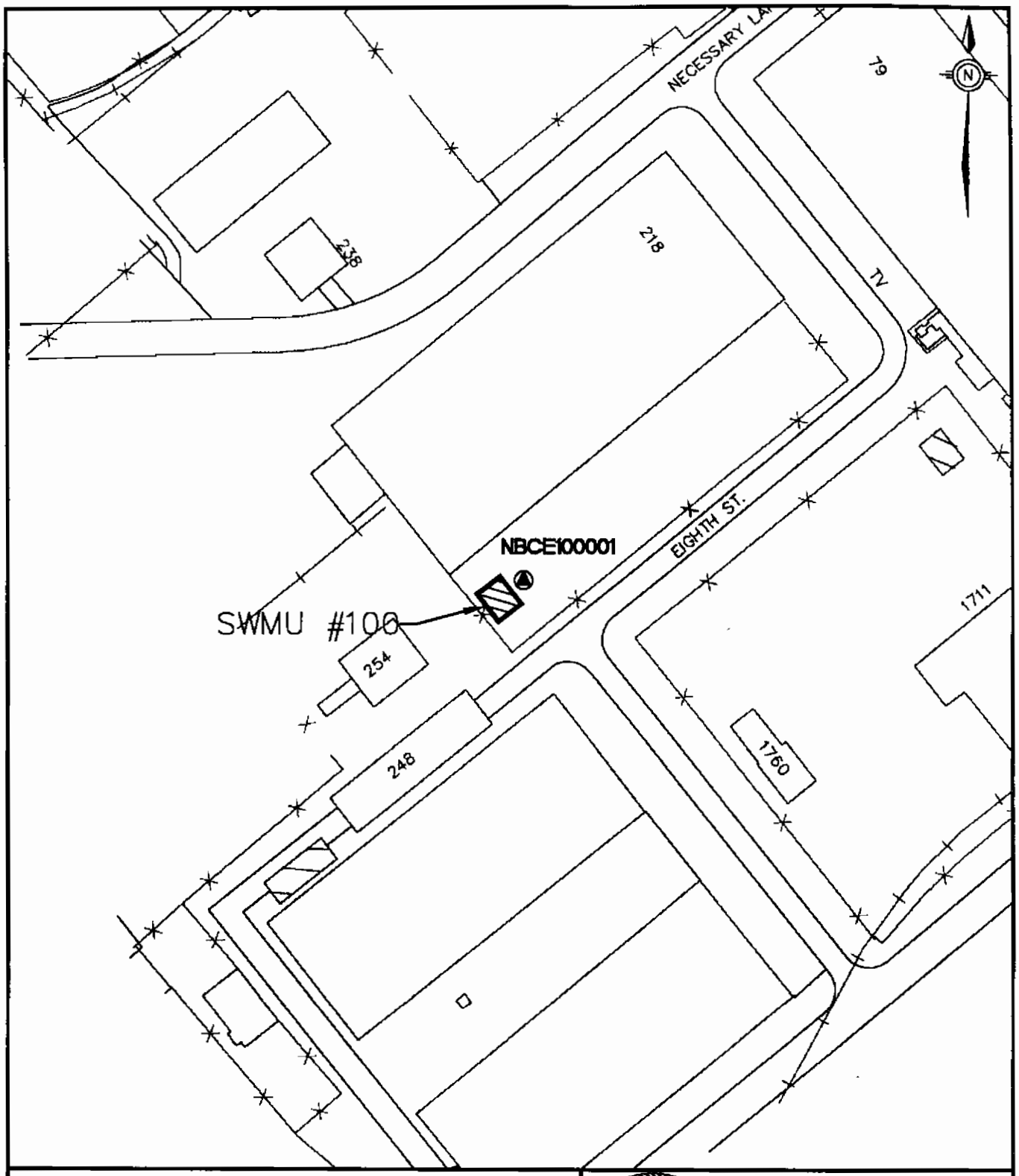
Arsenic was detected in three of three of lower-interval samples with a range of 10.8 to 23.6 mg/kg and a mean of 17.6 mg/kg. One lower-interval sample (100SB001, 23.6 mg/kg) exceeded both the arsenic SSL of 15 mg/kg and the background RC of 19.9 mg/kg.

10.13.3 Groundwater Sampling and Analysis

One shallow monitoring well was installed and sampled to assess groundwater quality at SWMU 100 as shown in Figure 10.13.2. The well was installed as follows:

- Shallow Well installed at SWMU 100 — NBCE100001

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. No samples were



LEGEND

- ● – SOIL BORINGS
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- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.13.2
MONITORING WELL LOCATIONS
SWMU#100
BUILDING 218
SAA

DWG DATE: 09/02/97 | DWG NAME: 10-13-2

selected as duplicates at this site. Table 10.13.3.1 summarizes groundwater sampling and analysis at SWMU 100.

Table 10.13.3.1
SWMU 100
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	1	1	Standard Suite[b], chlorides, TDS, sulfates, and organotins	Standard Suite[b], chlorides, TDS sulfates, and organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

The shallow monitoring well was installed at 12.5 feet bgs in the surficial aquifer in accordance with Section 3.3 of this report.

10.13.4 Nature of Contamination in Groundwater

Inorganic analytical results for groundwater are summarized in Table 10.13.4.1. No organic compounds were detected in shallow groundwater at SWMU 100. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.13.4.1
SWMU 100
Inorganic Detections for First-Quarter Groundwater (µg/L)
Shallow Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Arsenic (As)	1/1	20.6	20.6	0.0450	18.7	50.0	1
Calcium (Ca)	1/1	148,000	148,000	NA	NA	NA	NA
Iron (Fe)	1/1	7590	7,590	1,100	NA	NA	1

Table 10.13.4.1
SWMU 100
Inorganic Detections for First-Quarter Groundwater (μg/L)
Shallow Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Magnesium (Mg)	1/1	65,300	65,300	NA	NA	NA	NA
Manganese (Mn)	1/1	1,110	1,110	84.0	2,560	NA	0
Nickel (Ni)	1/1	1.20	1.20	73.0	15.2	100	0
Potassium (K)	1/1	34,300	34,300	NA	NA	NA	NA
Sodium (Na)	1/1	658,000	658,000	NA	NA	NA	NA
Vanadium (V)	1/1	1.40	1.40	26.0	11.4	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Inorganic Elements in Groundwater

Shallow Groundwater

Nine metals were detected in the shallow groundwater sample collected at SWMU 100. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and shallow groundwater RC.

Arsenic was detected in well NBCE100001 (20.6 μg/L), exceeding both the arsenic tap-water RBC of 0.0450 μg/L and shallow groundwater RC of 18.7 μg/L. The sample did not exceed the arsenic MCL of 50.0 μg/L.

Iron was detected in well NBCE10001 (7,590 μg/L), exceeding the iron tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

10.13.5 Fate and Transport Assessment for SWMU 100

SWMU 100 is a less-than-90 day accumulation area adjacent to Building 218, consisting of closed 55-gallon drums accumulated on asphalt, with no other containment structures. The surrounding area is paved, with engineered drainage. Environmental media sampled as part of the SWMU 100 RFI include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for SWMU 100 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil-to-air.

10.13.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.13.5.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) background RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No organic constituents were detected in SWMU 100 soil (surface or subsurface) above groundwater protection SSLs. Selenium was the only inorganic constituent detected in subsurface soil above its generic SSL. However, it was not detected in first-quarter groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer. Selenium only slightly exceeded its generic SSL of 2.5 mg/kg and background reference value of 2.4 μg/L in one sample with a concentration of 2.6 mg/kg. This concentration is likely indicative of prevailing background conditions. No inorganics were detected in SWMU 100 surface soil above groundwater protection SSLs or background reference values.

10.13.5.2 Groundwater-to-Surface Water Cross Media Transport: Tier One

Table 10.13.5.1 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs 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 RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic constituents were detected in SWMU 100 shallow groundwater. Arsenic was the only inorganic constituent detected in shallow groundwater at a concentration that exceeded its background reference value (18.7 μg/L) for groundwater. However, the detected concentration of 20.6 μ/L is below arsenic's MCL of 50 μ/L. No constituents were detected in groundwater at concentrations exceeding salt water surface water chronic screening levels.

10.13.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.13.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for SWMU 100 is 184,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.13.5.4 Soil-to-Air Cross Media Transport

Table 10.13.5.3 lists the single VOC (acetone) detected in surface soil samples collected at SWMU 100 along with its corresponding soil-to-air volatilization screening level. Little or no surface soil is exposed at SWMU 100. In addition, acetone was reported at a maximum concentration below its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be significant at SWMU 100.

10.13.5.5 Fate and Transport Summary

In the first-tier screen, selenium was detected above its generic SSL in one subsurface soil sample. Arsenic exceeded its background reference value in the single first-quarter sample from the shallow aquifer, but its concentration in this sample was below its respective MCL.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.13.5.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 100
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	16	130	ND	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	ND	20	ND	NA	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
1,1-Dichloroethane	ND	2	ND	NA	11500	810	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	6780	24800	ND	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	ND	1	ND	NA	2.5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	2.3	23.6	20.6	NA	23.9	18.7	36	MG/KG	UG/L	NO	YES	NO
Barium	21	50.7	ND	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.3	1.6	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	ND	0.41	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	13.4	53.8	ND	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	3.1	8.3	ND	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	5.3	47.1	ND	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.56	2.9	ND	NA	20	730	37.3	MG/KG	UG/L	NO	NO	NO
Lead	16.7	64	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	44.7	348	1110	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.06	0.47	ND	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	5.5	19.4	1.2	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.77	2.6	ND	NA	2.5	180	71	MG/KG	UG/L	YES	NO	NO
Vanadium	12.6	79.8	1.4	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	21.5	191	ND	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.13.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMU 100
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Inorganic Compounds																
Arsenic	2.3	23.6	20.6	NA	14.6	0.045	36	0.045	8.28E+03	50	1.66E+02	2.42E+02	MG/KG	UG/L	NO	NO
Selenium	0.77	2.6	ND	NA	2.5	180	71	71	1.31E+07	50	2.61E+05	6.53E+04	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 184,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.13.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMU 100
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	16	62000000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.13.6 Fixed-Point Risk Evaluation for SWMU 100

10.13.6.1 Site Background and Investigative Approach

SWMU 100 is a former satellite accumulation area (Building 218), which was once used to store hazardous waste, and is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of three surface soil samples were considered in the SWMU 100 FRE. One shallow monitoring well was installed as part of the 1995 RFI. Surface soil and groundwater data generated from the first-quarter RFI sampling event are used to represent point risk/hazard for the SWMU 100 FRE. Sections 10.13.1 and 10.13.3 contain summaries of the sampling effort for SWMU 100 soil and groundwater.

10.13.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.13.6.1 provides CPSS summaries for SWMU 100 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Concentrations of arsenic and beryllium were reported at levels exceeding residential RBCs. However, none of the reported concentrations for these chemicals exceeded corresponding background RCs. Cyanide was reported at a concentration exceeding its corresponding background RC, but was eliminated from further consideration in the FRE because it did not exceed its residential surface soil RBC. Therefore, no COPCs were identified in surface soil for the residential scenario at SWMU 100. SWMU 100 surface soil data were not sufficient to perform Wilcoxon rank sum test analyses, and as a result, arsenic and beryllium were eliminated from the soil FRE based on direct comparison of their maximum concentrations to their background RCs.

Industrial Scenario

No chemical concentrations were reported at levels exceeding industrial RBCs. Therefore, no COPCs were identified in surface soil for the industrial scenario at SWMU 100.

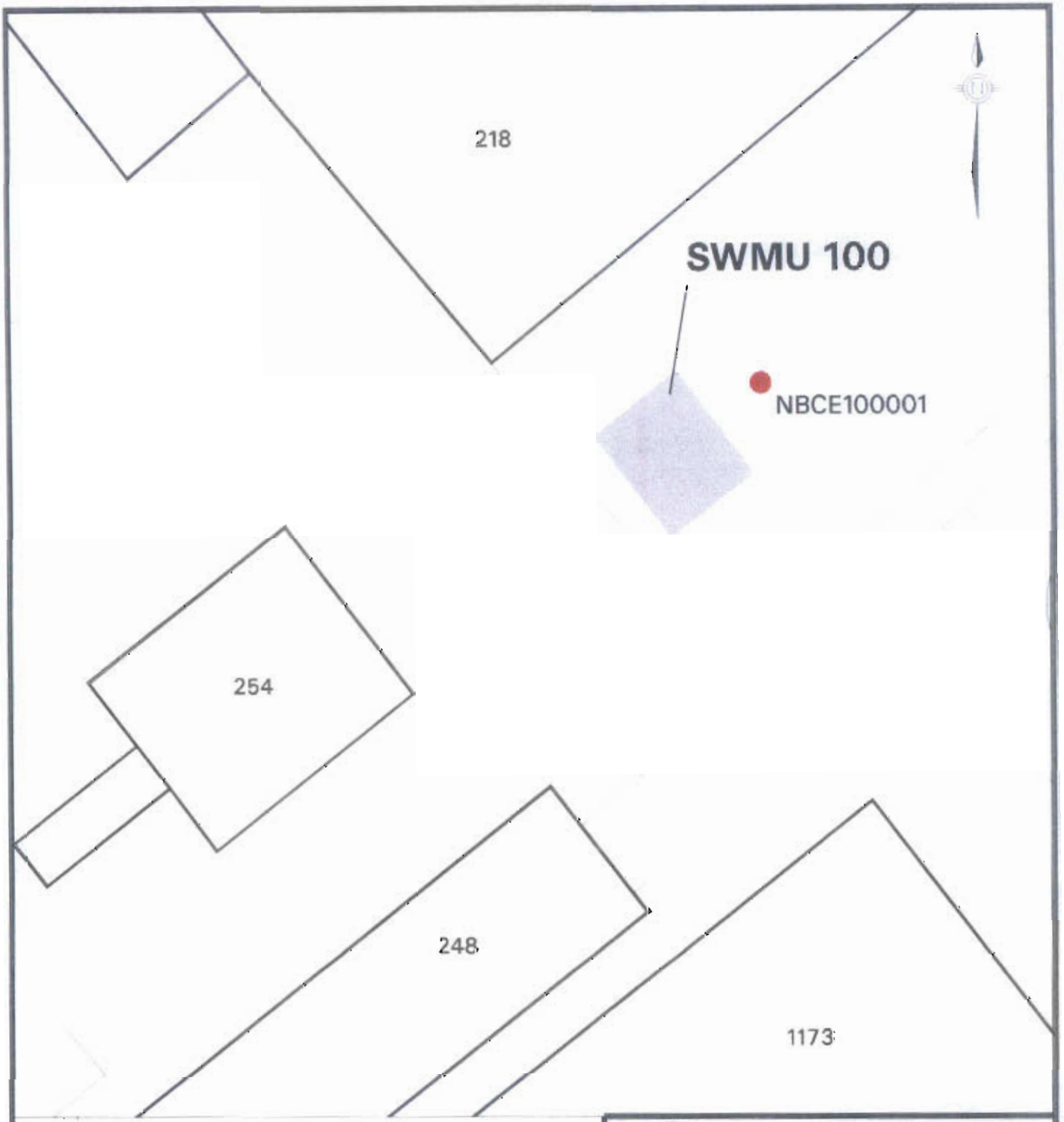
10.13.6.3 Fixed-Point Risk Evaluation for Groundwater

Residential Scenario

Table 10.13.6.2 provides CPSS summaries for SWMU 100 groundwater and identifies COPCs. Arsenic was identified as a groundwater COPC in the shallow aquifer. COPC identification was based on comparison of first-quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. Manganese was detected at a concentration exceeding its RBC, but was eliminated from further consideration because it did not exceed its corresponding background RC.

Table 10.13.6.3 summarizes the COPCs identified in the SWMU 100 monitoring well sampled during the first quarter. Risk projections above 1E-06 were associated with the arsenic concentration in the groundwater sample collected from monitoring well NBCE100001. The risk estimate was approximately 5E-4 for arsenic. Figure 10.13.3 illustrates the groundwater data as a function of point-specific risk projections.

Monitoring well NBCE100001 produced results corresponding with an arsenic HI above unity, as well. Arsenic was the sole contributor to HI projections for the corresponding groundwater sample. The hazard quotient for arsenic was approximately 4, with no other chemicals contributing to the cumulative HI. Figure 10.13.4 illustrates the groundwater data as a function of point-specific hazard projections.



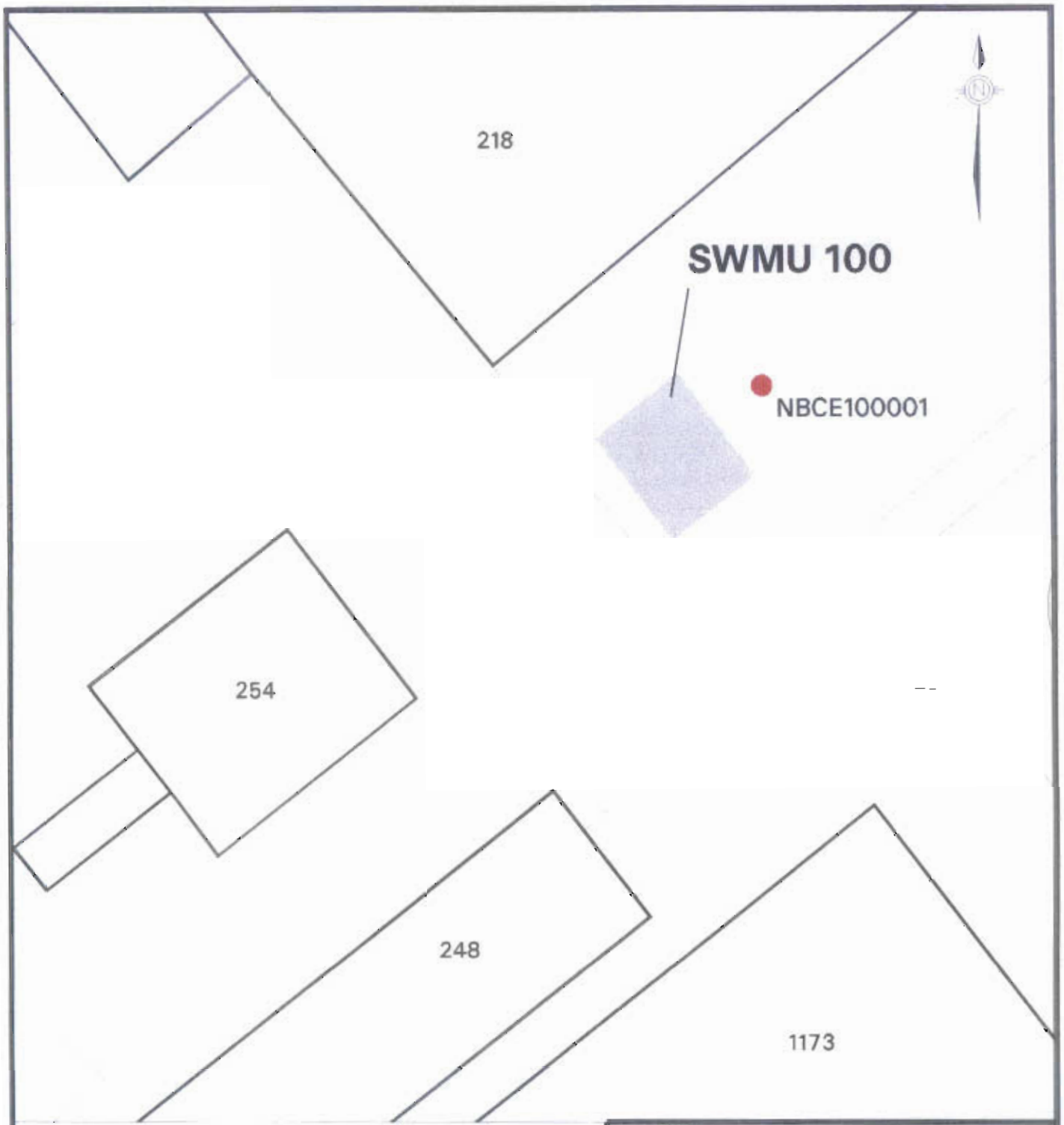
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 50

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

FIGURE 10.13.3
CUMULATIVE GROUNDWATER RISK IN WELLS
SWMU 100



LEGEND - CUMULATIVE GROUNDWATER HAZARD

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

0 feet 50

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

FIGURE 10.13.4
CUMULATIVE GROUNDWATER HAZARD IN WELLS
SWMU 100

10.13.6.4 Uncertainty

SWMU 100 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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 E, specifically as a marine cargo terminal and drydocking facility. The ground surface around SWMU 100 is currently covered with either asphalt or concrete. As a result, chronic exposure to current soil condition is highly unlikely and the associated direct contact exposure pathways evaluations overestimate risk and hazard. If this area were to be redeveloped, 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, chronic exposure to current surface soil conditions would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents. However, no COPCs were identified in surface soils at SWMU 100. Therefore, uncertainty is low for the surface soil pathway.

Groundwater is not currently used as a potable water source at SWMU 100, 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.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for SWMU 100. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none were reported at concentrations within 10% of their RBCs.

Arsenic and beryllium were present in SWMU 100 surface soil at concentrations above RBC benchmarks and were eliminated from consideration in the FRE based on comparison to background concentrations. As a result, their contribution to risk and hazard has not been considered for the surface soil pathways in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none were reported at concentrations within 10% of their RBCs.

Because data was collected from only one monitoring well at SWMU 100, inherent uncertainty is great. A comparison of the maximum reported concentration of arsenic at SWMU 100 was made with arsenic concentrations reported at nearby wells (NBCE590001, NBCE102001, GDEGW006, and GDEGW009) in an effort to reduce uncertainty and help to define the extent of contamination at SWMU 100. Arsenic was reported at 19.9 mg/L (NBCE590001), 5.1 mg/L (NBCE102001), 18.7 mg/L (GDEGW006), and 9.4 mg/L (GDEGW009). The arsenic concentration reported at NBCE590001 exceeded the RC of 18.7 mg/L. The arsenic concentration reported at GDEGW006 was approximately equal to the RC. All nearby arsenic concentrations were less than the maximum reported concentration of arsenic at SWMU 100, 20.6 mg/L.

In addition, monitoring well NBCE100001 was assumed to be a hypothetical future well supplying potable water to a single household. In this scenario, quarterly sample results from NBCE100001 were used to monitor SWMU 100 groundwater COPCs for a year. Concentrations previously addressed in this FRE were reported in the first-quarter sample. Arsenic concentrations were reported at 22.3 mg/L in the second quarter of sampling, 12.2 mg/L in the third, and 13.5 mg/L in the fourth. The arithmetic mean of arsenic concentrations collected quarterly from monitoring well NBCE100001 is 17.2 mg/L, which is less than its corresponding background RC of 18.7 mg/L, and could the sporadic exceedances be indicative of variability in ambient concentrations.

Based upon proximate well and subsequent quarterly results at NBCE100001, it is considered that risk and hazard posed by arsenic have been overestimated in this FRE. Arsenic was detected at concentrations greater than its corresponding background RC, only in the first two sampling quarters at NBCE100001. The two latest sampling rounds yielded arsenic concentrations below the RC, indicating that arsenic risk and hazard is likely an overestimate.

10.13.6.5 FRE Summary

The risk and hazard posed by contaminants at SWMU 100 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first-quarter data and considers the ingestion pathway. Risk and HI estimates for the groundwater pathway are presented on Table 10.13.6.3, such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC (arsenic) exceeds its RGO. Section 7, Table 7.13.1 provides residential groundwater RGOs for COPCs identified in Zone E.

Soil — Residential Scenario

No COPCs were detected in SWMU 100 surface soil at concentrations above their residential RGOs.

Soil — Site Worker Scenario

No COPCs were detected in SWMU 100 surface soil at concentrations above their industrial RGOs.

Groundwater — Residential Scenario

Arsenic was detected in SWMU 100 groundwater at concentrations above its residential RGO and RC. Arsenic, however, did not exceed its MCL of 50 mg/L.

Table 10.13.6.1
Chemicals Present in Site Samples
SWMU 100 - Surface Soil
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Screening Concentration: Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Inorganics													
Aluminum (Al)		3	3	4580 - 6780	5313	NA - NA	7800	100000	26600	MG/KG			
Arsenic (As)		3	3	1.5 - 2.3	1.8	NA - NA	0.43	3.8	23.9	MG/KG	3		
Barium (Ba)		3	3	7.1 - 21	12.5	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		1	3	0.3 - 0.3	0.3	0.11 - 0.11	0.15	1.3	1.7	MG/KG	1		
Calcium (Ca)	N	3	3	1180 - 27400	10197	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)		3	3	4.7 - 13.4	7.63	NA - NA	39	1000	94.6	MG/KG			
Cobalt (Co)		3	3	0.24 - 3.1	1.98	NA - NA	470	12000	19	MG/KG			
Copper (Cu)		3	3	0.77 - 5.3	2.69	NA - NA	310	8200	66	MG/KG			
Cyanide (CN)		1	3	0.56 - 0.56	0.56	0.23 - 0.23	160	4100	0.5	MG/KG			1
Iron (Fe)	N	3	3	3570 - 4900	4127	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)		3	3	3.5 - 16.7	8.2	NA - NA	400	400	265	MG/KG			
Magnesium (Mg)	N	3	3	124 - 759	343	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)		3	3	6.8 - 44.7	20	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)		1	3	0.06 - 0.06	0.06	0.02 - 0.02	2.3	61	2.6	MG/KG			
Nickel (Ni)		3	3	1.4 - 5.5	3.17	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N	1	3	617 - 617	617	254 - 319	NA	NA	NA	MG/KG			
Selenium (Se)		1	3	0.77 - 0.77	0.77	0.56 - 0.57	39	1000	1.7	MG/KG			
Sodium (Na)	N	1	3	300 - 300	300	56.4 - 57	NA	NA	NA	MG/KG			
Vanadium (V)		3	3	6.4 - 12.6	8.6	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		3	3	4.5 - 21.5	11.8	NA - NA	2300	61000	827	MG/KG			
Volatile Organics													
Acetone		1	3	16 - 16	16	11 - 11	780000	20000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.13.6.2
Chemicals Present in Site Samples
SWMU 100 - Shallow Groundwater
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Inorganics											
Arsenic (As)	*	1	1	20.6 - 20.6	20.6	NA - NA	0.045	18.7	UG/L	1	1
Calcium (Ca)	N	1	1	148000 - 148000	148000	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	1	1	7590 - 7590	7590	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	65300 - 65300	65300	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	1	1110 - 1110	1110	NA - NA	84	2560	UG/L	1	
Nickel (Ni)		1	1	1.2 - 1.2	1.2	NA - NA	73	15.2	UG/L		
Potassium (K)	N	1	1	34300 - 34300	34300	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	658000 - 658000	658000	NA - NA	NA	NA	UG/L		
Vanadium (V)		1	1	1.4 - 1.4	1.4	NA - NA	26	11.4	UG/L		

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

Table 10.13.6.3
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 100
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
100	G001	Arsenic (As)	20.60	UG/L	459.5695	100.00	4.3896	100.00
		Total			459.5695		4.3896	

10.13.7 Corrective Measures Considerations

For SWMU 100, the upper and lower soil intervals and shallow groundwater were investigated. Based on the analytical results and the risk assessment, COCs requiring further evaluation through the CMS process were identified for the 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. Since the site soil is capped with asphalt, chronic exposure to current surface soil conditions is highly unlikely.

Arsenic was identified in the shallow groundwater at concentrations that equal a risk of 4E-04 and an HI of 4. The single groundwater monitoring well installed is insufficient for determining whether a plume exists. Human health risk may not be a significant factor since the groundwater is not a potable drinking water source even though the associated risk is above USEPA's acceptable range of 1E-06 and 1E-04. Further assessment is needed to evaluate the natural attenuation process and potential discharge to surface water associated with arsenic in the shallow groundwater.

Potential corrective measures for the impacted medium and its respective COC are in Table 10.13.7.1.

Table 10.13.7.1
Potential Corrective Measures for SWMU 100

Medium	Compounds	Potential Corrective Measures
Shallow Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment

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10.14 SWMU 102, Mercury Spill, Building 79

SWMU 102 is a mercury spill under the central portion of Building 79 which housed an ordnance shop from 1943 to 1966.

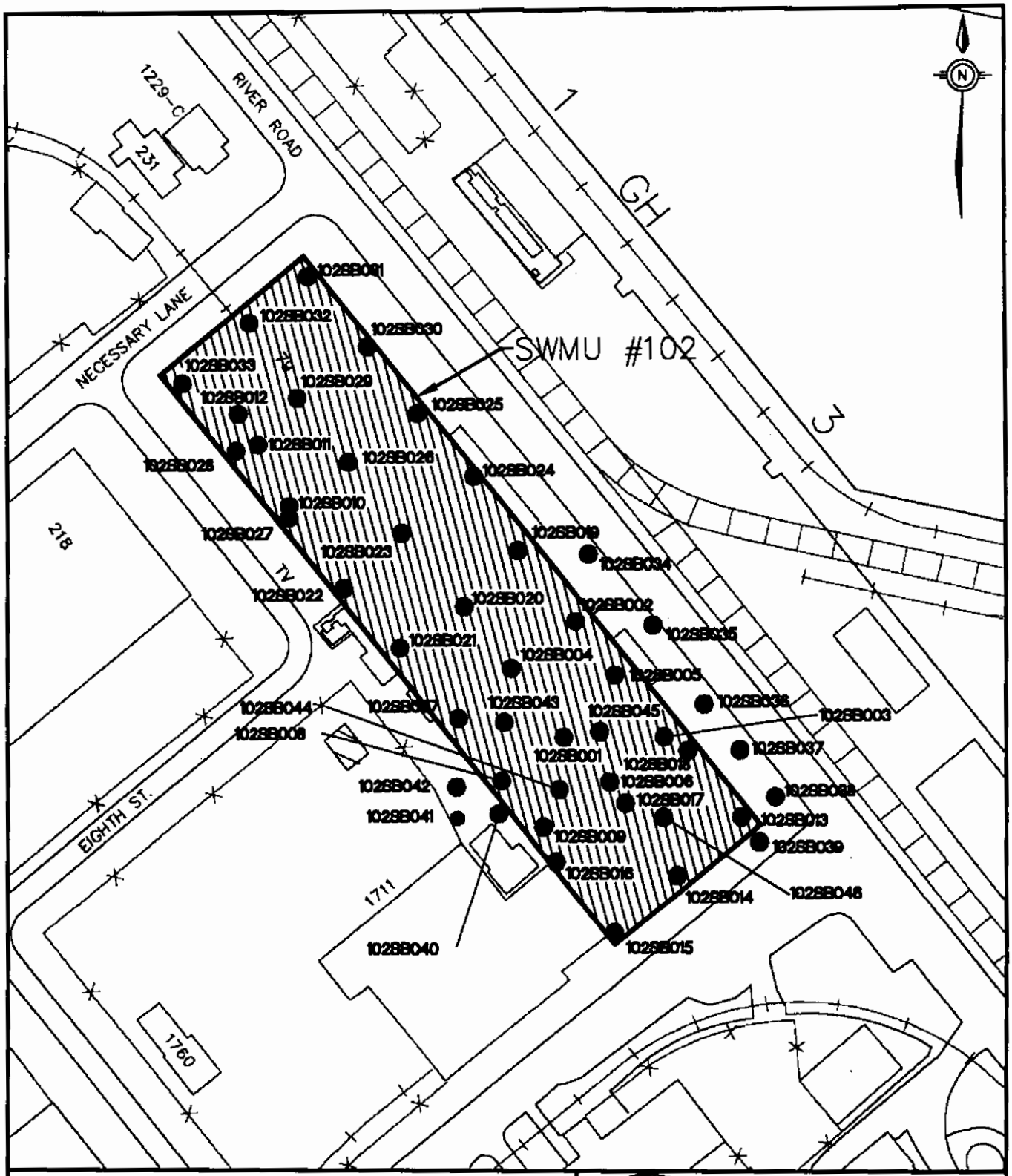
No environmental media data collected from previous investigations have been found for this site. However, several incidents involving hazardous material spills, as well as cleanup activities, have been documented since 1976. The most noteworthy was the discovery of a pool of mercury under the floor inside the central portion of the building. Mercury was reported to have been spilled and seeped under the floor, forming an approximately 10-foot diameter pool. The mercury release reportedly occurred in 1969. The level of cleanup conducted is not known.

Materials of concern at SWMU 102 include metals, mercury, and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill CSI objectives for SWMU 102, soil, groundwater, and air were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether contamination resulted from onsite activities.

10.14.1 Soil Sampling and Analysis

Soil was sampled in three rounds at SWMU 102 from the locations shown in Figure 10.14.1. The *Final Zone E RFI Work Plan* proposed collecting eight soil samples from the upper interval and eight samples from the lower interval. Soil samples were also collected at both intervals for the shallow monitoring well location proposed at this site.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.14.1
SOIL BORING LOCATIONS
SWMU#102
BUILDING 79
MERCURY SPILL

DWG DATE: 09/02/97 | DWG NAME: 10-14-1

First-round Sampling — During the first round of sampling, all 9 proposed upper-interval samples and 9 lower-interval samples were collected and submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. One upper-interval sample was selected as a duplicate and was submitted for analysis at DQO Level IV for Appendix IX analytical parameters to include mercury, herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.14.1.1 summarizes first round soil sampling at SWMU 102.

Table 10.14.1.1
SWMU 102
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	9	9	Standard Suite[a], organotins	Standard Suite[a], organotins	None
Lower	9	9	Standard Suite[a], organotins	Standard Suite[a], organotins	One sample was analyzed for TPH-GRO and TPH-DRO

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCB

Second and Third-round Sampling — Second and third round sampling were performed at SWMU 102 after first round sampling was completed to more accurately delineate the mercury contamination plume. Thirty-seven upper- and 37 lower-interval samples were proposed during the second and third rounds. Thirty-four of the 37 proposed upper-interval samples and 30 of the 37 proposed lower-interval soil samples were collected.

The upper-interval samples at 102SB010, 102SB011, and 102SB012 were only screened for mercury vapor. The lower-interval samples at those locations could not be collected due to

subsurface obstructions. Lower-interval samples at 102SB014, 102SB019, 102SB026, and 102SB038 could not be collected due to subsurface obstructions.

All second and third round samples were submitted for analysis for mercury at DQO Level III. Six of the additional samples (three upper-interval and three lower-interval) were duplicated and submitted for analysis at DQO Level IV for mercury only. Two of the additional samples from the upper interval were duplicated and submitted for analysis at DQO Level IV for Appendix IX analytical parameters including SVOCs, pesticides, metals and cyanide. Table 10.14.1.2 summarizes second and third round soil sampling at SWMU 102.

Table 10.14.1.2
SWMU 102
Second/Third Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	37	34	Mercury	Mercury	Three upper-interval samples could not be collected due to surface obstructions. One sample was analyzed for TPH-GRO and TPH-DRO
Lower	37	30	Mercury	Mercury	Seven lower-interval samples could not be collected due to subsurface obstructions. One sample was analyzed for TPH-GRO and TPH-DRO

10.14.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.14.2.1. Inorganic analytical results for soil are summarized in Table 10.14.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.14.2.1
SWMU 102
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	1/15	59.0	59.0	20,000,000	0
2-Butanone (MEK)	Upper	1/15	8.00	8.00	100,000,000	0
	Lower	5/15	12.0 - 25.0	20.8	NA	NA
SVOCs (μg/kg)						
Acenaphthene	Upper	11/22	89.0 - 810	413	12,000,000	0
	Lower	6/21	110 - 1,600	412	NA	NA
Acenaphthylene	Upper	4/22	140 - 2,300	878	8,200,000	0
	Lower	3/21	110 - 260	180	NA	NA
Anthracene	Upper	15/22	140 - 2,600	836	61,000,000	0
	Lower	8/21	53.0 - 1,900	448	NA	NA
Benzo(g,h,i)perylene	Upper	15/22	320 - 9,400	1,740	8,200,000	0
	Lower	6/21	170 - 1,100	623	NA	NA
Benzoic acid	Upper	3/22	39.0 - 85.0	56.7	100,000,000	0
	Lower	3/21	110 - 130	120	NA	NA
bis(2-Ethylhexyl)phthalate	Upper	4/22	44.0 - 600	316	410,000	0
	Lower	2/21	64.0 - 220	142	NA	NA
Butylbenzylphthalate	Upper	1/22	2,100	2,100	41,000,000	0
	Lower	1/21	170	170	NA	NA
Dibenzofuran	Upper	9/22	99.0 - 540	254	820,000	0
	Lower	5/21	65.0 - 850	251	NA	NA
Di-n-butylphthalate	Upper	2/22	59.0 - 280	170	20,000,000	0
	Lower	1/21	63.0	63.0	NA	NA
Fluoranthene	Upper	20/22	72.0 - 16,000	2,720	8,200,000	0
	Lower	15/21	79.0 - 6,400	1,130	NA	NA

Table 10.14.2.1
SWMU 102
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Fluorene	Upper	12/22	82.0 - 1,400	458	8,200,000	0
	Lower	7/21	97.0 - 1,400	377	NA	NA
2-Methylnaphthalene	Upper	9/22	67.0 - 320	213	8,200,000	0
	Lower	2/21	89.0 - 150	120	NA	NA
Naphthalene	Upper	9/22	84.0 - 540	228	8,200,000	0
	Lower	4/21	48.0 - 83.0	64.5	NA	NA
Phenanthrene	Upper	19/22	66.0 - 9,600	2,280	8,200,000	0
	Lower	14/21	60.0 - 7,400	973	NA	NA
Pyrene	Upper	20/22	90.0 - 17,000	3,790	6,100,000	0
	Lower	16/21	79.0 - 5,300	1,390	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	20/22	0.0510 - 17,500	2,740	780	12
	Lower	14/21	20.2 - 2,700	770	NA	NA
Benzo(a)anthracene	Upper	18/22	48.0 - 10,000	1,840	7,800	1
	Lower	13/21	79.0 - 2,200	591	NA	NA
Benzo(b)fluoranthene	Upper	15/22	51.0 - 11,000	2,420	7,800	1
	Lower	10/21	78.0 - 2,600	603	NA	NA
Benzo(k)fluoranthene	Upper	17/22	53.0 - 9,300	1,920	78,000	0
	Lower	10/21	100 - 2,700	892	NA	NA
Benzo(a)pyrene	Upper	17/22	46.0 - 8,200	1,910	780	11
	Lower	11/21	90.0 - 1,900	661	NA	NA
Chrysene	Upper	20/22	50.0 - 8,400	1,800	780,000	0
	Lower	13/21	100 - 2,000	751	NA	NA
Dibenz(a,h)anthracene	Upper	13/22	100 - 6,300	974	780	3
	Lower	4/21	360 - 550	438	NA	NA

Table 10.14.2.1
SWMU 102
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
Indeno(1,2,3-cd)pyrene	Upper	15/22	310 - 8,000	1,610	7,800	1
	Lower	4/21	540 - 1,000	743	NA	NA
Pesticides (μg/kg)						
delta-BHC	Upper	1/22	13.0	13.0	910	0
	Lower	1/21	22.0	22.0	NA	NA
alpha-Chlordane	Upper	2/22	5.80 - 14.0	9.90	4,400	0
gamma-Chlordane	Upper	4/22	4.10 - 53.0	27.8	4,400	0
	Lower	1/21	6.20	6.20	NA	NA
4,4'-DDD	Upper	4/22	8.40 - 87.0	33.6	24,000	0
	Lower	1/21	9.40	9.40	NA	NA
4,4'-DDE	Upper	5/22	28.0 - 190	63.2	17,000	0
	Lower	1/21	19.0	19.0	NA	NA
4,4'-DDT	Upper	7/22	8.50 - 230	113	17,000	0
	Lower	2/21	12.0 - 25.0	18.5	NA	NA
Dieldrin	Upper	1/22	5.40	5.40	360	0
	Lower	2/21	7.00 - 15.0	11.0	NA	NA
Endrin	Lower	1/21	6.20	6.20	NA	NA
Endrin aldehyde	Upper	1/22	3.40	3.40	61,000	0
Endrin ketone	Upper	2/22	7.90 - 20.0	14.0	61,000	0
Heptachlor	Upper	1/22	2.40	2.40	1,300	0
Heptachlor epoxide	Upper	2/22	2.40 - 8.90	5.65	630	0
Methoxychlor	Upper	2/22	19.0 - 42.0	30.5	1,000,000	0
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	1/1	0.131	0.131	1,000	0
1234678-HpCDD	Upper	1/1	6.79	6.79	NA	NA

Table 10.14.2.1
SWMU 102
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
OCDD	Upper	1/1	63.5	63.5	NA	NA
TPH (μg/kg)						
Gasoline	Upper	1/1	42.8	42.8	NA	NA
	Lower	1/2	28.3	28.3	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.14.2.2
SWMU 102
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	22/22	2,380 - 12,500	7,180	100,000	26,600	0
	Lower	21/21	1,110 - 23,000	11,700	NA	41,100	NA
Antimony (Sb)	Upper	12/22	0.600 - 9.00	1.71	82.0	1.77	0
	Lower	15/21	0.740 - 10.3	1.82	NA	1.60	NA
Arsenic (As)	Upper	22/22	2.60 - 27.8	12.4	3.80	23.9	3
	Lower	21/21	3.20 - 64.1	18.8	NA	19.9	NA
Barium (Ba)	Upper	13/22	15.5 - 78.5	33.4	14,000	130	0
	Lower	17/21	6.40 - 262	55.7	NA	94.1	NA
Beryllium (Be)	Upper	20/22	0.310 - 0.810	0.581	1.30	1.70	0
	Lower	20/21	0.210 - 1.40	0.868	NA	2.71	NA
Cadmium (Cd)	Upper	19/22	0.140 - 1.30	0.582	100	1.50	0
	Lower	16/21	0.160 - 2.80	0.825	100	0.960	NA

Table 10.14.2.2
SWMU 102
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Calcium (Ca)	Upper	22/22	4,820 - 79,400	38,800	NA	NA	NA
	Lower	21/21	957 - 6,8100	27,500	NA	NA	NA
Chromium (Cr)	Upper	22/22	4.50 - 197	37.0	1,000	94.6	0
	Lower	21/21	3.10 - 48.5	26.1	NA	75.2	NA
Cobalt (Co)	Upper	22/22	2.70 - 554	55.4	12,000	19.0	0
	Lower	21/21	0.460 - 10.0	5.29	NA	14.9	NA
Copper (Cu)	Upper	22/22	2.40 - 197	53.0	8,200	66.0	0
	Lower	21/21	1.40 - 548	70.1	NA	152	NA
Cyanide (CN)	Upper	3/22	0.220 - 1.30	0.907	4,100	0.500	0
	Lower	2/21	0.290 - 0.360	0.325	NA	NA	NA
Iron (Fe)	Upper	22/22	2,680 - 17,900	11,400	61,000	NA	0
	Lower	21/21	4,690 - 56,800	20,800	NA	NA	NA
Lead (Pb)	Upper	22/22	5.70 - 919	222	1,300	265	0
	Lower	20/21	21.9 - 9,930	776	NA	173	NA
Magnesium (Mg)	Upper	21/22	488 - 5,150	3,160	NA	NA	NA
	Lower	21/21	144 - 6,930	3,490	NA	NA	NA
Manganese (Mn)	Upper	22/22	26.1 - 387	149	4,700	302	0
	Lower	21/21	14.9 - 863	260	NA	881	NA
Mercury (Hg)	Upper	36/43	0.0500 - 27.3	4.42	61.0	2.60	0
	Lower	35/39	0.0500 - 11.7	1.68	NA	1.59	NA
Nickel (Ni)	Upper	22/22	3.30 - 134	19.2	4,100	77.1	0
	Lower	21/21	1.60 - 18.0	11.2	NA	57.0	NA
Potassium (K)	Upper	4/22	1,130 - 2,030	1,420	NA	NA	NA
	Lower	13/21	280 - 3,610	2,000	NA	NA	NA
Selenium (Se)	Upper	7/22	0.730 - 1.50	1.07	1,000	1.70	0
	Lower	10/21	0.990 - 1.80	1.33	NA	2.40	NA

Table 10.14.2.2
SWMU 102
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Silver (Ag)	Upper	7/22	0.250 - 11.0	2.31	1,000	NA	0
Sodium (Na)	Upper	13/22	300 - 1,870	945	NA	NA	NA
	Lower	17/21	188 - 2,870	1,030	NA	NA	NA
Thallium (Tl)	Lower	1/21	3.30	3.30	NA	NA	NA
Tin (Sn)	Upper	6/22	2.60 - 43.2	12.5	6,100	59.4	0
	Lower	2/21	7.30 - 26.6	17.0	NA	9.23	NA
Vanadium (V)	Upper	22/22	6.60 - 35.2	21.0	1,400	94.3	0
	Lower	21/21	3.60 - 76.0	38.8	NA	155	NA
Zinc (Zn)	Upper	21/22	11.0 - 1,130	281	61,000	827	0
	Lower	21/21	9.70 - 2,340	378	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Two VOCs were detected in soil samples at SWMU 102. Two detections occurred in the upper interval and five in the lower interval. No VOC was detected above its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty-two SVOCs were detected in soil samples collected at SWMU 102. Two hundred and sixty-eight detections occurred in the upper interval and 158 in the lower interval. Five SVOCs — benzo(a)anthracene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzo(a)pyrene — exceeded their respective industrial RBC in the upper interval. Additionally,

two SVOCs — benzo(a)anthracene and chrysene — exceeded their respective SSL in the lower interval. Benzo(a)anthracene was detected in 18 of 22 upper-interval samples with a range of 48.0 to 10,000 μg/kg and a mean of 1,840 μg/kg. One upper-interval sample (102SB037, 10,000 μg/kg) exceeded the benzo(a)anthracene industrial RBC of 7,800 μg/kg.

Benzo(b)fluoranthene was detected in 15 of 22 upper-interval samples with a range of 51.0 to 11,000 μg/kg and a mean of 2,420 μg/kg. One upper-interval sample (102SB037, 11,000 μg/kg) exceeded the benzo(b)fluoranthene industrial RBC of 7,800 μg/kg.

Dibenz(a,h)anthracene was detected in 13 of 22 upper-interval samples with a range of 100 to 6,300 μg/kg and a mean of 974 μg/kg. Three upper-interval samples (102SB036, 1,400 μg/kg; 102SB037, 6,300 μg/kg; and 102SB038, 1,500 μg/kg) exceeded the dibenz(a,h)anthracene industrial RBC of 780 μg/kg.

Indeno(1,2,3-cd)pyrene was detected in 15 of 22 samples with a range of 310 to 8,000 μg/kg and a mean of 1,610 μg/kg. One upper-interval sample (102SB037, 8,000 μg/kg) exceeded the indeno(1,2,3-cd)pyrene industrial RBC of 7,800 μg/kg.

Benzo(a)pyrene was detected in 17 of 22 samples with a range of 46.0 to 8,200 μg/kg and a mean of 1,910 μg/kg. The following eleven upper-interval samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg:

102SB002 (980 μg/kg)	102SB034 (1,200 μg/kg)	102SB040 (6,100 μg/kg)
102SB003 (1,300 μg/kg)	102SB036 (2,900 μg/kg)	102SB042 (1,700 μg/kg)
102SB005 (890 μg/kg)	102SB037 (8,200 μg/kg)	102SB045 (2,100 μg/kg)
102SB008 (1,800 μg/kg)	102SB038 (3,000 μg/kg)	

Benzo(a)anthracene was detected in 13 of 21 lower-interval samples with a range of 79 to 2,200 μg/kg and a mean of 591 μg/kg. Three lower-interval samples (102SB001, 1,600 μg/kg; 102SB002, 2,200 μg/kg; and 102SB004, 1,800 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

Chrysene was detected in 13 of 21 lower-interval samples with a range of 100 to 2,000 μg/kg and a mean of 751 μg/kg. Three lower-interval samples (102SB001, 2,000 μg/kg; 102SB002, 2,000 μg/kg; and 102SB004, 2,000 μg/kg) exceeded the chrysene SSL of 1,000 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at SWMU 102. The upper-interval BEQ was calculated for 20 samples with a range of 0.0510 to 17,500 μg/kg and a mean of 2,740 μg/kg. The following twelve upper-interval samples exceeded the industrial RBC of 780 μg/kg for benzo(a)pyrene:

102SB002 (1,998 μg/kg)	102SB008 (2,929 μg/kg)	102SB038 (5,404 μg/kg)
102SB003 (2,150 μg/kg)	102SB034 (1,537 μg/kg)	102SB040 (8,149 μg/kg)
102SB004 (1,028 μg/kg)	102SB036 (5,193 μg/kg)	102SB042 (2,249 μg/kg)
102SB005 (1,365 μg/kg)	102SB037 (17,500 μg/kg)	102SB045 (3,072 μg/kg)

Pesticides and PCBs in Soil

Thirteen pesticides were detected in soil samples collected at SWMU 102. Thirty-two detections occurred in the upper interval and 9 in the lower interval. No pesticides exceeded their respective industrial RBC in the upper interval. However, one pesticide — dieldrin — exceeded its respective SSL in the lower interval.

Dieldrin was detected in two of 21 lower-interval samples with a range of 7.0 to 15.0 μg/kg and a mean of 11.0 μg/kg. Two lower-interval samples (102SB036, 7 μg/kg; 102SB037, 15 μg/kg) exceeded the dieldrin SSL of 1.0 μg/kg.

No PCBs were detected in soil samples collected at SWMU 102.

Other Organic Compounds in Soil

Two dioxins were detected in one upper-interval duplicate soil sample collected at SWMU 102. No industrial RBCs have been established for either dioxin.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for the upper-interval duplicate soil sample. The calculated TEQ was 0.131 ng/kg, below the industrial RBC of 1,000 ng/kg.

Gasoline (TPH-GRO) was detected in one of one upper-interval samples; no industrial RBC has been established for this compound.

Inorganic Elements in Soil

Twenty-two metals were detected in soil samples collected at SWMU 102. Four hundred and twenty-four detections occurred in the upper interval and 420 in the lower interval. One metal — arsenic — exceeded both its respective industrial RBC and background RC in the upper interval. Additionally, two metals — arsenic and barium — exceeded both their respective SSL and background RC in the lower interval.

Arsenic was detected in 22 of 22 upper-interval samples with a range of 2.60 to 27.8 mg/kg and a mean of 12.4 mg/kg. Three upper-interval samples (102SB034, 27.8 mg/kg; 102SB036, 26.6 mg/kg; and 102SB038, 27.2 mg/kg) exceeded both the arsenic industrial RBC of 3.80 mg/kg

and the arsenic background RC of 23.9 mg/kg. Arsenic was detected in 21 of 21 lower-interval samples with a range of 3.20 to 64.1 mg/kg and a mean of 18.8 mg/kg. The following six lower-interval samples exceeded both the arsenic SSL of 15 mg/kg and the background RC of 19.9 mg/kg:

102SB008 (22.2 mg/kg)	102SB036 (64.1 mg/kg)	102SB040 (23.0 mg/kg)
102SB009 (23.6 mg/kg)	102SB037 (38.3 mg/kg)	102SB041 (47.0 mg/kg)

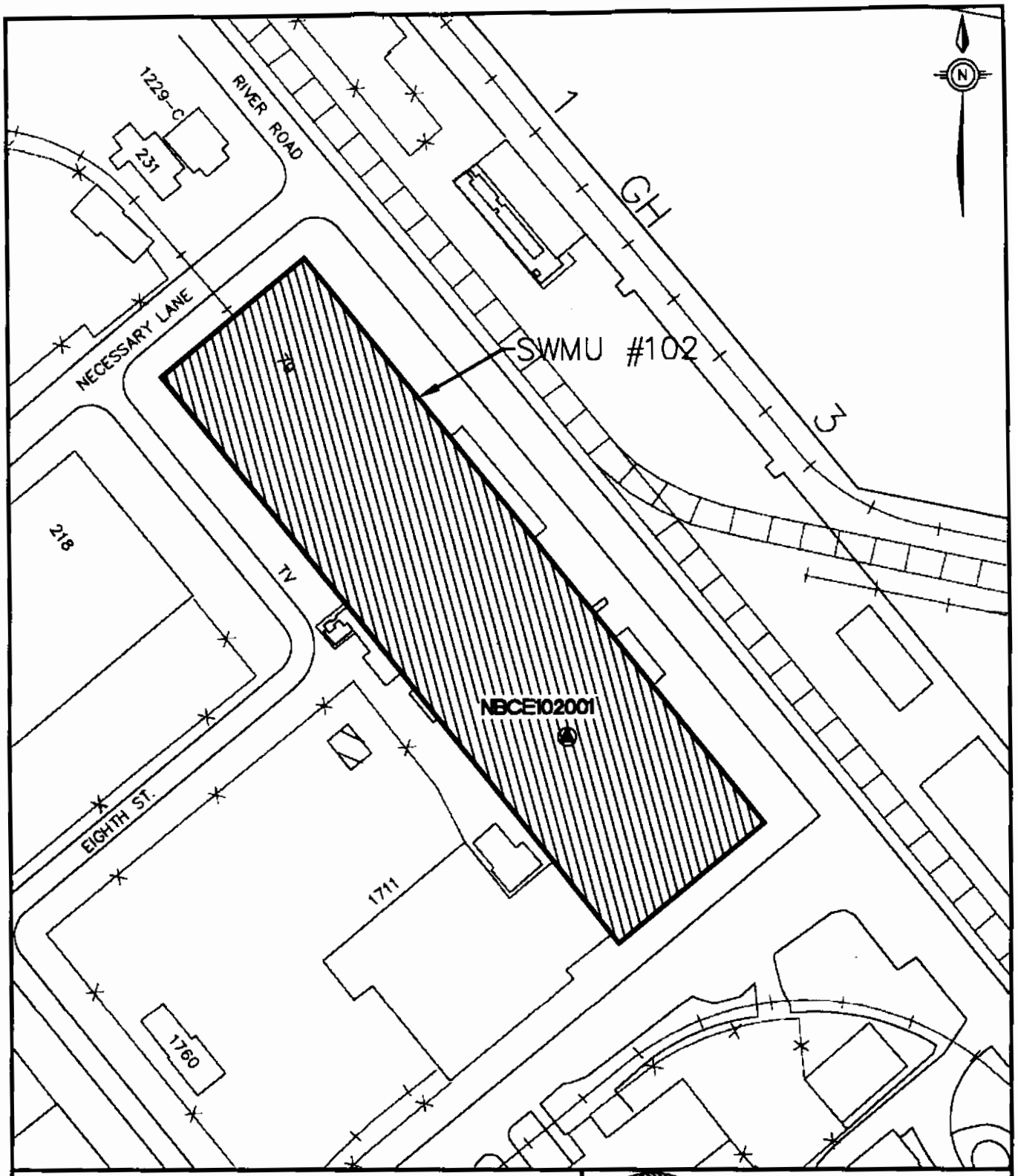
Barium was detected in 17 of 21 lower-interval samples with a range of 6.40 to 262 mg/kg and a mean of 55.7 mg/kg. Three lower-interval samples (102SB003, 141 mg/kg; 102SB008, 109 mg/kg; and 102SB036, 262 mg/kg) exceeded both the barium SSL of 32 mg/kg and the background RC of 94.1 mg/kg.

10.14.3 Groundwater Sampling and Analysis

One shallow monitoring well was installed and sampled to assess groundwater quality at SWMU 102 as shown in Figure 10.14.2. The well was installed as follows:

- Shallow Well installed at SWMU 102 — NBCE102001

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. No samples were selected as duplicates at this site. Table 10.14.3.1 summarizes groundwater sampling and analysis at SWMU 102.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ▲ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.14.2
MONITORING WELL LOCATIONS
SWMU#102
BUILDING 79
MERCURY SPILL

DWG DATE: 09/02/97 | DWG NAME: 10-14-2

Table 10.14.3.1
SWMU 102
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	1	1	Standard Suite[a], chlorides, TDS, sulfates, and organotins	Standard Suite[a], chlorides, sulfates, TDS, and organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

The shallow monitoring well was installed at 12.5 feet bgs in the surficial aquifer in accordance with Section 3.3 of this report.

10.14.4 Nature of Contamination in Groundwater

Organic compound analytical results for groundwater are summarized in Table 10.14.4.1. Inorganic analytical results for groundwater are summarized in Table 10.14.4.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.14.4.1
SWMU 102
Organic Compounds Detected in First-Quarter Groundwater (μg/L)
Shallow Monitoring Well

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs						
Benzoic acid	1/1	3.00	3.00	15,000	NA	0
bis(2-Ethylhexyl)phthalate	1/1	3.00	3.00	4.80	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.14.4.2
SWMU 102
Inorganic Detections for First-Quarter Groundwater (μg/L)
Shallow Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/1	50.4	50.4	3,700	319	NA	0
Arsenic (As)	1/1	5.10	5.10	0.0450	16.4	50.0	0
Chromium (Cr)	1/1	1.40	1.40	18.0	15.5	100	0
Vanadium (V)	1/1	4.60	4.60	26.0	5.3	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No MCL established

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

Two SVOCs — benzoic acid and bis(2-ethylhexyl)phthalate — were detected in the one shallow groundwater sample collected at SWMU 102. Neither SVOC exceeded its respective tap-water RBC. No MCL has been established for either SVOC.

Inorganic Elements in Groundwater

Shallow Groundwater

Four metals were detected in the one shallow groundwater sample collected at SWMU 102. No metal detection exceeded its respective tap-water RBC, background shallow groundwater RC, or MCL (where available).

10.14.5 Air Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting random air samples at SWMU 102 with a mercury vapor analyzer. Both the number and location of screening samples were to be determined in the field. A Technical Memorandum issued on February 21, 1996 amended the sampling plan for SWMU 102. In accordance with the amended plan, a total of 46 mercury vapor samples were collected from beneath the intermediate wood flooring (upper interval) and seven samples were collected from beneath the concrete sub-floor (lower interval). Table 10.14.5.1 summarizes air sampling activity for SWMU 102.

Table 10.14.5.1
SWMU 102
Air Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
Upper	TBD	46	Mercury Vapor	Mercury Vapor	No deviation from proposed strategy
Lower	TBD	7	Mercury Vapor	Mercury Vapor	No deviation from proposed strategy

10.14.6 Nature of Contamination in Air

Table 10.14.6.1 summarizes the analytical results of air samples collected at SWMU 102. Sample locations were determined in the field and were biased in an attempt to identify worst case situations.

Table 10.14.6.1
SWMU 102
Air Sampling Results

Parameter	Interval	Frequency of Detection	Range of Detections (mg/m^3)
Mercury Vapor	Upper	29/46	0.001 - 0.074
	Lower	3/7	0.007 - 0.061

Note:
mg/m^3 = Milligrams per cubic meter

Mercury Vapor Detected in Air

Mercury vapor was detected in 29 of 46 upper-interval samples and in 3 of 7 lower-interval samples.

10.14.7 Fate and Transport Assessment for SWMU 102

SWMU 102 is the site of a mercury spill under the central portion of Building 79. Environmental media sampled as part of the SWMU 102 CSI include surface soil, subsurface soil, shallow groundwater, and air. Potential constituent migration pathways investigated for SWMU 102 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.14.7.1 Soil-to-Groundwater Cross Media-Transport: Tier One

Table 10.14.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) background RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Seven organic compounds — benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, delta-BHC, and dieldrin — were detected in SWMU 102 soil above generic groundwater protection SSLs. Benzo(a)anthracene exceeded its corresponding groundwater protection SSL in ten surface soil samples and three subsurface soil samples. Benzo(b)fluoranthene exceeded its SSL in four surface soil samples and one subsurface soil sample, delta-BHC in one surface soil sample and one subsurface soil sample, dieldrin in one surface soil sample and two subsurface soil samples, benzo(a)pyrene in two surface soil samples, and dibenzo(a,h)anthracene in three surface soil samples. The maximum reported concentration of dibenzo(a,h)anthracene (6,300μg/kg in surface soil sample 102SB037) was more than four times the next highest reported detection (1,500 μg/kg in 102SB038). Indeno(1,2,3-cd)pyrene exceeded its generic SSL in one surface soil sample. None of these organic constituents was detected in first-quarter groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

Nine inorganics — antimony, arsenic, chromium, cobalt, copper, lead, mercury, nickel, and thallium — were detected in soil above their respective generic groundwater protection SSLs or background reference values. Antimony exceeded its groundwater protection SSL in one surface soil sample and one subsurface soil sample. Arsenic exceeded its background reference value in three surface soil samples and three subsurface soil samples. Chromium exceeded its background reference value in two surface soil samples. Cobalt exceeded its background value in eight surface soil samples, but not in subsurface samples. The maximum detected concentration of cobalt (554 mg/kg in 102SB035) was more than twice as high as that from any other sample. Copper exceeded its background reference value in three surface soil samples and two subsurface soil samples. Lead exceeded its *de facto* SSL of 400 μg/L in four surface soil samples and three subsurface soil samples. The maximum reported concentration of lead in subsurface soil (9,930 mg/kg in 102SB036) was nearly three times the next highest reported concentration in

subsurface soil (3,700 mg/kg in 102SB039), and more than ten times the highest reported concentration in surface soil (919 mg/kg in 102SB039).

Mercury exceeded its groundwater protection SSL in 11 of 43 surface soil samples and six of 39 subsurface soil samples. The maximum concentration of mercury reported in surface soil (27.3 mg/kg in 102SB008) was more than twice the maximum reported concentration in subsurface soil (11.7 mg/kg in 102SB018), as was the mean of detected concentrations (4.42 mg/kg vs. 1.68 mg/kg). Nickel and thallium exceeded their corresponding groundwater protection SSLs in one surface soil sample each, but not in subsurface samples. Of the nine inorganics exceeding SSLs, arsenic and chromium were the only ones detected in first-quarter groundwater samples; however, neither was detected at a concentration above tap water RBCs or background reference values, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

10.14.7.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.14.7.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to RBCs 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 RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. No constituents were detected in first-round samples from SWMU 102 shallow monitoring wells at concentrations exceeding corresponding tap water RBCs, background reference values, or salt water surface water chronic screening levels.

10.14.7.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.14.7.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for SWMU 102 is 86,400:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.14.7.4 Soil-to-Air Cross-Media Transport

Table 10.14.7.3 lists the VOCs detected in surface soil samples collected at SWMU 102 along with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at SWMU 102. 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 expected to be significant at SWMU 102.

10.14.7.5 Fate and Transport Summary

Mercury was the focus of the investigation at SWMU 102. Although it was detected in nearly all of the surface and subsurface soil samples, mercury concentrations were consistently lower in

subsurface soil than in surface soil. No mercury was detected in the first-round groundwater sample from the single shallow well at SWMU 102, nor was it detected in samples from later rounds. The current distribution of mercury concentrations in soil appears to be protective of groundwater at the site.

In the first-tier screen, seven organic compounds — benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, delta-BHC, and dieldrin — were detected in SWMU 102 soil above generic groundwater protection SSLs. Nine inorganics — antimony, arsenic, chromium, cobalt, copper, lead, mercury, nickel, and thallium — were detected in soil above their respective generic groundwater protection SSLs or background reference values. None of these constituents was detected above tap water RBCs, background reference values, or salt water surface water chronic screening levels in first-quarter shallow aquifer groundwater samples.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.14.7.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 102
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	59	ND	ND	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	8	25	ND	NA	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	810	1600	ND	NA	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	2300	260	ND	NA	150000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	2600	1900	ND	NA	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	85	130	3	NA	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	9400	1100	ND	NA	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	10000	2200	ND	NA	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	8200	1900	ND	NA	4000	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	11000	2600	ND	NA	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	9300	2700	ND	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	8400	2000	ND	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	6300	550	ND	NA	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	8000	1000	ND	NA	7000	0.092	NA	UG/KG	UG/L	YES	NO	NO
Butylbenzylphthalate	2100	170	ND	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	540	850	ND	NA	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	280	63	ND	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	600	220	3	NA	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	16000	6400	ND	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	1400	1400	ND	NA	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	320	150	ND	NA	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	228	64.5	ND	NA	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	9600	7400	ND	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	17000	5300	ND	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
delta-BHC	13	22	ND	NA	1.5	0.037	NA	UG/KG	UG/L	YES	NO	NO
alpha-Chlordane	14	ND	ND	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	53	6.2	ND	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	87	9.4	ND	NA	8000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	190	19	ND	NA	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	230	25	ND	NA	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Dieldrin	5.4	15	ND	NA	2	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO
Endrin	ND	6.2	ND	NA	500	11	0.0023	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	3.4	ND	ND	NA	500	11	NA	UG/KG	UG/L	NO	NO	NO
Endrin ketone	20	ND	ND	NA	500	11	NA	UG/KG	UG/L	NO	NO	NO
Heptachlor	2.4	ND	ND	NA	11500	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	8.9	ND	ND	NA	350	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Methoxychlor	42	ND	ND	NA	80000	180	0.03	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.131	ND	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
TPH - Gasoline Range Organics												
Gasoline	42.8	28.3	NA	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	12500	23000	50.4	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	9	10.3	ND	NA	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	27.8	64.1	5.1	NA	23.9	18.7	36	MG/KG	UG/L	YES	NO	NO
Barium	78.5	262	ND	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.81	1.4	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	1.3	2.8	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO

Table 10.14.7.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 102
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Chromium (total)	197	48.5	1.4	NA	94.6	37000	103	MG/KG	UG/L	YES	NO	NO
Cobalt	554	10	ND	NA	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	197	548	ND	NA	152	1500	2.9	MG/KG	UG/L	YES	NO	NO
Cyanide	1.3	0.36	ND	NA	20	730	37.3	MG/KG	UG/L	NO	NO	NO
Lead	919	9930	ND	NA	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	387	863	ND	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	27.3	11.7	ND	NA	2.6	11	0.2	MG/KG	UG/L	YES	NO	NO
Nickel	134	18	ND	NA	77.1	730	42.2	MG/KG	UG/L	YES	NO	NO
Selenium	1.5	1.8	ND	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	11	ND	ND	NA	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	ND	3.3	ND	NA	2.8	2.9	21.3	MG/KG	UG/L	YES	NO	NO
Tin	43.2	26.6	ND	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	35.2	76	4.6	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	1130	2340	ND	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.14.7.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMU 102
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	10000	2200	ND	NA	800	0.092	NA	0.092	7.95E+03	0.1	7.95E+04	6.36E+06	UG/KG	UG/L	NO	NO
Benzo(a)pyrene	8200	1900	ND	NA	4000	0.0092	NA	0.0092	7.95E+02	0.2	3.97E+03	1.59E+06	UG/KG	UG/L	NO	NO
Benzo(b)fluoranthene	11000	2600	ND	NA	2500	0.092	NA	0.092	7.95E+03	0.1	7.95E+04	1.04E+07	UG/KG	UG/L	NO	NO
Dibenzo(a,h)anthracene	6300	550	ND	NA	800	0.0092	NA	0.0092	7.95E+02	0.01	7.95E+04	6.36E+06	UG/KG	UG/L	NO	NO
Indeno(1,2,3-cd)pyrene	8000	1000	ND	NA	7000	0.092	NA	0.092	7.95E+03	0.1	7.95E+04	1.04E+07	UG/KG	UG/L	NO	NO
Pesticides/PCB Compounds																
delta-BHC	13	22	ND	NA	1.5	0.037	NA	0.037	3.20E+03	0.05	6.39E+04	9.59E+03	UG/KG	UG/L	NO	NO
Dieldrin	5.4	15	ND	NA	2	0.0042	0.0019	0.0019	1.64E+02	0.005	3.28E+04	6.57E+03	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	9	10.3	ND	NA	2.5	15	NA	15	1.30E+06	6	2.16E+05	5.40E+04	MG/KG	UG/L	NO	NO
Arsenic	27.8	64.1	5.1	NA	14.6	0.045	36	0.045	3.89E+03	50	7.78E+01	1.14E+02	MG/KG	UG/L	NO	NO
Chromium (total)	197	48.5	1.4	NA	19	180	50	50	4.32E+06	100	4.32E+04	8.21E+04	MG/KG	UG/L	NO	NO
Cobalt	554	10	ND	NA	1040	2200	NA	2200	1.90E+08	2200	8.64E+04	1.00E+06	MG/KG	UG/L	NO	NO
Copper	197	548	ND	NA	458	1500	2.9	2.9	2.51E+05	1300	1.93E+02	8.83E+03	MG/KG	UG/L	NO	NO
Lead	919	9930	ND	NA	400	15	8.5	8.5	7.34E+05	15	4.90E+04	1.00E+06	MG/KG	UG/L	NO	NO
Mercury	27.3	11.7	ND	NA	1.04	11	0.2	0.2	1.73E+04	2	8.64E+03	8.99E+02	MG/KG	UG/L	NO	NO
Nickel	134	18	ND	NA	65	730	42.2	42.2	3.65E+06	100	3.65E+04	2.37E+05	MG/KG	UG/L	NO	NO
Thallium	ND	3.3	ND	NA	0.36	2.9	21.3	2.9	2.51E+05	2	1.25E+05	4.51E+03	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 86,400: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.14.7.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMU 102
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	59	62000000	UG/KG	NO
2-Butanone (MEK)	8	10000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996. The value for 2-Butanone (MEK) was estimated.

10.14.8 Fixed-Point Risk Evaluation for SWMU 102

10.14.8.1 Site Background and Investigative Approach

SWMU 102 is the site of a reported mercury spill under the central portion of Building 79. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of 43 surface soil samples were considered in the SWMU 102 FRE (21 of these surface soil samples were analyzed for mercury only). One monitoring well was installed as part of the 1995 RFI. This monitoring well was installed into the shallow aquifer. Groundwater data generated from the first-quarter RFI sampling event are used to represent point risk/hazard for the SWMU 102 FRE. Sections 10.14.1 and 10.14.3 contain summaries of the sampling effort for SWMU 102 soil and groundwater.

10.14.8.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.14.8.1 provides CPSS summaries for SWMU 102 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Based on residential RBCs, seven COPCs (antimony, arsenic, BEQs, chromium, cobalt, lead, manganese, and mercury) were identified for SWMU 102. Chromium, which predominantly exists in either the trivalent or hexavalent state, was identified as a COPC based on a conservative comparison of the maximum concentration (regardless of valence) to the RBC for its hexavalent species (39 mg/kg). Analyses for hexavalent chromium in soil indicate that the trivalent valence state predominates for SWMU 102 surface soil. The RBC for trivalent chromium is 7,800 mg/kg. Since it is evident that SWMU 102 chromium in soil predominantly exist in the trivalent state, chromium was eliminated as a COPC. Aluminum and beryllium were detected in SWMU 102 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE 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 based on background concentration.

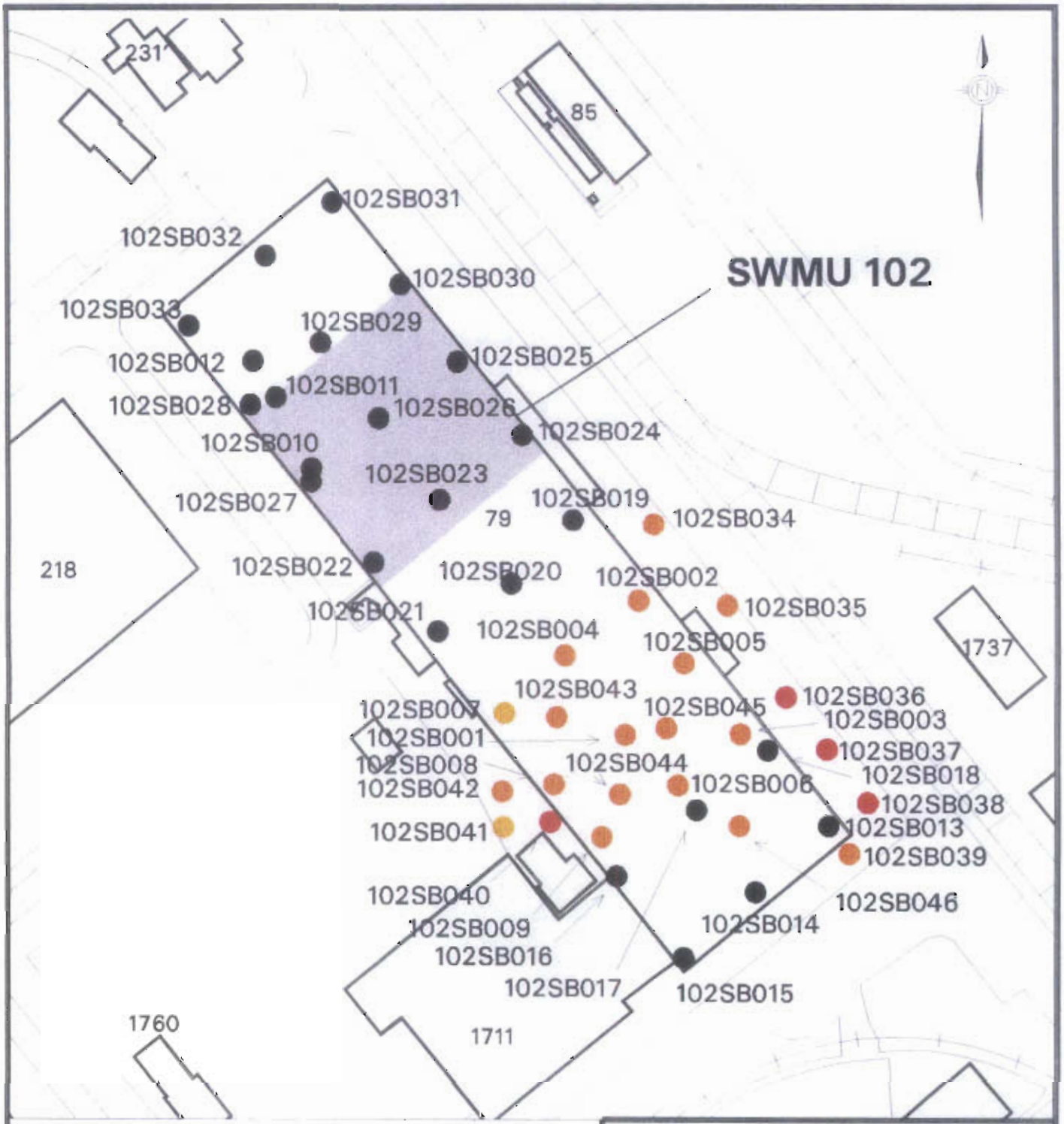
Table 10.14.8.2 summarizes the residential COPCs detected at each combined SWMU 102 sample location with contribution to risk and hazard. As shown, arsenic and BEQ compounds are the only contributors to risk for SWMU 102, exceeding 1E-06 at all 22 locations. Figure 10.14.3 is a spatial presentation of residential risk estimates for SWMU 102 soil. Risk estimates range from 8E-06 to 4E-04 with an arithmetic mean risk of 7E-05.

Figure 10.14.4 is a spatial presentation of HI estimates for SWMU 102 surface soil. As shown, HI projections exceeded the threshold of unity at 10 of 43 sample locations. Seven surface soil samples (102SB020, 102SB023, 102SB024, 102SB026, 102SB028, 102SB029, and 102SB031) had no detected COPCs that would have contributed to HI estimate. HI estimates range from 0.002 to 2 with an arithmetic mean HI of 0.5 (assuming a deminumus HI of 0.01 for sample locations with no COPCs that would have contributed to HI projections). Concentrations of arsenic and mercury were the primary contributors to HI projections.

Industrial Scenario

Based on industrial RBCs, arsenic and BEQs were identified as COPCs for SWMU 102 soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.14.8.3 summarizes the industrial COPCs detected at each SWMU 102 sample location with contribution to risk and hazard. As shown, arsenic and BEQ compounds are the only contributors to risk for SWMU 102, exceeding 1E-06 at all 22 locations, based on the industrial scenario. Figure 10.14.5 is a spatial presentation of industrial scenario risk estimates for



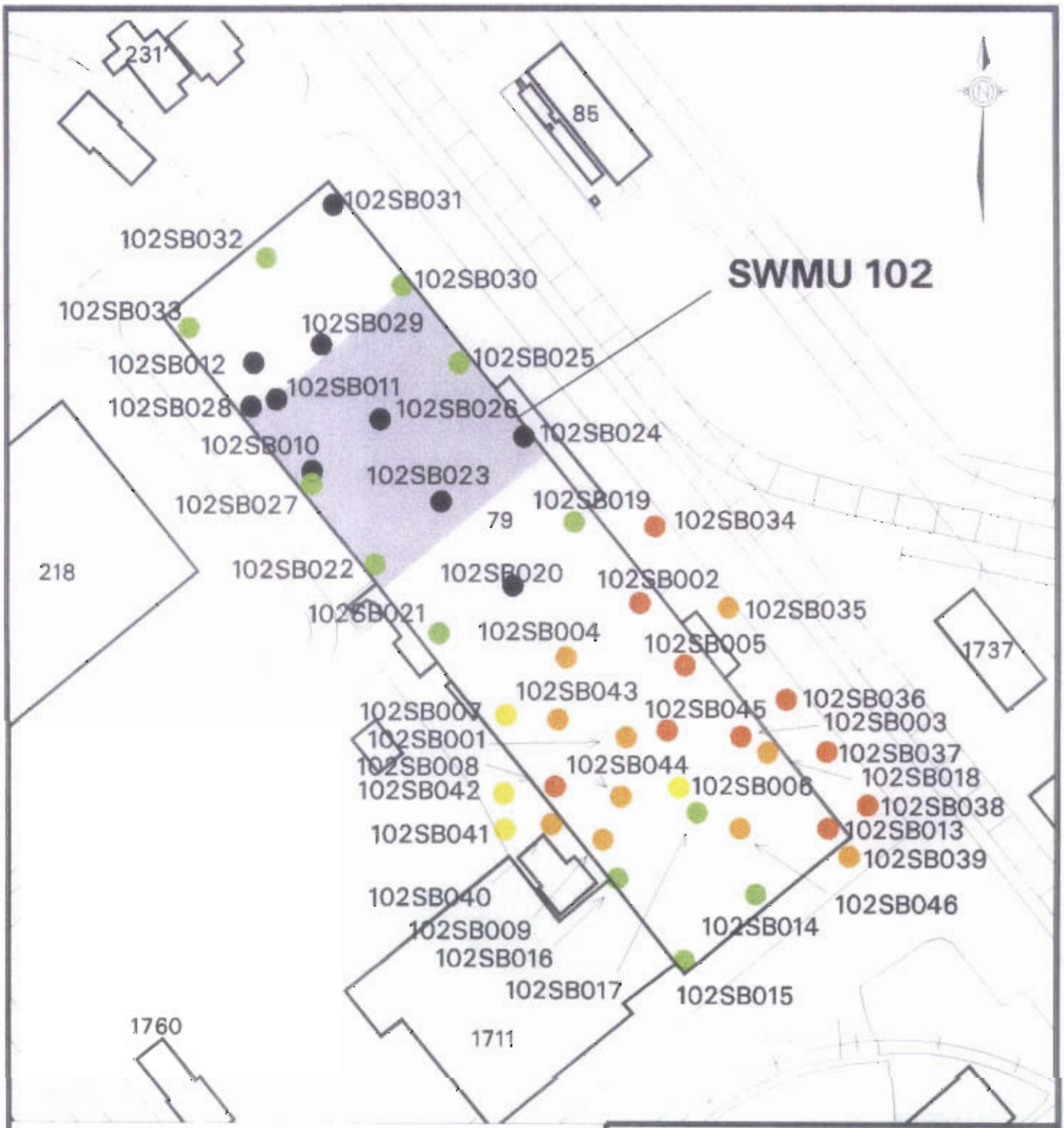
LEGEND - CUMULATIVE SOIL RISK

- 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

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

FIGURE 10.14.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
SWMU 102



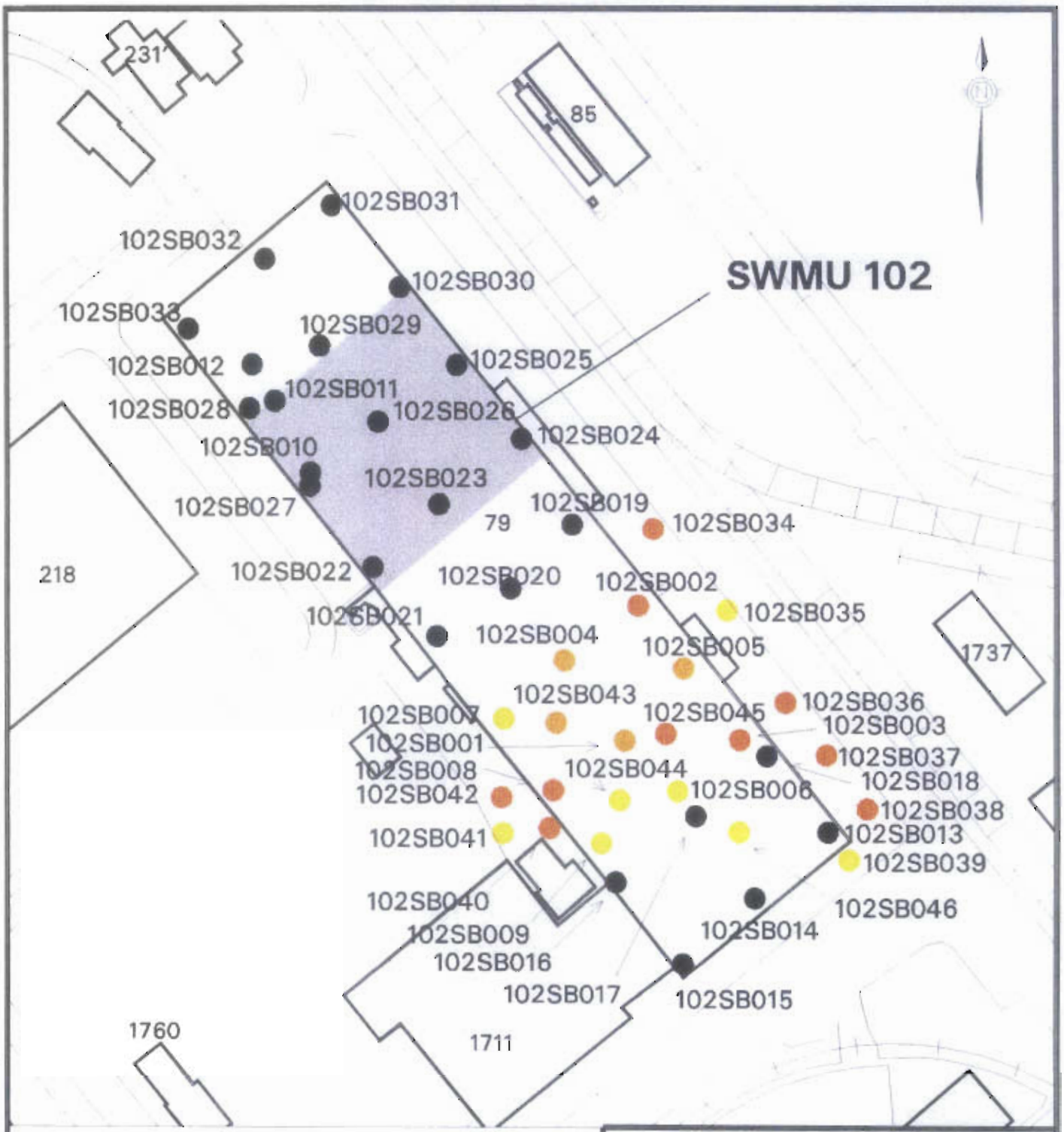
LEGEND - CUMULATIVE SOIL HAZARD

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

0 feet 160

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

FIGURE 10.14.4
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
SWMU 102



LEGEND - CUMULATIVE SOIL RISK

- 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

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

FIGURE 10.14.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
SWMU 102

combined SWMU 21 surface soil. Risk estimates range from 1E-06 to 7E-05 with an arithmetic mean risk of 1E-05. HI projections did not exceed the threshold of unity at any sample locations based on the industrial scenario. HI estimates range from 0.006 to 0.06.

Lead

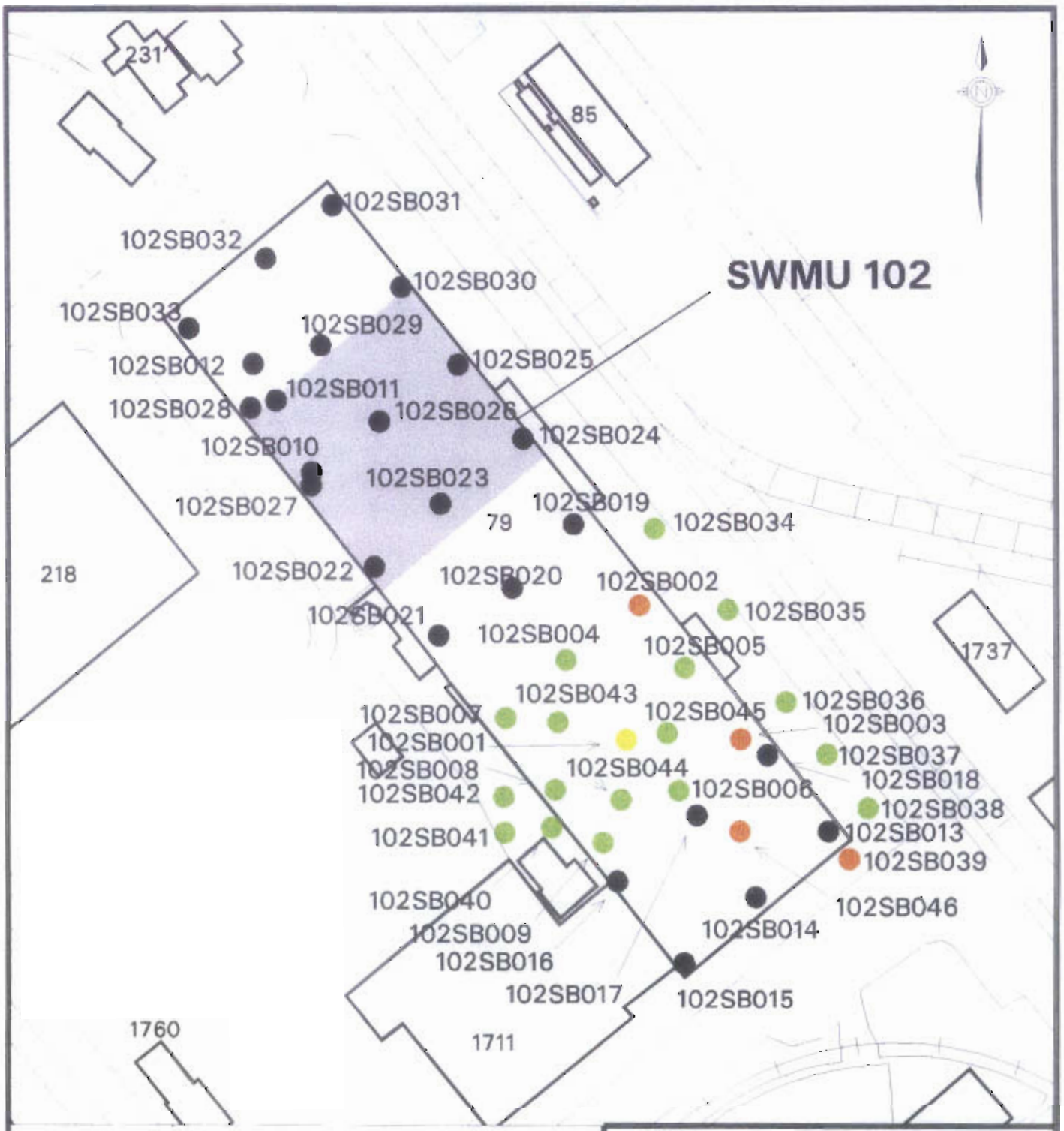
Lead was detected in all 22 surface soil samples collected and analyzed for this parameter at SWMU 102. Soil concentrations ranged from 5.7 to 919 mg/kg and exceeded the residential clean up level of 400 mg/kg in four of 22 samples (102SB002, 102SB003, 102SB039, and 102SB046). The mean detected lead concentration for SWMU 102 is 222 mg/kg which is below the action level of 400 mg/kg, considered protective of children under a residential scenario, and the industrial cleanup level of 1,300 mg/kg, considered protective of adults under an industrial scenario. Additionally, the mean lead soil concentration within the worst one-half acre exposure area (as represented by samples 102SB003, 102SB005, 102SB006, 102SB035, 102SB036, 102SB038, 102SB039, 102SB046) was calculated to be approximately 345 mg/kg. Figure 10.14.6 is a spatial presentation of lead soil concentrations, using the surface soil background concentration of 265 mg/kg, the residential soil lead cleanup level of 400 mg/kg, and the industrial soil lead cleanup concentration of 1,300 mg/kg as benchmark levels to illustrate the lead soil concentrations for SWMU 102.

10.14.8.3 Fixed-Point Risk Evaluation for Groundwater

No COPCs were identified for SWMU 102 groundwater based on first-quarter results.

10.14.8.4 Uncertainty

SWMU 102 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.



LEAD IN SURFACE SOIL

- NON DETECT
- < 265
- 265 - 400
- 401 - 1,300
- > 1,300

0 feet 160

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

FIGURE 10.14.6
DISTRIBUTION OF LEAD
IN SURFACE SOIL
SWMU 102

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 SCDEHC 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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at SWMU 102, 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.

COPC Selection

Chromium was identified as a COPC in soil based on a conservative comparison to the RBC for the hexavalent species. One surface soil sample was analyzed for hexavalent chromium and had

no detectable concentrations. Chromium was therefore eliminated as a soil COPC based on comparison to the RBC for trivalent chromium. The maximum concentration of chromium (197 mg/kg) was detected in surface soil sample 102SB041. Hexavalent chromium analysis was conducted on surface soil sample 102CB004 which is in the same general location as 102SB041. These findings indicate that uncertainty associated with the elimination of chromium as a COPC is minimal.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for SWMU 102 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

Aluminum and beryllium were present in SWMU 102 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their background concentration. As a result, their contribution to risk/hazard has not been considered in this FRE.

Arsenic was a contributor to both risk and hazard projections for residential and industrial soil pathways. Arsenic exceeded its background RC in only three of 22 surface soil samples (102SB034, 102SB036, and 102SB038). These findings indicate that while arsenic contributes to

elevated risk and hazard projections, its maximum concentration was only marginally above background RCs and its average concentrations was below its background RC.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 concentrations close to its RBCs (e.g. within 10% of its RBCs).

10.14.8.5 FRE Summary

The risk and hazard posed by contaminants at SWMU 102 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first-quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.14.8.2 and 10.14.8.3 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO. Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Arsenic, BEQ compounds, and mercury were detected in SWMU 102 surface soil at concentrations above their residential RGOs. It should be noted that arsenic, one of the primary contributors to risk and hazard projections, was detected at a maximum concentration only marginally above its background RC.

Soil — Site Worker Scenario

Arsenic and BEQ compounds were detected in SWMU 102 surface soil at concentrations above their industrial RGOs. It should be noted that arsenic was detected at a maximum concentration only marginally above its background RC.

Groundwater — Residential Scenario

No COPCs were identified for groundwater at SWMU 102.

Table 10.14.8.1
Chemicals Present in Site Samples
SWMU 102 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RBC	Ref.
Carcinogenic PAHs													
B(a)P Equiv.	* *	20	22	0.051 - 17501	2743.3	1664 - 1779	88	780	NA	UG/KG	15	12	
Benzo(a)anthracene	* *	18	22	48 - 10000	1835.9	480 - 930	880	7800	NA	UG/KG	10	1	
Benzo(a)pyrene	* *	17	22	46 - 8200	1910.7	480 - 930	88	780	NA	UG/KG	15	11	
Benzo(b)fluoranthene	* *	15	22	51 - 11000	2423.4	480 - 930	880	7800	NA	UG/KG	10	1	
Benzo(k)fluoranthene	*	17	22	53 - 9300	1924.7	480 - 930	8800	78000	NA	UG/KG	1		
Chrysene		20	22	50 - 8400	1798.1	720 - 770	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	* *	13	22	100 - 6300	973.8	370 - 930	88	780	NA	UG/KG	13	3	
Indeno(1,2,3-cd)pyrene	* *	15	22	310 - 8000	1614.7	370 - 930	880	7800	NA	UG/KG	7	1	
Gasoline		1	1	42.8 - 42.8	42.8	NA - NA	NA	NA	NA	UG/KG			
TCDD Equivalents													
Dioxin Equiv.		1	1	0.13 - 0.13	0.13	NA - NA	1000	1000	NA	NG/KG			
Inorganics													
Aluminum (Al)		22	22	2380 - 12500	7180.9	NA - NA	7800	100000	26600	MG/KG	9		
Antimony (Sb)	*	12	22	0.6 - 9	1.7	0.46 - 5	3.1	82	1.77	MG/KG	1		2
Arsenic (As)	* *	22	22	2.6 - 27.8	12.4	NA - NA	0.43	3.8	23.9	MG/KG	22	20	3
Barium (Ba)		13	22	15.5 - 78.5	33.35	6.7 - 84	550	14000	130	MG/KG			
Beryllium (Be)		20	22	0.31 - 0.81	0.58	0.11 - 0.11	0.15	1.3	1.7	MG/KG	20		
Cadmium (Cd)		19	22	0.14 - 1.3	0.58	0.11 - 0.12	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	22	22	4820 - 79400	38776	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)	*	22	22	4.5 - 197	37.0	NA - NA	39	1000	94.6	MG/KG	3		2
Chromium (Hexavalent)		0	1	ND - ND	ND	0.0746 - 0.0746	39	1000	NA	MG/KG			
Cobalt (Co)	*	22	22	2.7 - 554	55.4	NA - NA	470	12000	19	MG/KG	1		8
Copper (Cu)		22	22	2.4 - 197	53.0	NA - NA	310	8200	66	MG/KG			6
Cyanide (CN)		3	22	0.22 - 1.3	0.91	0.1 - 0.32	160	4100	0.5	MG/KG			2
Iron (Fe)	N	22	22	2680 - 17900	11372	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)	*	22	22	5.7 - 919	222	NA - NA	400	1300	265	MG/KG	4		6
Magnesium (Mg)	N	21	22	488 - 5150	3157	293 - 293	NA	NA	NA	MG/KG			
Manganese (Mn)	*	22	22	26.1 - 387	149	NA - NA	180	4700	302	MG/KG	7		1
Mercury (Hg)	*	36	43	0.05 - 27.3	4.42	0.04 - 0.04	2.3	61	2.6	MG/KG	11		11
Nickel (Ni)		22	22	3.3 - 134	19.2	NA - NA	160	4100	77.1	MG/KG			1
Potassium (K)	N	4	22	1130 - 2030	1423	172 - 2180	NA	NA	NA	MG/KG			

Table 10.14.8.1
Chemicals Present in Site Samples
SWMU 102 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RBC	Ref.
Selenium (Se)		7	22	0.73 - 1.5	1.07	0.52 - 0.77	39	1000	1.7	MG/KG			
Silver (Ag)		7	22	0.25 - 11	2.31	0.23 - 0.32	39	1000	NA	MG/KG			
Sodium (Na)	N	13	22	300 - 1870	944.6	131 - 611	NA	NA	NA	MG/KG			
Tin (Sn)		6	22	2.6 - 43.2	12.53	2.2 - 8.4	4700	6100	59.4	MG/KG			
Vanadium (V)		22	22	6.6 - 35.2	21	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		21	22	11 - 1130	280.6	8.3 - 8.3	2300	61000	827	MG/KG			1
Pesticides													
4,4'-DDD		4	22	8.4 - 87	33.6	2.7 - 3.8	2700	24000	NA	UG/KG			
4,4'-DDE		5	22	28 - 190	63.2	2.7 - 3.8	1900	17000	NA	UG/KG			
4,4'-DDT		7	22	8.5 - 230	113	2.7 - 3.8	1900	17000	NA	UG/KG			
alpha-Chlordane		2	22	5.8 - 14	9.9	1.4 - 2	470	2200	NA	UG/KG			
delta-BHC		1	22	13 - 13	13	1.4 - 2	100	910	NA	UG/KG			
Dieldrin		1	22	5.4 - 5.4	5.4	2.7 - 3.8	40	360	NA	UG/KG			
Endrin aldehyde		1	22	3.4 - 3.4	3.4	2.7 - 3.8	2300	61000	NA	UG/KG			
Endrin ketone		2	22	7.9 - 20	14.0	2.7 - 3.8	2300	61000	NA	UG/KG			
gamma-Chlordane		4	22	4.1 - 53	27.8	1.4 - 2	470	2200	NA	UG/KG			
Heptachlor		1	22	2.4 - 2.4	2.4	1.4 - 2	140	1300	NA	UG/KG			
Heptachlor epoxide		2	22	2.4 - 8.9	5.65	1.4 - 2	70	630	NA	UG/KG			
Methoxychlor		2	22	19 - 42	30.5	14 - 20	39000	1000000	NA	UG/KG			
Semivolatile Organics													
2-Methylnaphthalene		9	22	67 - 320	213	370 - 980	310000	8200000	NA	UG/KG			
Acenaphthene		11	22	89 - 810	412.6	370 - 1600	470000	12000000	NA	UG/KG			
Acenaphthylene		4	22	140 - 2300	877.5	370 - 2000	310000	8200000	NA	UG/KG			
Anthracene		15	22	140 - 2600	836	370 - 930	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene		15	22	320 - 9400	1735	370 - 930	310000	8200000	NA	UG/KG			
Benzoic acid		3	22	39 - 85	56.7	2400 - 9500	31000000	100000000	NA	UG/KG			
bis(2-Ethylhexyl)phthalate (BEHP)		4	22	44 - 600	316	370 - 2000	46000	410000	NA	UG/KG			
Butylbenzylphthalate		1	22	2100 - 2100	2100	370 - 2000	1600000	41000000	NA	UG/KG			
Dibenzofuran		9	22	99 - 540	254.3	370 - 2000	31000	820000	NA	UG/KG			
Di-n-butylphthalate		2	22	59 - 280	169.5	370 - 2000	780000	20000000	NA	UG/KG			
Fluoranthene		20	22	72 - 16000	2724	720 - 770	310000	8200000	NA	UG/KG			
Fluorene		12	22	82 - 1400	458	370 - 930	310000	8200000	NA	UG/KG			
Naphthalene		9	22	84 - 540	228	480 - 2000	310000	8200000	NA	UG/KG			

Table 10.14.8.1
Chemicals Present in Site Samples
SWMU 102 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Number Exceeding Ind. RBC	Number Exceeding Ref.
Phenanthrene	19	22	66 - 9600	2278	370 - 770	310000	8200000	NA	UG/KG			
Pyrene	20	22	90 - 17000	3786	720 - 770	230000	6100000	NA	UG/KG			
Volatile Organics												
2-Butanone (MEK)	1	15	8 - 8	8	10 - 15	4700000	100000000	NA	UG/KG			
Acetone	1	15	59 - 59	59	10 - 68	780000	20000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.14.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B001	Antimony (Sb)	1.20	MG/KG	NA		0.0411	5.37
102	B001	Arsenic (As)	9.90	MG/KG	25.8588	67.65	0.4525	59.02
102	B001	B(a)P Equiv.	746.71	UG/KG	12.3658	32.35	NA	
102	B001	Cobalt (Co)	11.80	MG/KG	NA		0.0027	0.35
102	B001	Lead (Pb)	387.00	MG/KG	NA		NA	
102	B001	Manganese (Mn)	206.00	MG/KG	NA		0.0601	7.84
102	B001	Mercury (Hg)	4.60	MG/KG	NA		0.2103	27.42
		Total			38.2246		0.7667	
102	B002	Antimony (Sb)	1.60	MG/KG	NA		0.0548	3.49
102	B002	Arsenic (As)	14.30	MG/KG	37.3516	53.03	0.6536	41.65
102	B002	B(a)P Equiv.	1998.00	UG/KG	33.0875	46.97	NA	
102	B002	Cobalt (Co)	4.00	MG/KG	NA		0.0009	0.06
102	B002	Lead (Pb)	434.00	MG/KG	NA		NA	
102	B002	Manganese (Mn)	269.00	MG/KG	NA		0.0785	5.00
102	B002	Mercury (Hg)	17.10	MG/KG	NA		0.7816	49.80
		Total			70.4391		1.5695	
102	B003	Antimony (Sb)	0.76	MG/KG	NA		0.0261	2.25
102	B003	Arsenic (As)	12.30	MG/KG	32.1276	47.44	0.5622	48.52
102	B003	B(a)P Equiv.	2149.80	UG/KG	35.6014	52.56	NA	
102	B003	Cobalt (Co)	3.30	MG/KG	NA		0.0008	0.07
102	B003	Lead (Pb)	415.00	MG/KG	NA		NA	
102	B003	Manganese (Mn)	214.00	MG/KG	NA		0.0624	5.39
102	B003	Mercury (Hg)	11.10	MG/KG	NA		0.5074	43.78
		Total			67.7290		1.1588	
102	B004	Antimony (Sb)	0.81	MG/KG	NA		0.0278	5.13
102	B004	Arsenic (As)	8.60	MG/KG	22.4632	56.90	0.3931	72.63
102	B004	B(a)P Equiv.	1027.62	UG/KG	17.0177	43.10	NA	
102	B004	Cobalt (Co)	4.60	MG/KG	NA		0.0011	0.19
102	B004	Lead (Pb)	83.70	MG/KG	NA		NA	
102	B004	Manganese (Mn)	174.00	MG/KG	NA		0.0508	9.38
102	B004	Mercury (Hg)	1.50	MG/KG	NA		0.0686	12.67
		Total			39.4809		0.5412	
102	B005	Antimony (Sb)	0.60	MG/KG	NA		0.0206	2.04
102	B005	Arsenic (As)	9.50	MG/KG	24.8140	52.33	0.4342	43.12
102	B005	B(a)P Equiv.	1364.98	UG/KG	22.6045	47.67	NA	
102	B005	Cobalt (Co)	2.70	MG/KG	NA		0.0006	0.06
102	B005	Lead (Pb)	229.00	MG/KG	NA		NA	
102	B005	Manganese (Mn)	387.00	MG/KG	NA		0.1129	11.21
102	B005	Mercury (Hg)	9.60	MG/KG	NA		0.4388	43.57
		Total			47.4185		1.0071	

Table 10.14.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B006	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B006	Arsenic (As)	6.50	MG/KG	16.9780	57.76	0.2971	77.85
102	B006	B(a)P Equiv.	749.87	UG/KG	12.4181	42.24	NA	
102	B006	Cobalt (Co)	4.10	MG/KG	NA		0.0009	0.25
102	B006	Lead (Pb)	86.50	MG/KG	NA		NA	
102	B006	Manganese (Mn)	98.60	MG/KG	NA		0.0288	7.54
102	B006	Mercury (Hg)	1.20	MG/KG	NA		0.0548	14.37
		Total			29.3961		0.3817	
102	B007	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B007	Arsenic (As)	3.10	MG/KG	8.0972	100.00	0.1417	90.48
102	B007	B(a)P Equiv.	ND	UG/KG	NA		NA	
102	B007	Cobalt (Co)	5.50	MG/KG	NA		0.0013	0.80
102	B007	Lead (Pb)	5.70	MG/KG	NA		NA	
102	B007	Manganese (Mn)	37.40	MG/KG	NA		0.0109	6.97
102	B007	Mercury (Hg)	0.06	MG/KG	NA		0.0027	1.75
		Total			8.0972		0.1566	
102	B008	Antimony (Sb)	0.93	MG/KG	NA		0.0319	1.63
102	B008	Arsenic (As)	13.40	MG/KG	35.0008	41.91	0.6125	31.27
102	B008	B(a)P Equiv.	2929.00	UG/KG	48.5052	58.09	NA	
102	B008	Cobalt (Co)	4.60	MG/KG	NA		0.0011	0.05
102	B008	Lead (Pb)	106.00	MG/KG	NA		NA	
102	B008	Manganese (Mn)	224.00	MG/KG	NA		0.0653	3.34
102	B008	Mercury (Hg)	27.30	MG/KG	NA		1.2478	63.71
		Total			83.5060		1.9586	
102	B009	Antimony (Sb)	0.66	MG/KG	NA		0.0226	3.90
102	B009	Arsenic (As)	8.50	MG/KG	22.2020	99.99	0.3885	67.03
102	B009	B(a)P Equiv.	0.12	UG/KG	0.0020	0.01	NA	
102	B009	Cobalt (Co)	3.10	MG/KG	NA		0.0007	0.12
102	B009	Lead (Pb)	60.20	MG/KG	NA		NA	
102	B009	Manganese (Mn)	152.00	MG/KG	NA		0.0443	7.65
102	B009	Mercury (Hg)	2.70	MG/KG	NA		0.1234	21.29
		Total			22.2040		0.5796	
102	B013	Mercury (Hg)	22.60	MG/KG	NA		1.0330	100.00
		Total			NA		1.0330	
102	B014	Mercury (Hg)	0.16	MG/KG	NA		0.0073	100.00
		Total			NA		0.0073	
102	B015	Mercury (Hg)	0.18	MG/KG	NA		0.0082	100.00
		Total			NA		0.0082	

Table 10.14.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B016	Mercury (Hg)	0.93	MG/KG	NA		0.0425	100.00
		Total			NA		0.0425	
102	B017	Mercury (Hg)	0.93	MG/KG	NA		0.0425	100.00
		Total			NA		0.0425	
102	B018	Mercury (Hg)	18.60	MG/KG	NA		0.8502	100.00
		Total			NA		0.8502	
102	B019	Mercury (Hg)	0.28	MG/KG	NA		0.0128	100.00
		Total			NA		0.0128	
102	B020	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B021	Mercury (Hg)	0.05	MG/KG	NA		0.0023	100.00
		Total			NA		0.0023	
102	B022	Mercury (Hg)	0.18	MG/KG	NA		0.0082	100.00
		Total			NA		0.0082	
102	B023	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B024	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B025	Mercury (Hg)	0.16	MG/KG	NA		0.0073	100.00
		Total			NA		0.0073	
102	B026	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B027	Mercury (Hg)	0.07	MG/KG	NA		0.0032	100.00
		Total			NA		0.0032	
102	B028	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B029	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B030	Mercury (Hg)	0.08	MG/KG	NA		0.0037	100.00
		Total			NA		0.0037	

Table 10.14.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B031	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
102	B032	Mercury (Hg)	0.13	MG/KG	NA		0.0059	100.00
		Total			NA		0.0059	
102	B033	Mercury (Hg)	0.06	MG/KG	NA		0.0027	100.00
		Total			NA		0.0027	
102	B034	Antimony (Sb)	9.00	MG/KG	NA		0.3085	19.00
102	B034	Arsenic (As)	27.80	MG/KG	72.6136	74.04	1.2707	78.27
102	B034	B(a)P Equiv.	1537.40	UG/KG	25.4598	25.96	NA	
102	B034	Cobalt (Co)	33.60	MG/KG	NA		0.0077	0.47
102	B034	Lead (Pb)	260.00	MG/KG	NA		NA	
102	B034	Manganese (Mn)	66.10	MG/KG	NA		0.0193	1.19
102	B034	Mercury (Hg)	0.38	MG/KG	NA		0.0174	1.07
		Total			98.0735		1.6235	
102	B035	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B035	Arsenic (As)	13.10	MG/KG	34.2172	100.00	0.5988	81.33
102	B035	B(a)P Equiv.	ND	UG/KG	NA		NA	
102	B035	Cobalt (Co)	554.00	MG/KG	NA		0.1266	17.20
102	B035	Lead (Pb)	31.40	MG/KG	NA		NA	
102	B035	Manganese (Mn)	27.80	MG/KG	NA		0.0081	1.10
102	B035	Mercury (Hg)	0.06	MG/KG	NA		0.0027	0.37
		Total			34.2172		0.7362	
102	B036	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B036	Arsenic (As)	26.60	MG/KG	69.4792	44.69	1.2158	90.16
102	B036	B(a)P Equiv.	5192.70	UG/KG	85.9927	55.31	NA	
102	B036	Cobalt (Co)	69.80	MG/KG	NA		0.0160	1.18
102	B036	Lead (Pb)	339.00	MG/KG	NA		NA	
102	B036	Manganese (Mn)	118.00	MG/KG	NA		0.0344	2.55
102	B036	Mercury (Hg)	1.80	MG/KG	NA		0.0823	6.10
		Total			155.4720		1.3485	
102	B037	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B037	Arsenic (As)	23.50	MG/KG	61.3820	17.48	1.0741	93.34
102	B037	B(a)P Equiv.	17501.40	UG/KG	289.8287	82.52	NA	
102	B037	Cobalt (Co)	61.30	MG/KG	NA		0.0140	1.22
102	B037	Lead (Pb)	190.00	MG/KG	NA		NA	
102	B037	Manganese (Mn)	138.00	MG/KG	NA		0.0403	3.50
102	B037	Mercury (Hg)	0.49	MG/KG	NA		0.0224	1.95
		Total			351.2107		1.1508	

Table 10.14.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B038	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B038	Arsenic (As)	27.20	MG/KG	71.0464	44.25	1.2433	93.52
102	B038	B(a)P Equiv.	5404.30	UG/KG	89.4969	55.75	NA	
102	B038	Cobalt (Co)	70.70	MG/KG	NA		0.0162	1.22
102	B038	Lead (Pb)	98.00	MG/KG	NA		NA	
102	B038	Manganese (Mn)	163.00	MG/KG	NA		0.0475	3.58
102	B038	Mercury (Hg)	0.49	MG/KG	NA		0.0224	1.68
		Total			160.5433		1.3294	
102	B039	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B039	Arsenic (As)	9.40	MG/KG	24.5528	97.86	0.4297	78.54
102	B039	B(a)P Equiv.	32.41	UG/KG	0.5367	2.14	NA	
102	B039	Cobalt (Co)	6.20	MG/KG	NA		0.0014	0.26
102	B039	Lead (Pb)	919.00	MG/KG	NA		NA	
102	B039	Manganese (Mn)	84.20	MG/KG	NA		0.0246	4.49
102	B039	Mercury (Hg)	2.00	MG/KG	NA		0.0914	16.71
		Total			25.0895		0.5470	
102	B040	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B040	Arsenic (As)	10.60	MG/KG	27.6872	17.02	0.4845	62.20
102	B040	B(a)P Equiv.	8149.80	UG/KG	134.9632	82.98	NA	
102	B040	Cobalt (Co)	9.30	MG/KG	NA		0.0021	0.27
102	B040	Lead (Pb)	83.80	MG/KG	NA		NA	
102	B040	Manganese (Mn)	77.60	MG/KG	NA		0.0226	2.91
102	B040	Mercury (Hg)	5.90	MG/KG	NA		0.2697	34.62
		Total			162.6504		0.7789	
102	B041	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B041	Arsenic (As)	2.60	MG/KG	6.7912	87.89	0.1188	86.19
102	B041	B(a)P Equiv.	56.48	UG/KG	0.9353	12.11	NA	
102	B041	Cobalt (Co)	28.00	MG/KG	NA		0.0064	4.64
102	B041	Lead (Pb)	15.00	MG/KG	NA		NA	
102	B041	Manganese (Mn)	26.10	MG/KG	NA		0.0076	5.52
102	B041	Mercury (Hg)	0.11	MG/KG	NA		0.0050	3.65
		Total			7.7265		0.1379	
102	B042	Antimony (Sb)	ND	MG/KG	NA		NA	
102	B042	Arsenic (As)	7.10	MG/KG	18.5452	33.24	0.3245	85.93
102	B042	B(a)P Equiv.	2248.80	UG/KG	37.2408	66.76	NA	
102	B042	Cobalt (Co)	48.80	MG/KG	NA		0.0112	2.95
102	B042	Lead (Pb)	33.20	MG/KG	NA		NA	
102	B042	Manganese (Mn)	95.30	MG/KG	NA		0.0278	7.36
102	B042	Mercury (Hg)	0.31	MG/KG	NA		0.0142	3.75
		Total			55.7860		0.3776	

Table 10.14.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B043	Antimony (Sb)	1.00	MG/KG	NA		0.0343	6.10
102	B043	Arsenic (As)	9.00	MG/KG	23.5080	69.20	0.4114	73.22
102	B043	B(a)P Equiv.	631.92	UG/KG	10.4648	30.80	NA	
102	B043	Cobalt (Co)	17.80	MG/KG	NA		0.0041	0.72
102	B043	Lead (Pb)	58.00	MG/KG	NA		NA	
102	B043	Manganese (Mn)	212.00	MG/KG	NA		0.0618	11.01
102	B043	Mercury (Hg)	1.10	MG/KG	NA		0.0503	8.95
		Total			33.9728		0.5618	
102	B044	Antimony (Sb)	1.10	MG/KG	NA		0.0377	6.64
102	B044	Arsenic (As)	9.20	MG/KG	24.0304	100.00	0.4205	74.00
102	B044	B(a)P Equiv.	0.05	UG/KG	0.0008	0.00	NA	
102	B044	Cobalt (Co)	7.20	MG/KG	NA		0.0016	0.29
102	B044	Lead (Pb)	36.90	MG/KG	NA		NA	
102	B044	Manganese (Mn)	168.00	MG/KG	NA		0.0490	8.62
102	B044	Mercury (Hg)	1.30	MG/KG	NA		0.0594	10.46
		Total			24.0313		0.5683	
102	B045	Antimony (Sb)	1.00	MG/KG	NA		0.0343	2.20
102	B045	Arsenic (As)	10.60	MG/KG	27.6872	35.24	0.4845	31.09
102	B045	B(a)P Equiv.	3071.84	UG/KG	50.8706	64.76	NA	
102	B045	Cobalt (Co)	5.80	MG/KG	NA		0.0013	0.09
102	B045	Lead (Pb)	253.00	MG/KG	NA		NA	
102	B045	Manganese (Mn)	190.00	MG/KG	NA		0.0554	3.56
102	B045	Mercury (Hg)	21.50	MG/KG	NA		0.9827	63.07
		Total			78.5578		1.5583	
102	B046	Antimony (Sb)	1.90	MG/KG	NA		0.0651	8.25
102	B046	Arsenic (As)	9.40	MG/KG	24.5528	95.26	0.4297	54.44
102	B046	B(a)P Equiv.	73.76	UG/KG	1.2215	4.74	NA	
102	B046	Cobalt (Co)	263.00	MG/KG	NA		0.0601	7.62
102	B046	Lead (Pb)	754.00	MG/KG	NA		NA	
102	B046	Manganese (Mn)	145.00	MG/KG	NA		0.0423	5.36
102	B046	Mercury (Hg)	4.20	MG/KG	NA		0.1920	24.33
		Total			25.7743		0.7892	

Table 10.14.8.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B001	Arsenic (As)	9.90	MG/KG	3.6581	59.27	0.0228	100.00
102	B001	B(a)P Equiv.	746.71	UG/KG	2.5143	40.73	NA	
		Total			6.1724		0.0228	
102	B002	Arsenic (As)	14.30	MG/KG	5.2840	43.99	0.0329	100.00
102	B002	B(a)P Equiv.	1998.00	UG/KG	6.7275	56.01	NA	
		Total			12.0115		0.0329	
102	B003	Arsenic (As)	12.30	MG/KG	4.5449	38.57	0.0283	100.00
102	B003	B(a)P Equiv.	2149.80	UG/KG	7.2387	61.43	NA	
		Total			11.7836		0.0283	
102	B004	Arsenic (As)	8.60	MG/KG	3.1778	47.87	0.0198	100.00
102	B004	B(a)P Equiv.	1027.62	UG/KG	3.4601	52.13	NA	
		Total			6.6379		0.0198	
102	B005	Arsenic (As)	9.50	MG/KG	3.5103	43.30	0.0218	100.00
102	B005	B(a)P Equiv.	1364.98	UG/KG	4.5961	56.70	NA	
		Total			8.1064		0.0218	
102	B006	Arsenic (As)	6.50	MG/KG	2.4018	48.75	0.0149	100.00
102	B006	B(a)P Equiv.	749.87	UG/KG	2.5249	51.25	NA	
		Total			4.9267		0.0149	
102	B007	Arsenic (As)	3.10	MG/KG	1.1455	100.00	0.0071	100.00
102	B007	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			1.1455		0.0071	
102	B008	Arsenic (As)	13.40	MG/KG	4.9514	33.42	0.0308	100.00
102	B008	B(a)P Equiv.	2929.00	UG/KG	9.8624	66.58	NA	
		Total			14.8137		0.0308	
102	B009	Arsenic (As)	8.50	MG/KG	3.1408	99.99	0.0195	100.00
102	B009	B(a)P Equiv.	0.12	UG/KG	0.0004	0.01	NA	
		Total			3.1412		0.0195	
102	B034	Arsenic (As)	27.80	MG/KG	10.2723	66.49	0.0639	100.00
102	B034	B(a)P Equiv.	1537.40	UG/KG	5.1766	33.51	NA	
		Total			15.4489		0.0639	
102	B035	Arsenic (As)	13.10	MG/KG	4.8405	100.00	0.0301	100.00
102	B035	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			4.8405		0.0301	
102	B036	Arsenic (As)	26.60	MG/KG	9.8289	35.99	0.0612	100.00
102	B036	B(a)P Equiv.	5192.70	UG/KG	17.4845	64.01	NA	
		Total			27.3134		0.0612	

Table 10.14.8.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 102
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
102	B037	Arsenic (As)	23.50	MG/KG	8.6834	12.84	0.0540	100.00
102	B037	B(a)P Equiv.	17501.40	UG/KG	58.9297	87.16	NA	
		Total			67.6131		0.0540	
102	B038	Arsenic (As)	27.20	MG/KG	10.0506	35.58	0.0625	100.00
102	B038	B(a)P Equiv.	5404.30	UG/KG	18.1970	64.42	NA	
		Total			28.2476		0.0625	
102	B039	Arsenic (As)	9.40	MG/KG	3.4734	96.95	0.0216	100.00
102	B039	B(a)P Equiv.	32.41	UG/KG	0.1091	3.05	NA	
		Total			3.5825		0.0216	
102	B040	Arsenic (As)	10.60	MG/KG	3.9168	12.49	0.0244	100.00
102	B040	B(a)P Equiv.	8149.80	UG/KG	27.4415	87.51	NA	
		Total			31.3583		0.0244	
102	B041	Arsenic (As)	2.60	MG/KG	0.9607	83.48	0.0060	100.00
102	B041	B(a)P Equiv.	56.48	UG/KG	0.1902	16.52	NA	
		Total			1.1509		0.0060	
102	B042	Arsenic (As)	7.10	MG/KG	2.6235	25.73	0.0163	100.00
102	B042	B(a)P Equiv.	2248.80	UG/KG	7.5720	74.27	NA	
		Total			10.1955		0.0163	
102	B043	Arsenic (As)	9.00	MG/KG	3.3256	60.98	0.0207	100.00
102	B043	B(a)P Equiv.	631.92	UG/KG	2.1278	39.02	NA	
		Total			5.4533		0.0207	
102	B044	Arsenic (As)	9.20	MG/KG	3.3995	99.99	0.0212	100.00
102	B044	B(a)P Equiv.	0.05	UG/KG	0.0002	0.01	NA	
		Total			3.3996		0.0212	
102	B045	Arsenic (As)	10.60	MG/KG	3.9168	27.47	0.0244	100.00
102	B045	B(a)P Equiv.	3071.84	UG/KG	10.3433	72.53	NA	
		Total			14.2601		0.0244	
102	B046	Arsenic (As)	9.40	MG/KG	3.4734	93.33	0.0216	100.00
102	B046	B(a)P Equiv.	73.76	UG/KG	0.2484	6.67	NA	
		Total			3.7217		0.0216	

10.14.9 Corrective Measures Considerations

For SWMU 102, the upper and lower soil intervals and the shallow groundwater were investigated. Based on the analytical results and the risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval. 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 paved with concrete or asphalt and all soil samples were collected from beneath the pavement. The industrial exposure risk for the upper soil interval exceeds 1E-06 for arsenic and BEQs. Risk associated with the upper interval is diminished due to the site being capped with concrete and asphalt. Direct exposure is unlikely.

Arsenic, mercury, and BEQs were identified as COCs in the upper soil interval. The soil pathway residential exposure risk ranges between 8E-06 to 4E-04 with an arithmetic mean risk of 7E-05 and the HI ranges between 0.002 and 2 with an arithmetic mean HI of 0.5. Both means are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI.

Lead was identified at four locations (102SB002, 102SB003, 102SB039, and 102SB046) above USEPA's residential acceptable residential level of 400 mg/kg: 434 mg/kg, 415, mg/kg, 919 mg/kg, and 754 mg/kg, respectively. All samples were collected from beneath paved areas.

No COCs were detected in the shallow groundwater at this location. No further action is recommended for the shallow groundwater.

Potential corrective measures in addition to no further action for soil and respective COCs are presented in Table 10.14.9.1.

Table 10.14.9.1
Potential Corrective Measures for SWMU 102

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, lead, mercury, and BaP	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

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10.15 SWMU 106, Blast Area, Drydock 3; and AOC 603, Burning Dump, Drydock 3 Area

SWMU 106 consists of an abrasive blasting area near Drydocks 3 and 4. AOC 603 is outside on an area paved with asphalt/concrete, however, this area at one time was merely graded and covered with rock. When blasting operations occurred, temporary structures were erected using scaffolding and herculite to contain blast material. Steel grit and sodium bicarbonate are the reported materials used for blasting, although blasting operations are rarely conducted here.

AOC 603 has not been investigated previously. However, SWMU 106 was investigated in June of 1989 in the area between Drydocks 3 and 4. Table 10.15.1 summarizes the results of this investigation.

Table 10.15.1
SWMU 106
Previous Investigations

Previous Investigation	Analytical Results	
Date: June 2, 1989	Flash Point	> 140°F
	Total Halogens	0.12 wt%
Type: Blast Media	pH	7.0 @ 25°C
	Arsenic	< 1.0 ppm
Location:	Cadmium	< 0.5 ppm
Adjacent to quaywall between DDs 3 and 4	Chromium	< 1.0 ppm
	Lead	< 1.0 ppm

Materials of concern identified in the *Final Zone E RFI Work Plan*, include metals, paints, solvents, and blasting material at SWMU 106. Petroleum hydrocarbons, and products of incomplete combustion are the materials of concern at AOC 603. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the RFI obligations for SWMU 106 and CSI obligations for AOC 603, soil and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether contamination resulted from onsite activities.

10.15.1 Soil Sampling and Analysis

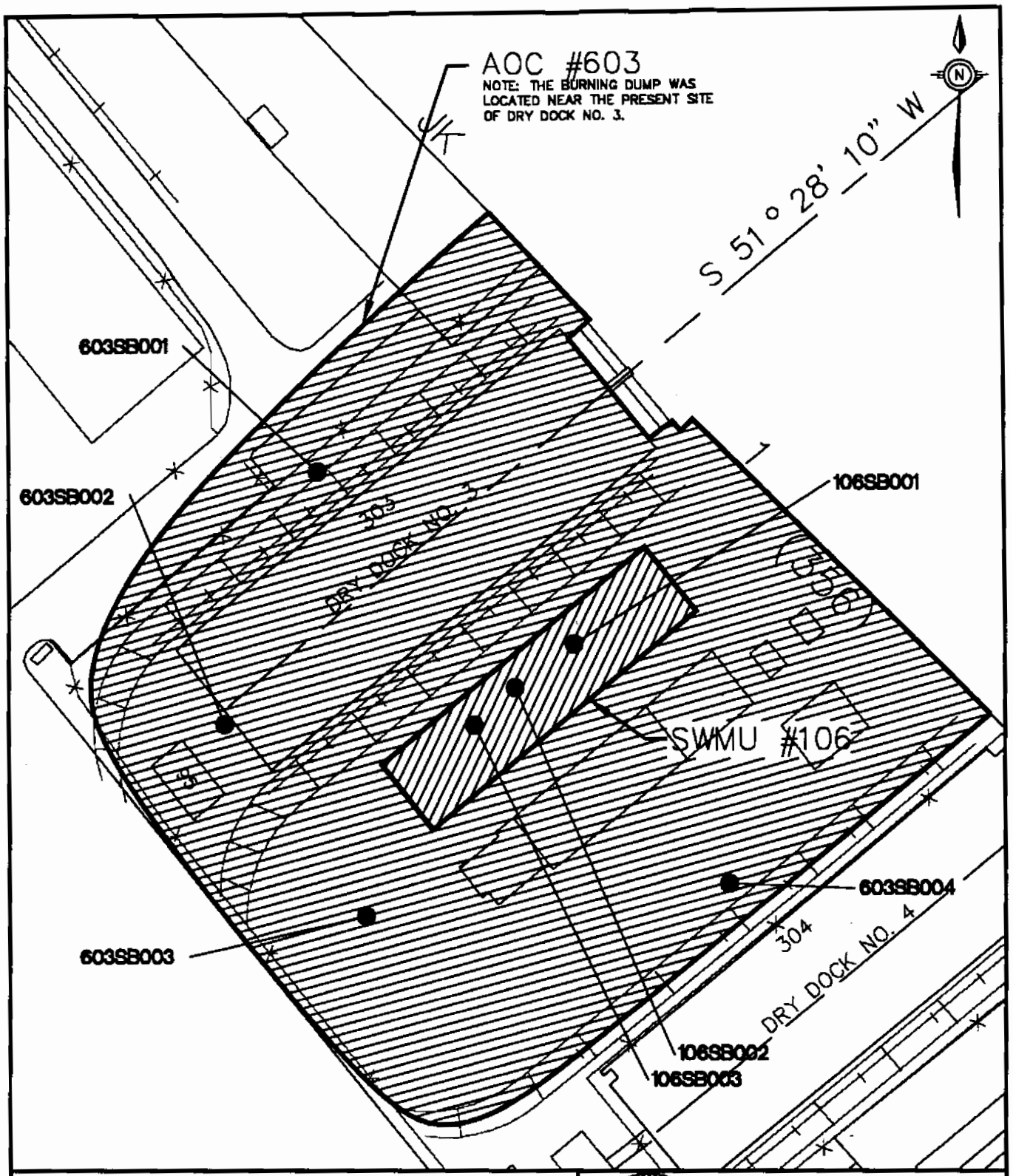
Soil was sampled in one round at SWMU 106 and AOC 603 from the locations shown in Figure 10.15.1. The *Final Zone E RFI Work Plan*, proposed collecting six soil samples from the upper interval and six samples from the lower interval. Soil samples were also collected at both intervals for the shallow monitoring well location proposed at this site.

All seven proposed upper- and seven lower-interval samples were collected. All samples were submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. The grid well location along the northern edge of the site was sampled for the standard suite of parameters at DQO Level III, but it was not sampled for organotins. No samples were selected as duplicates at this site. Table 10.15.1.1 summarizes soil sampling at SWMU 106 and AOC 603.

Table 10.15.1.1
SWMU 106 and AOC 603
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	7	7	Standard Suite[a], organotins	Standard Suite[a], organotins	pH analysis was added to one sample
Lower	7	7	Standard Suite[a], organotins	Standard Suite[a], organotins	pH analysis was added to one sample

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCB



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◓ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.15.1
SOIL BORING LOCATIONS
SWMU #106, BLAST AREA, DD #3
AOC #603
BURNING DUMP, DD #3

DWG DATE: 09/02/97 | DWG NAME: 10-15-1

10.15.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.15.2.1. Inorganic analytical results for soil are summarized in Table 10.15.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.15.2.1
SWMU 106 and AOC 603
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Acetone	Upper	2/7	28.0 - 58.0	43.0	20,000,000	0
	Lower	3/7	44.0 - 84.0	69.0	NA	NA
SVOCs						
Acenaphthene	Upper	1/7	220	220	12,000,000	0
	Lower	1/7	1,100	1,100	NA	NA
Anthracene	Lower	2/7	540 - 1,600	1,070	NA	NA
Benzo(g,h,i)perylene	Upper	6/7	100 - 430	248	8,200,000	0
	Lower	4/7	150 - 640	303	NA	NA
Benzoic acid	Upper	2/7	120 - 180	150	100,000,000	0
	Lower	1/7	140	140	NA	NA
bis(2-Ethylhexyl)phthalate	Lower	1/7	140	140	NA	NA
4-Chloro-3-methylphenol	Upper	1/7	100	100	NA	NA
Dibenzofuran	Lower	1/7	390	390	NA	NA
Fluoranthene	Upper	3/7	79.0 - 240	163	8,200,000	0
	Lower	3/7	110 - 800	447	NA	NA
Fluorene	Lower	2/7	380 - 1,700	1,040	NA	NA
2-Methylnaphthalene	Lower	2/7	410 - 3,500	1,960	NA	NA
Naphthalene	Lower	1/7	870	870	NA	NA

Table 10.15.2.1
SWMU 106 and AOC 603
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs						
Phenanthrene	Upper	3/7	88.0 - 130	109	8,200,000	0
	Lower	3/7	300 - 6,300	2,730	NA	NA
Pyrene	Upper	5/7	120 - 680	274	6,100,000	0
	Lower	5/7	160 - 4,700	1,630	NA	NA
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	5/7	128 - 338	200	780	0
	Lower	5/7	261 - 836	425	NA	NA
Benzo(a)anthracene	Upper	3/7	120 - 180	157	7,800	0
	Lower	5/7	120 - 1,000	428	NA	NA
Benzo(b)fluoranthene	Upper	1/7	82.0	82.0	7,800	0
	Lower	2/7	160 - 190	175	NA	NA
Benzo(k)fluoranthene	Upper	3/7	110 - 240	157	78,000	0
	Lower	4/7	190 - 280	248	NA	NA
Benzo(a)pyrene	Upper	4/7	88.0 - 320	175	780	0
	Lower	5/7	140 - 710	336	NA	NA
Chrysene	Upper	5/7	80.0 - 330	176	780,000	0
	Lower	5/7	180 - 1,100	470	NA	NA
Dibenz(a,h)anthracene	Upper	2/7	100 - 120	110	780	0
	Lower	1/7	110	110	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	2/7	99.0 - 110	105	7,800	0
	Lower	4/7	140 - 240	188	NA	NA
Pesticides						
alpha-BHC	Lower	1/7	8.39	8.39	NA	NA

Table 10.15.2.1
SWMU 106 and AOC 603
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides						
delta-BHC	Lower	1/7	29.0	29.0	910	NA
gamma-BHC (Lindane)	Lower	1/7	5.74	5.74	NA	NA
alpha-Chlordane	Upper	1/7	3.01	3.01	4,400	0
gamma-Chlordane	Lower	1/7	8.36	8.36	NA	NA
4,4'-DDT	Upper	1/7	8.23	8.23	17,000	0
Endrin aldehyde	Upper	1/7	3.55	3.55	61,000	0
Heptachlor epoxide	Lower	1/7	6.25	6.25	NA	NA

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.15.2.2
SWMU 106 and AOC 603
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	7/7	1,030 - 9,370	5,780	100,000	26,600	0
	Lower	7/7	6,810 - 34,700	16,900	NA	41,100	NA
Antimony (Sb)	Upper	6/7	0.510 - 3.30	1.13	82	1.77	0
	Lower	4/7	0.900 - 2.00	1.40	NA	1.60	NA
Arsenic (As)	Upper	7/7	0.610 - 26.8	7.30	3.80	23.9	1
	Lower	7/7	4.60 - 47.2	21.3	NA	19.9	NA
Barium (Ba)	Upper	7/7	3.80 - 411	70.6	14,000	130	0
	Lower	7/7	14.4 - 55.5	37.4	NA	94.1	NA

Table 10.15.2.2
SWMU 106 and AOC 603
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Beryllium (Be)	Upper	5/7	0.150 - 0.930	0.344	1.30	1.70	0
	Lower	7/7	0.360 - 1.50	0.917	NA	2.71	NA
Cadmium (Cd)	Upper	2/7	0.160 - 1.90	1.03	100	1.50	0
	Lower	3/7	0.200 - 0.860	0.453	NA	0.960	NA
Calcium (Ca)	Upper	7/7	269 - 22,600	12,400	NA	NA	NA
	Lower	7/7	853 - 27,900	15,100	NA	NA	NA
Chromium (Cr)	Upper	7/7	3.30 - 23.0	10.6	1,000	94.6	0
	Lower	7/7	19.9 - 53.1	35.0	NA	75.2	NA
Cobalt (Co)	Upper	7/7	0.290 - 30.6	6.02	12,000	19.0	0
	Lower	7/7	1.80 - 8.90	4.77	NA	14.9	NA
Copper (Cu)	Upper	7/7	2.50 - 28.4	14.7	8,200	66.0	0
	Lower	7/7	5.20 - 31.6	17.9	NA	152	NA
Cyanide (CN)	Lower	1/7	0.820	0.820	NA	NA	NA
Iron (Fe)	Upper	7/7	1,360 - 19,500	8,050	61,000	NA	0
	Lower	7/7	8,910 - 44,200	25,100	NA	NA	NA
Lead (Pb)	Upper	7/7	3.40 - 84.3	29.1	1,300	265	0
	Lower	7/7	6.10 - 272	70.0	NA	173	NA
Magnesium (Mg)	Upper	7/7	58.2 - 3,320	968	NA	NA	NA
	Lower	7/7	454 - 6,270	3,550	NA	NA	NA
Manganese (Mn)	Upper	7/7	5.40 - 200	68.0	4,700	302	0
	Lower	7/7	47.0 - 1,040	400	NA	881	NA
Mercury (Hg)	Upper	2/7	0.0300 - 0.350	0.190	61	2.60	0
	Lower	3/7	0.0500 - 0.320	0.143	NA	1.59	NA
Nickel (Ni)	Upper	7/7	2.60 - 13.2	6.04	4,100	77.1	0
	Lower	7/7	4.80 - 18.1	11.7	NA	57.0	NA

Table 10.15.2.2
SWMU 106 and AOC 603
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Potassium (K)	Upper	5/7	651 - 1,760	999	NA	NA	NA
	Lower	7/7	601 - 4,660	2,360	NA	NA	NA
Selenium (Se)	Lower	5/7	0.720 - 1.20	0.942	NA	2.40	0
Silver (Ag)	Upper	1/7	0.280	0.280	1,000	NA	0
Sodium (Na)	Upper	7/7	105 - 2,340	940	NA	NA	NA
	Lower	7/7	85.2 - 6,070	2,740	NA	NA	NA
Thallium (Tl)	Lower	1/7	0.800	0.800	NA	NA	NA
Tin (Sn)	Upper	5/7	2.40 - 6.10	3.36	100,000	59.4	0
	Lower	5/7	2.70 - 6.60	4.26	NA	9.23	NA
Vanadium (V)	Upper	7/7	2.20 - 44.5	15.9	1,400	94.3	0
	Lower	7/7	20.3 - 88.5	48.8	NA	155	NA
Zinc (Zn)	Upper	7/7	2.60 - 478	103	61,000	827	0
	Lower	7/7	33.1 - 507	141	NA	886	NA
pH							
pH	Upper	1/1	7.76 SU	7.76 SU	NA	NA	NA
	Lower	1/1	7.80 SU	7.80 SU	NA	NA	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

One VOC — acetone — was detected in soil samples collected at SWMU 106 and AOC 603. Two detections occurred in upper interval and three detections occurred in the lower interval. The VOC did not exceed its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty SVOCs were detected in soil samples collected at SWMU 106 and AOC 603. Forty-one detections occurred in the upper interval and 52 in the lower interval. No SVOC exceeded its respective industrial RBC in the upper-interval. However, two SVOCs — benzo(a)anthracene and chrysene — exceeded their respective SSL in the lower-interval.

Benzo(a)anthracene was detected in five of seven lower-interval samples with a range of 120 to 1,000 μg/kg and a mean of 428 μg/kg. One lower-interval sample (106SB003, 1000 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

Chrysene was detected in five of seven lower-interval samples with a range of 180 to 1,100 μg/kg and a mean of 470 μg/kg. One lower-interval sample (106SB003, 1,100 μg/kg) exceeded the chrysene SSL of 1,000 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at SWMU 106 and AOC 603. The upper-interval BEQ was calculated for five samples with a range of 128 to 338 μg/kg and a mean of 200 μg/kg. No samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

Pesticides and PCBs in Soil

Eight pesticides were detected in soil samples collected at SWMU 106 and AOC 603. Three detections occurred in the upper-interval and five occurred in the lower-interval. No pesticides exceeded their respective industrial RBC in the upper-interval. However, one pesticide — alpha-BHC — exceeded its respective SSL in the lower-interval.

Alpha-BHC was detected in one of seven lower-interval samples at 8.39 μg/kg. One sample (106SB003, 8.39 μg/kg) exceeded the alpha-BHC SSL of 0.4 μg/kg.

No PCBs were detected in soil samples collected at SWMU 106 and AOC 603.

Other Organic Compounds in Soil

No other organic compounds were detected in soil samples collected at SWMU 106 and AOC 603.

Inorganic Elements in Soil

Twenty-five metals were detected in soil samples collected at SWMU 106 and AOC 603. One hundred and twenty-nine detections occurred in the upper-interval and 141 occurred in the lower-interval. One metal — arsenic — exceeded both its respective industrial RBC and RC in the upper-interval and respective SSL and RC in the lower-interval.

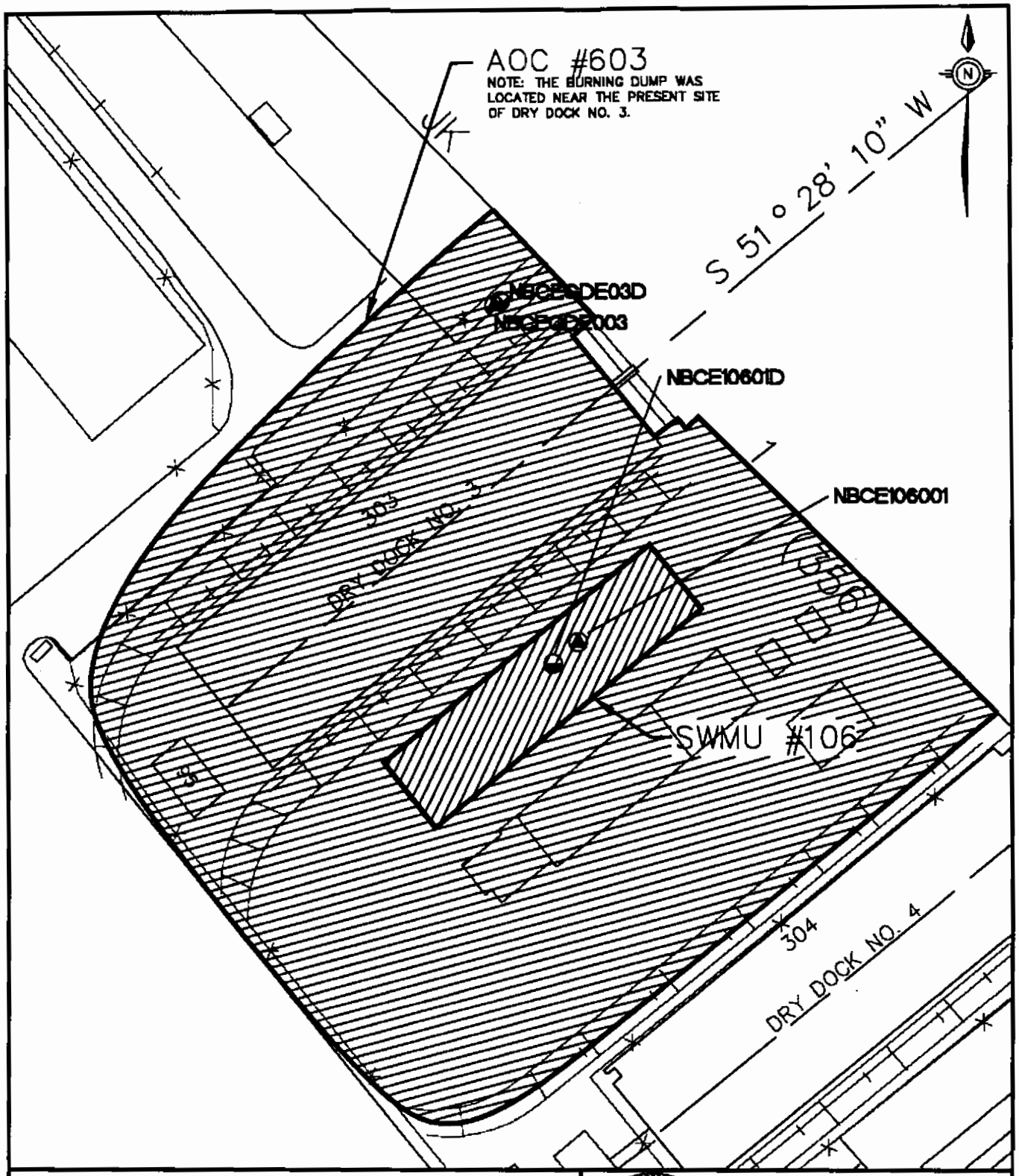
Arsenic was detected in seven of seven upper-interval samples with a range of 0.610 to 26.8 mg/kg and a mean of 7.30 mg/kg. One upper-interval sample (106SB001, 26.8 mg/kg) exceeded both the arsenic industrial RBC of 3.80 mg/kg and the RC of 23.9 mg/kg.

Arsenic was detected in seven of seven lower-interval samples with a range of 4.60 to 47.2 mg/kg and a mean of 21.3 mg/kg. Four lower-interval samples (106SB001, 27.5 mg/kg; 106SB002, 24.1 mg/kg; 106SB003, 47.2 mg/kg; and 603SB003, 20.1 mg/kg) exceeded both the arsenic SSL of 15 mg/kg and the RC of 19.9 mg/kg.

10.15.3 Groundwater Sampling and Analysis

One deep monitoring well and one shallow monitoring well were installed and sampled to assess groundwater quality at SWMU 106 and AOC 603 as shown in Figure 10.15.2. The wells were installed as follows:

- Shallow Well installed at SWMU 106 — NBCE106001
- Deep Well installed at SWMU 106 — NBCE10601D



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.15.2
MONITORING WELL LOCATIONS
SWMU #106, BLAST AREA, DD #3
AOC #603
BURNING DUMP, DD #3

DWG DATE: 09/02/97 | DWG NAME: 10-15-2

One deep and one shallow well proposed for this site were not installed due to the proximity of supplemental well pair NBCEGDE003 and NBCEGDE03D. The shallow and deep grid-based well pair, installed adjacent to AOC 603, were used to assess the groundwater along the northern boundary of AOC 603. Groundwater samples from SWMU 106 and AOC 603 were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. The grid-based shallow and deep well pair samples were not submitted for organotins. No duplicate samples were collected at this site. Table 10.15.3.1 summarizes groundwater sampling and analysis at SWMU 106 and AOC 603.

Table 10.15.3.1
SWMU 106 and AOC 603
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2[a]	1[a]	Standard Suite[b], chlorides, TDS, sulfates, and organotins	Standard Suite[b], chlorides, TDS, sulfates, and organotins	A shallow grid-based well replaced one well
Deep	2[a]	1[a]	Standard Suite[b], chlorides, TDS, sulfates, and organotins	Standard Suite[b], chlorides, TDS, sulfates, and organotins	A deep grid-based well replaced one well

Notes:
a = Per the *Final Zone E RFI Work Plan*, one shallow and deep grid-based well pair were incorporated in characterizing the site due to proximity of the well pair
b = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

The shallow monitoring wells were installed at 14.8 to 17 feet bgs in the surficial aquifer. The Deep wells were installed at 32.6 to 32.9 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.15.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow and deep groundwater are summarized in Tables 10.15.4.1 and 10.15.4.2, respectively. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.15.4.3 and 10.15.4.4, respectively. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.15.4.1
SWMU 106 and AOC 603
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Shallow Monitoring Well

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs						
4-Methylphenol (p-Cresol)	1/1	1.000	1.000	18.0	NA	0

Notes:
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.15.4.2
SWMU 106 and AOC 603
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Deep Monitoring Well

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
Volatile Organic Compounds						
Acetone	1/1	13.0	13.0	370	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.15.4.3
SWMU 106 and AOC 603
Inorganic Detections for First Quarter Groundwater (μg/L)
Shallow Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Arsenic (As)	1/1	36.3	36.3	0.0450	18.7	50.0	1
Calcium (Ca)	1/1	179,000	179,000	NA	NA	NA	NA
Cobalt (Co)	1/1	4.10	4.10	220	2.5	NA	0
Iron (Fe)	1/1	20,400	20,400	1,100	NA	NA	1
Magnesium (Mg)	1/1	483,000	483,000	NA	NA	NA	NA
Manganese (Mn)	1/1	204	204	84.0	2,560	NA	0
Nickel (Ni)	1/1	11.9	11.9	73.0	15.2	100	0
Potassium (K)	1/1	269,000	269,000	NA	NA	NA	NA
Sodium (Na)	1/1	7,940,000	7,940,000	NA	NA	NA	NA

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Table 10.15.4.4
SWMU 106 and AOC 603
Inorganic Detections for First Quarter Groundwater (μg/L)
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Barium (Ba)	1/1	77.3	77.3	260	218	2,000	0
Beryllium (Be)	1/1	1.30	1.30	0.0160	1.2	4.00	1
Calcium (Ca)	1/1	429,000	429,000	NA	NA	NA	NA
Copper (Cu)	1/1	3.90	3.90	150	NA	1,300	0
Iron (Fe)	1/1	1,430	1,430	1,100	NA	NA	1

Table 10.15.4.4
SWMU 106 and AOC 603
Inorganic Detections for First Quarter Groundwater (µg/L)
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Magnesium (Mg)	1/1	1,070,000	1,070,000	NA	NA	NA	NA
Manganese (Mn)	1/1	949	949	84.0	869	NA	1
Nickel (Ni)	1/1	8.60	8.60	73.0	42.2	100	0
Potassium (K)	1/1	298,000	298,000	NA	NA	NA	NA
Sodium (Na)	1/1	8,270,000	8,270,000	NA	NA	NA	NA

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Volatile Organic Compounds in Groundwater

Deep Groundwater

One VOC — acetone — was detected in the one deep groundwater sample collected at SWMU 106 (no deep wells were installed at AOC 603). The VOC did not exceed its respective tap-water RBC.

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

One SVOC — 4-methylphenol — was detected in the one shallow groundwater sample collected at SWMU 106 (no shallow groundwater wells were installed at AOC 603). The SVOC did not exceed its respective tap-water RBC.

Inorganic Elements in Groundwater

Shallow Groundwater

Nine metals were detected in the one shallow groundwater sample collected at SWMU 106. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and shallow groundwater RC.

Arsenic was detected in well NBCE106001 (36.3 μg/L), exceeding both the arsenic tap-water RBC of 0.0450 μg/L and shallow groundwater RC of 18.7 μg/L. The sample did not exceed the arsenic MCL of 50.0 μg/L.

Iron was detected in well NBCE106001 (20,400 μg/L), exceeding the iron tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

Deep Groundwater

Ten metals were detected in the one deep groundwater sample collected at SWMU 106. Three metals — beryllium, iron, and manganese — exceeded both their respective tap-water RBC and deep groundwater RC.

Beryllium was detected in well NBCE10601D (1.30 μg/L), exceeding both the beryllium tap-water RBC of 0.0160 μg/L and deep groundwater RC of 1.20 μg/L. The sample did not exceed the beryllium MCL of 4.00 μg/L.

Iron was detected in well NBCE10601D (1,430 μg/L), exceeding the iron tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

Manganese was detected in well NBCE10601D (949 μg/L), exceeding both the manganese tap-water RBC of 84.0 μg/L and deep groundwater RC of 869 μg/L. No MCL has been established for manganese.

10.15.5 Fate and Transport Assessment for SWMU 106 and AOC 603

Combined SWMU 106 consists of an abrasive blasting area near Drydocks 3 and 4 and a former burning dump at AOC 603 near Drydock 3. The entire ground surface at these sites consists of asphalt pavement or concrete; however, at one time this area was graded and covered with rock. Environmental media sampled as part of the combined SWMU 106 RFI include surface soil, subsurface soil, and shallow and deep groundwater. Potential constituent migration pathways investigated for combined SWMU 106 include soil to groundwater, groundwater to surface water, and emission of VOCs from surface soil to air.

10.15.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.15.5.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Four organic compounds — benzo(a)anthracene, alpha-BHC, delta-BHC, and gamma-BHC (Lindane) — were detected in combined SWMU 106 soil at concentrations greater than groundwater protection SSLs and were carried over to the second-tier screen. All four exceedances were reported from the same subsurface soil sample, 106SB003. None of the four compounds was detected in groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer. Mean and maximum concentrations of the VOC, most pesticides, and virtually all SVOCs were higher in subsurface samples than in

surface soil, indicating that a layer of uncontaminated fill dirt may have been applied before the burning dump site was paved.

Four inorganics — antimony, arsenic, cobalt, and manganese — were detected in soil sample above their groundwater protection SSLs and were carried over to the second-tier screen. Arsenic, cobalt, and manganese were also detected in groundwater samples, indicating a completed pathway from soil to groundwater for these three metals. Of the three, only arsenic was detected in groundwater above its tap water RBC or RC. Antimony and cobalt exceeded their respective groundwater protection SSLs in single surface soil samples (603SB001 and 603SB002, respectively). Manganese exceeded its RC in a single subsurface soil sample (106SB003) while arsenic exceeded its RC in a single surface soil sample (106SB001) and two subsurface soil samples (106SB001 and 106SB003). As with the organic compounds, most inorganics were detected at higher concentrations in subsurface soil.

10.15.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.15.5.1 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs 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) RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic compounds were detected in groundwater samples at concentrations above tap water RBCs or saltwater surface water chronic screening levels.

Three inorganics — arsenic, beryllium, and copper — were detected in first-round groundwater samples above their respective tap water RBCs and/or saltwater surface water chronic screening levels and were carried over to the second-tier screen. Arsenic exceedances occurred in samples from shallow wells NBCE106001 and NBCEGDE003 but not from deep groundwater wells. Beryllium and copper exceeded their tap water RBC and saltwater surface water chronic screening values, respectively, in a deep groundwater sample from well NBCE10601D. These two metals were not detected in shallow groundwater samples. Preliminary analysis of subsequent sampling round results indicates continuing exceedances for arsenic in shallow groundwater, but copper and beryllium exceedances were limited to first-round samples.

10.15.5.3 Soil and Groundwater-to-Surface Water Cross-Media Transport: Tier Two

Table 10.15.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that may pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined SWMU 106 is 138,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River through the associated migration pathways. The elevated concentrations of benzo(a)anthracene and several pesticides in soil samples are not of concern

because PAHs and most pesticides are not particularly mobile in soil or groundwater. The maximum arsenic concentration in subsurface soil was just over 25% of its adjusted SSL. Arsenic was also the closest of all second-tier groundwater constituents to its adjusted ecological/human health RBC value, which was over two orders of magnitude higher. The adjusted SSLs were obtained assuming a DAF of 1, while the calculated DAF for combined SWMU 106 is 27, taking into account dilution only. Consequently, the margin between detected soil concentrations and levels protective of the Cooper River is actually much greater than indicated by the table.

10.15.5.4 Soil-to-Air Cross-Media Transport

Table 10.15.5.3 lists the only VOC (acetone) detected in surface soil samples collected at combined SWMU 106 along with its corresponding soil-to-air volatilization screening level. No exposed soil is currently present at the site. In addition, acetone was not 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 expected to be a viable pathway at combined SWMU 106.

10.15.5.5 Fate and Transport Summary

In the first-tier screen, four organic compounds were detected above their generic SSLs in a single subsurface soil sample but were not detected in groundwater samples. Slightly elevated PAH concentrations in subsurface soil may reflect past site use as a burning dump. Of the four inorganics (antimony, arsenic, cobalt and manganese) exceeding their groundwater protection SSLs in soil, only arsenic was detected in shallow groundwater above both its RC and saltwater surface water chronic screening values. Beryllium and copper in deep groundwater samples exceeded their RC and saltwater surface water screening values, respectively. Sample results from subsequent sampling rounds indicate continued elevated arsenic concentrations in shallow groundwater but decreased beryllium and copper concentrations below groundwater screening values in deep groundwater. There is no threat to surface water in the Cooper River via the evaluated migration pathways since none of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons.

Table 10.15.5.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 106 and AOC 603
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	58	84	ND	13	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	220	1100	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	ND	1600	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	180	140	ND	ND	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	430	640	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	180	1000	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	320	710	ND	ND	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	82	190	ND	ND	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	240	280	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	330	1100	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	120	110	ND	ND	800	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	110	240	ND	ND	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
4-Chloro-3-methylphenol	100	ND	ND	ND	3150	180	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	390	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	ND	140	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	240	800	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	1700	ND	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	ND	3500	ND	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	ND	1	ND	690	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	ND	870	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	130	6300	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	680	4700	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
alpha-BHC	ND	8.39	ND	ND	0.25	0.011	1400	UG/KG	UG/L	YES	NO	NO
delta-BHC	ND	29	ND	ND	1.5	0.037	NA	UG/KG	UG/L	YES	NO	NO
gamma-BHC (Lindane)	ND	5.74	ND	ND	4.5	0.052	0.016	UG/KG	UG/L	YES	NO	NO
alpha-Chlordane	3.01	ND	ND	ND	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	ND	8.36	ND	ND	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	8.23	ND	ND	ND	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	3.55	ND	ND	ND	500	11	NA	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	ND	6.25	ND	ND	350	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	9370	34700	ND	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	3.3	2	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	26.8	47.2	36.3	ND	23.9	18.7	36	MG/KG	UG/L	YES	YES	YES
Barium	411	55.5	ND	77.3	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.93	1.5	ND	1.3	32	1.2	NA	MG/KG	UG/L	NO	YES	NO
Cadmium	1.9	0.86	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	23	53.1	ND	ND	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	30.6	8.9	4.1	ND	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	28.4	31.6	ND	3.9	152	1500	2.9	MG/KG	UG/L	NO	NO	YES
Cyanide	ND	0.82	ND	ND	20	730	37.3	MG/KG	UG/L	NO	NO	NO
Lead	84.3	272	ND	ND	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	200	1040	204	949	881	2560	NA	MG/KG	UG/L	YES	NO	NO
Mercury	0.35	0.32	ND	ND	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	13.2	18.1	11.9	8.6	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	ND	1.2	ND	ND	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.28	ND	ND	ND	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	ND	0.8	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	6.1	6.6	ND	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO

Table 10.15.5.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 106 and AOC 603
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Vanadium	44.5	88.5	ND	ND	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	478	507	ND	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.15.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMU 106 and AOC 603
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	180	1000	ND	ND	800	0.092	NA	0.092	1.27E+04	0.1	1.27E+05	1.02E+07	UG/KG	UG/L	NO	NO
Pesticides/PCB Compounds																
alpha-BHC	ND	8.39	ND	ND	0.25	0.011	1400	0.011	1.52E+03	0.01	1.52E+05	3.80E+03	UG/KG	UG/L	NO	NO
delta-BHC	ND	29	ND	ND	1.5	0.037	NA	0.037	5.11E+03	0.05	1.02E+05	1.53E+04	UG/KG	UG/L	NO	NO
gamma-BHC (Lindane)	ND	5.74	ND	ND	4.5	0.052	0.016	0.016	2.21E+03	0.2	1.10E+04	4.97E+03	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	3.3	2	ND	ND	2.5	15	NA	15	2.07E+06	6	3.45E+05	8.63E+04	MG/KG	UG/L	NO	NO
Arsenic	26.8	47.2	36.3	ND	14.6	0.045	36	0.045	6.21E+03	50	1.24E+02	1.81E+02	MG/KG	UG/L	NO	NO
Beryllium	0.93	1.5	ND	1.3	32	0.016	NA	0.016	2.21E+03	4	5.52E+02	1.77E+03	MG/KG	UG/L	NO	NO
Cobalt	30.6	8.9	4.1	ND	1040	2200	NA	2200	3.04E+08	2200	1.38E+05	1.00E+06	MG/KG	UG/L	NO	NO
Copper	28.4	31.6	ND	3.9	458	1500	2.9	2.9	4.00E+05	1300	3.08E+02	1.41E+04	MG/KG	UG/L	NO	NO
Manganese	200	1040	204	949	548	840	NA	840	1.16E+08	840	1.38E+05	1.00E+06	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 138,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.15.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMU 106 and AOC 603
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	58	62000000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.15.6 Fixed-Point Risk Evaluation for SWMU 106

10.15.6.1 Site Background and Investigative Approach

SWMU 106 is an abrasive blast area near drydock number 3 and AOC 603 is the site of a former burning dump. The following refers to these sites as combined SWMU 106. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of seven surface soil samples were considered in the combined SWMU 106 FRE. Two monitoring wells were installed as part of the 1995 RFI. One of these monitoring wells was installed into the shallow aquifer and one was installed into the deep aquifer. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the combined SWMU 106 FRE. Sections 10.15.1 and 10.15.3 contain summaries of the sampling effort for SWMU 106 soil and groundwater.

10.15.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.15.6.1 provides CPSS summaries for combined SWMU 106 soil and identifies COPCs based on comparison to residential and industrial RBCs and RCs. Based on residential RBCs, three COPCs (antimony, arsenic, and BEQs) were identified for combined SWMU 106. Aluminum and beryllium were detected in combined SWMU 106 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE based on comparison to their RCs. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on RC.

Table 10.15.6.2 summarizes the residential COPCs detected at each combined SWMU 106 sample location with contribution to risk and hazard. As shown, arsenic and BEQ compounds are the only contributors to risk for combined SWMU 106, exceeding 1E-06 at all seven locations.

Figure 10.15.3 is a spatial presentation of residential risk estimates for combined SWMU 106 soil. Risk estimates range from 4E-06 to 8E-05 with an arithmetic mean risk of 2E-05.

Figure 10.15.4 is a spatial presentation of HI estimates for combined SWMU 106 surface soil. As shown, HI projections exceeded the threshold of unity at one of seven sample locations. HI estimates range from 0.03 to 1 with an arithmetic mean HI of 0.4. Arsenic was the primary contributor to HI projections.

Industrial Scenario

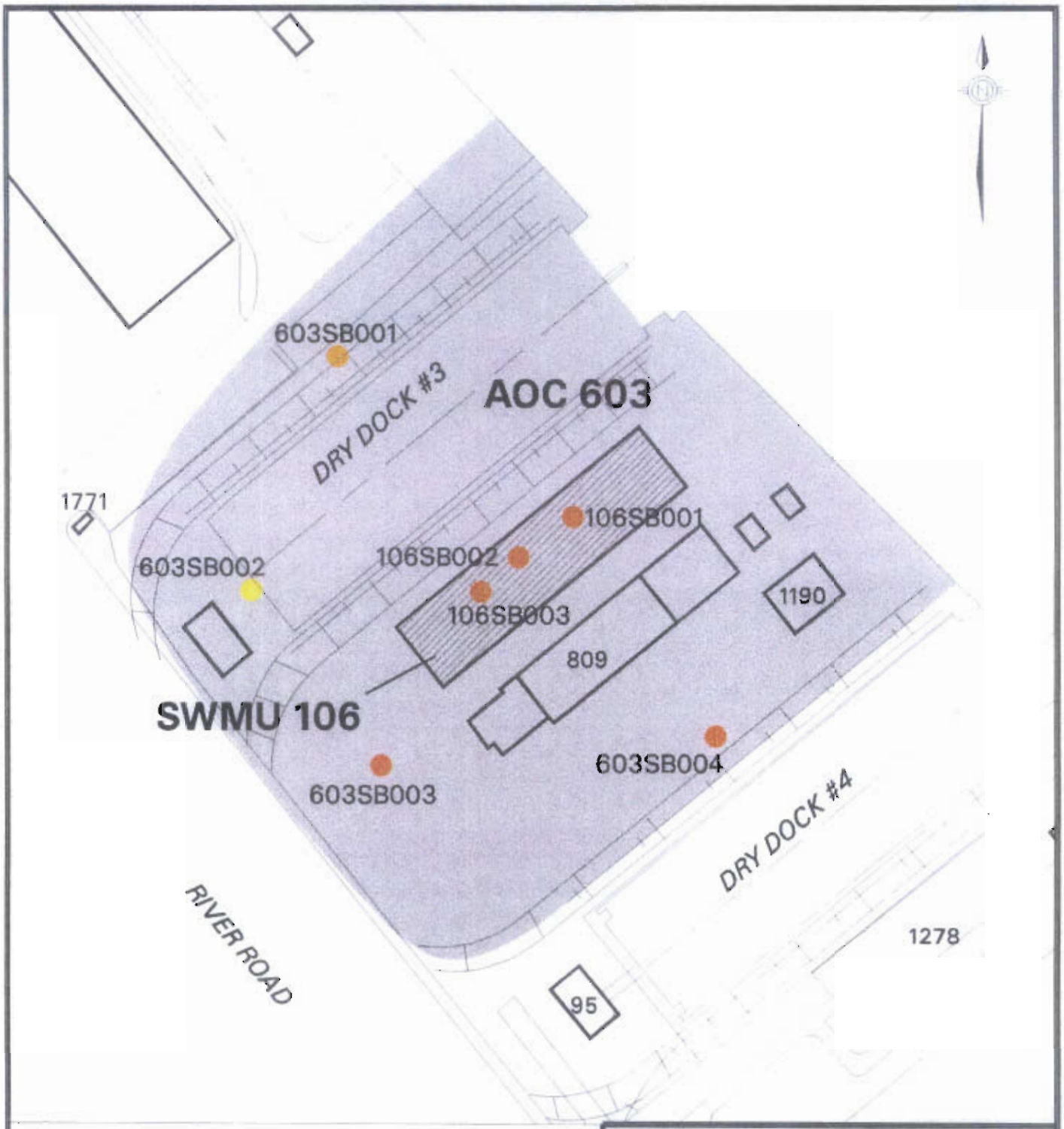
Based on industrial RBCs, arsenic was identified as a COPC for combined SWMU 106 soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on RC.

Table 10.15.6.3 summarizes the industrial COPCs detected at each combined SWMU 106 sample location with contribution to risk and hazard. As shown, arsenic related risk estimates for combined SWMU 106, exceeded 1E-06 at all seven locations, based on the industrial scenario. Figure 10.15.5 is a spatial presentation of industrial scenario risk estimates for combined SWMU 106 surface soil. Risk estimates range from 2E-07 to 1E-05 with an arithmetic mean risk of 3E-06.

HI projections did not exceed the threshold of unity at any sample locations based on the industrial scenario. HI estimates range from 0.001 to 0.06.

10.15.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.15.6.4 provides CPSS summaries for combined SWMU 106 groundwater and identifies COPCs. Beryllium and manganese were identified as groundwater COPCs in the deep aquifer and



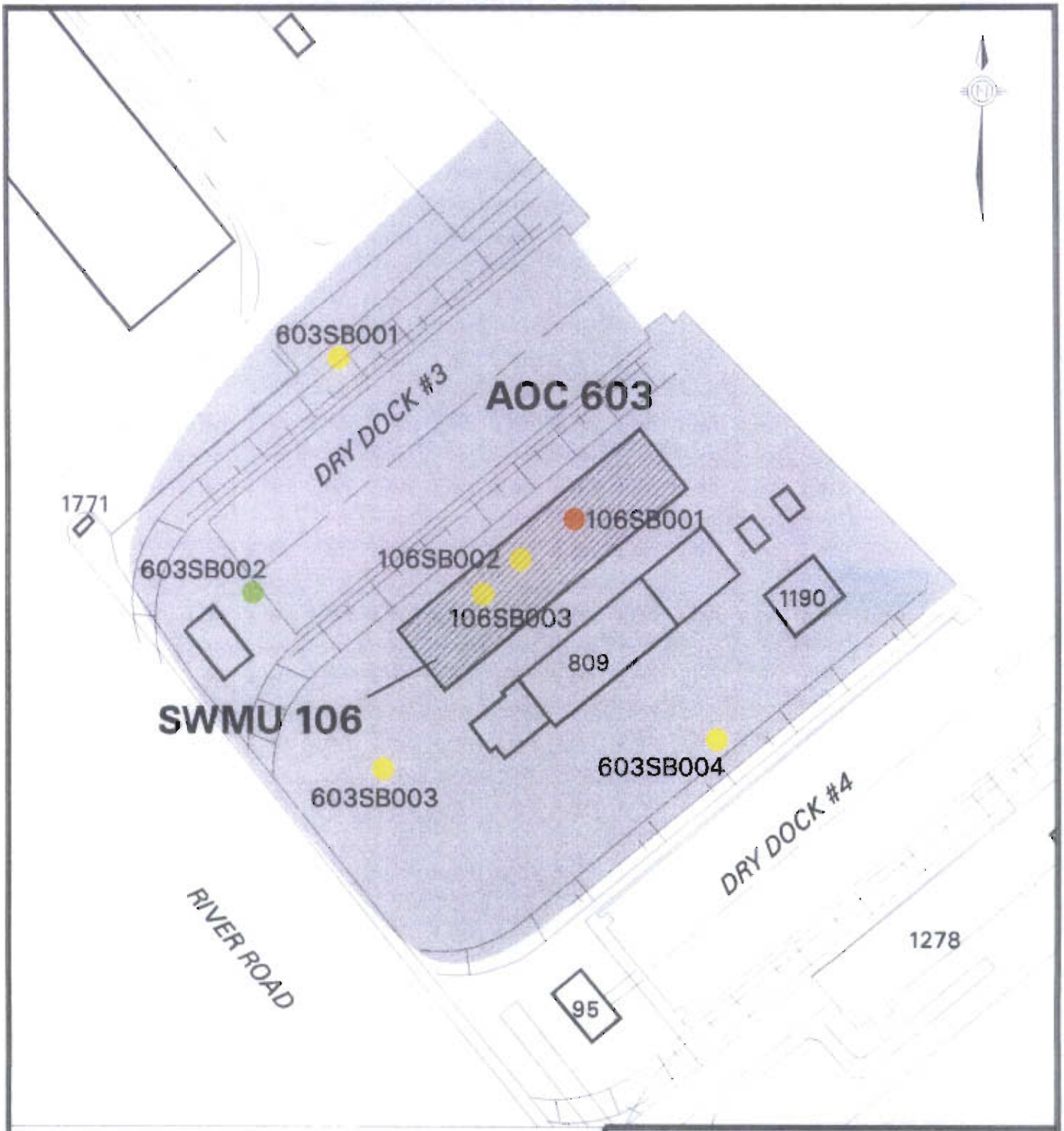
LEGEND - CUMULATIVE SOIL RISK

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

0 feet 200

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

FIGURE 10.15.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
SWMU 106



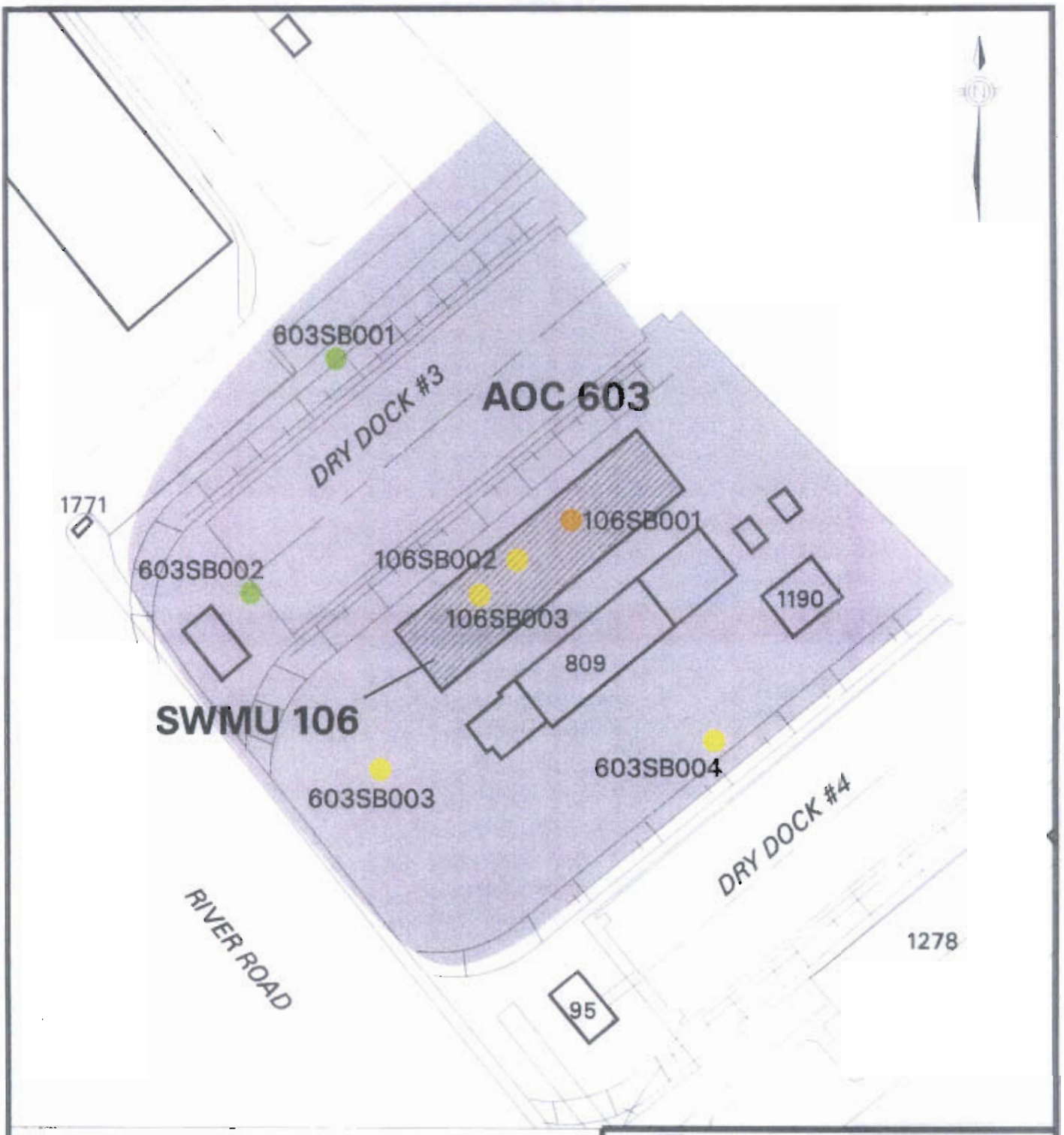
LEGEND - CUMULATIVE SOIL HAZARD

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

0 feet 200

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

FIGURE 10.15.4
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
SWMU 106



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 200

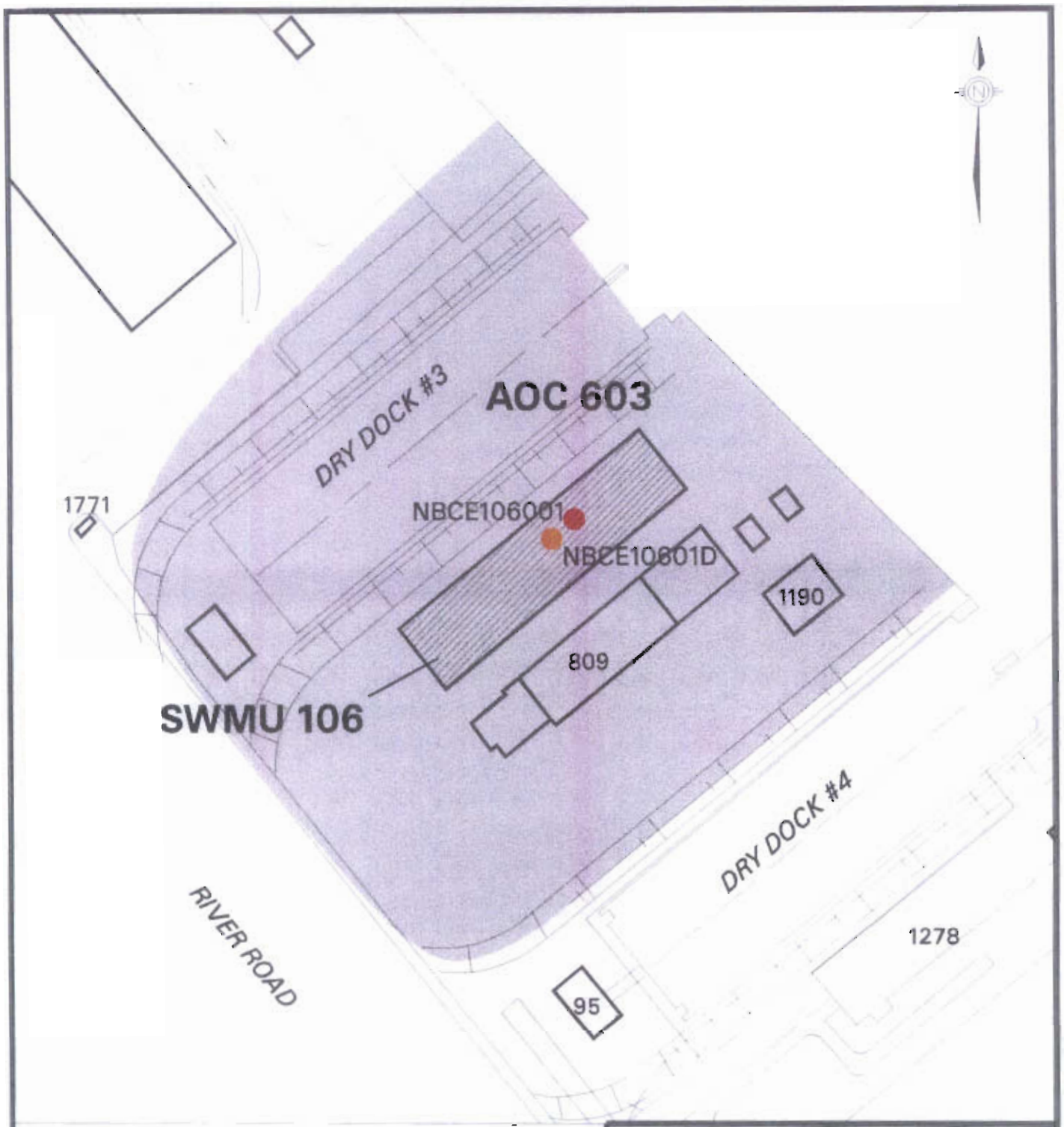
ZONE E - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.15.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
SWMU 106

arsenic was identified as a groundwater COPC in the shallow aquifer. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding RCs for inorganics. Manganese was detected in combined SWMU 106 shallow groundwater at a concentration above its RBC, but was eliminated from consideration in the FRE for shallow groundwater, based on comparison to its RC. The maximum concentration of manganese reported in the deep well sample did not exceed the corresponding shallow aquifer RCs. Because there is no physical distinction between the two units, it is possible that deep well results are representative of natural conditions. Combined SWMU 106 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses, and as a result, manganese was eliminated from the shallow groundwater FRE based on direct comparison of its maximum concentration to its RC.

Table 10.15.6.5 summarizes the COPCs identified in combined SWMU 106 monitoring wells sampled during the first quarter. Risk projections above 1E-06 were associated with the arsenic concentration in the groundwater sample collected from monitoring well NBCE106001; and with the concentration of beryllium in the groundwater sample collected from well NBCE10601D. Risk estimations were approximately 8E-4 for arsenic, and 8E-5 for beryllium. The arithmetic mean was calculated to be 4E-04. Figure 10.15.6 illustrates the groundwater data as a function of point-specific risk projections.

Monitoring wells NBCE10601D and NBCE106001 produced results corresponding with HIs above unity, as well. Manganese was the primary contributor to HI projections for the sample collected from the deep well, while arsenic was the sole contributor to the HI projections in the shallow aquifer. HIs ranged from 3 (NBCE10601D) to 8 (NBCE106001). The arithmetic mean HI for combined SWMU 106 is 5. Figure 10.15.7 illustrates the groundwater data as a function of point-specific hazard projections.



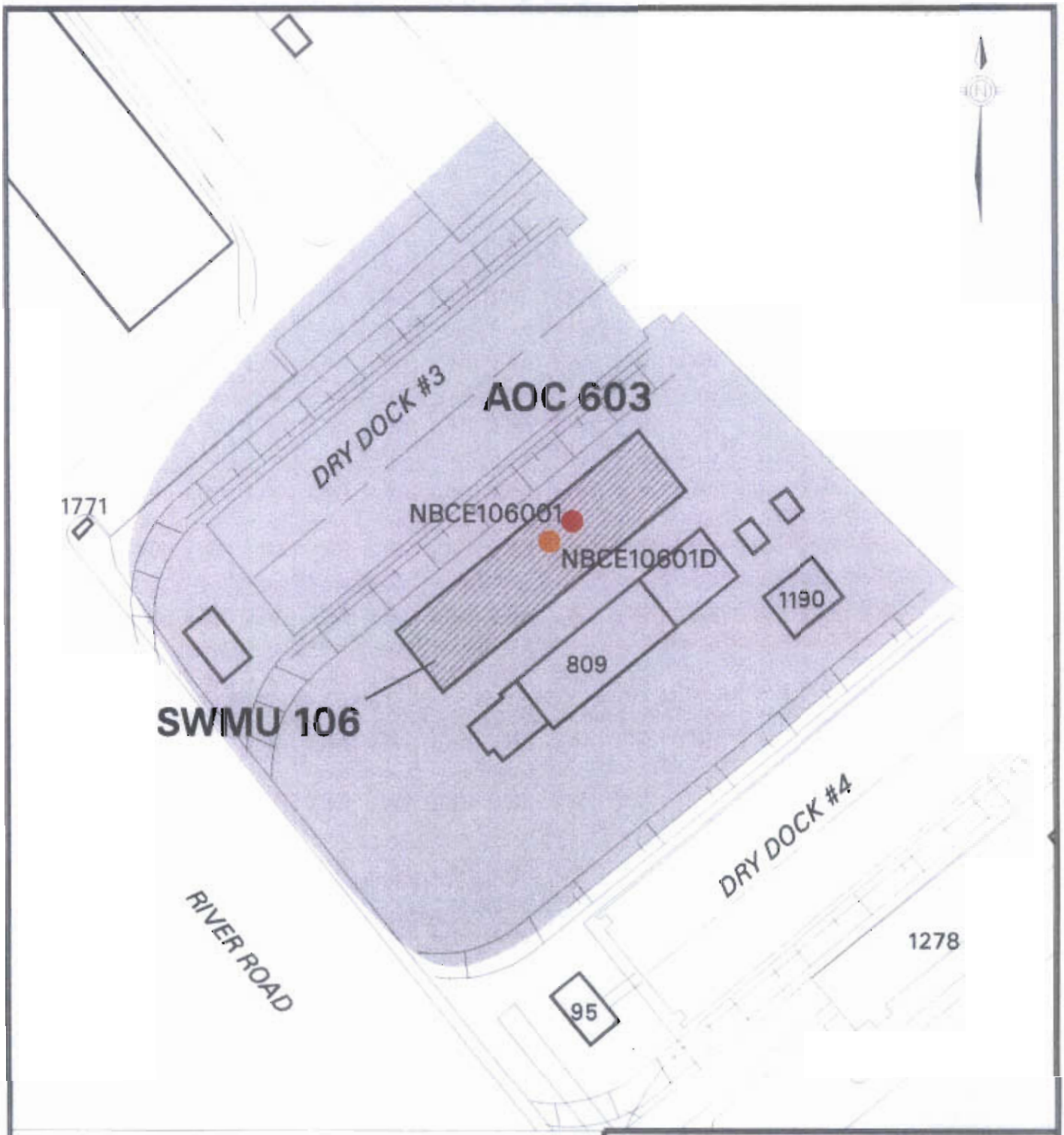
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 200

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

FIGURE 10.15.6
CUMULATIVE GROUNDWATER RISK IN WELLS
SWMU 106



LEGEND - CUMULATIVE GROUNDWATER HAZARD

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

0 feet 200

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

FIGURE 10.15.7
CUMULATIVE GROUNDWATER HAZARD IN WELLS
SWMU 106

10.15.6.4 Uncertainty

SWMU 106 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined SWMU 106, 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.

COPC Selection

4-Chloro-3-methylphenol was detected in one of seven surface soil samples at a concentration of 100 μg/kg. There are no RBCs listed for this chemical in the Region III RBC tables, nor are there toxicological data with which to calculate a RBC. As a result, 4-chloro-3-methylphenol was not included in the FRE for combined SWMU 106. The maximum 4-chloro-3-methylphenol concentration did not exceed the RBC for 2-chlorophenol (39,000 μg/kg). This minimizes the uncertainty associated with the elimination of 4-chloro-3-methylphenol from consideration in the FRE.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for combined SWMU 106. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

Aluminum, beryllium, and manganese were present in combined SWMU 106 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their RC. As a result, their contribution to risk/hazard has not been considered in this FRE.

Arsenic was a contributor to both risk and hazard projections for residential and industrial soil pathways. Arsenic exceeded its RC in only one of seven surface soil samples (106SB001). These

findings indicate that while arsenic contributes to elevated risk and hazard projections, its maximum concentration was only marginally above RCs and its average concentrations (7.3 mg/kg) was well below its RC (23.9 mg/kg).

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 concentrations close to its RBCs (e.g. within 10% of its RBCs).

Beryllium and manganese were contributors to risk and/or hazard projections for groundwater exposure pathways. Beryllium was detected in two of the four quarterly samples collected from the shallow aquifer (second and third quarters) at concentrations above its RC. The mean beryllium shallow groundwater concentration (assuming one-half SQL for nondetects) for all four quarters was calculated to be 0.61 μg/L which is only marginally above its RC of 0.43 μg/L. Additionally, the concentration of beryllium in the deep groundwater averaged over four quarters is 0.79 μg/L which is below its RC for deep groundwater (1.2 μg/L). The concentration of manganese in the deep groundwater averaged over four quarters is 699 μg/L which is below its RC for deep groundwater (869 μg/L). These findings indicate that while beryllium and manganese contribute to elevated risk and/or hazard projections, their average concentrations were only marginally above their RCs.

10.15.6.5 FRE Summary

The risk and hazard posed by contaminants at combined SWMU 106 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based

on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.15.6.2, 10.15.6.3, and 10.15.6.5 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Arsenic and BEQ compounds were detected in combined SWMU 106 surface soil at concentrations above their residential RGOs. It should be noted that arsenic was detected at a maximum concentration only marginally above its RC.

Soil — Site Worker Scenario

Arsenic was detected in combined SWMU 106 surface soil at concentrations above its industrial RGOs. It should be noted that arsenic was detected at a maximum concentration only marginally above its RC.

Groundwater — Residential Scenario

Beryllium and manganese were detected in deep groundwater at concentrations above their RGOs and arsenic was detected in shallow groundwater above its RGO. Arsenic and beryllium did not exceed their MCLs through four quarters of sampling. While manganese was detected in deep groundwater at concentrations above its deep groundwater RCs, its average concentration over four quarters did not exceed its deep groundwater RC.

Table 10.15.6.1
Chemicals Present in Site Samples
SWMU 106; AOC 603 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter			Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Carcinogenic PAHs														
B(a)P Equiv.	*		5	7	128.35 - 338.33	199.9	1710.14 - 1779.47	88	780	NA	UG/KG	5		
Benzo(a)anthracene			3	7	120 - 180	156.7	710 - 770	880	7800	NA	UG/KG			
Benzo(a)pyrene	*		4	7	88 - 320	174.5	710 - 770	88	780	NA	UG/KG	4		
Benzo(b)fluoranthene			1	7	82 - 82	82.0	740 - 860	880	7800	NA	UG/KG			
Benzo(k)fluoranthene			3	7	110 - 240	156.7	710 - 860	8800	78000	NA	UG/KG			
Chrysene			5	7	80 - 330	176.0	740 - 770	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*		2	7	100 - 120	110.0	740 - 860	88	780	NA	UG/KG	2		
Indeno(1,2,3-cd)pyrene			2	7	99 - 110	104.5	710 - 860	880	7800	NA	UG/KG			
Inorganics														
Aluminum (Al)			7	7	1030 - 9370	5780.0	NA - NA	7800	100000	26600	MG/KG	2		
Antimony (Sb)	*		6	7	0.51 - 3.3	1.13	0.44 - 0.44	3.1	82	1.77	MG/KG	1		1
Arsenic (As)	*	*	7	7	0.61 - 26.8	7.30	NA - NA	0.43	3.8	23.9	MG/KG	7	5	1
Barium (Ba)			7	7	3.8 - 411	70.6	NA - NA	550	14000	130	MG/KG			1
Beryllium (Be)			5	7	0.15 - 0.93	0.34	0.11 - 0.11	0.15	1.3	1.7	MG/KG	5		
Cadmium (Cd)			2	7	0.16 - 1.9	1.03	0.11 - 0.13	3.9	100	1.5	MG/KG			1
Calcium (Ca)	N		7	7	269 - 22600	12362.7	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)			7	7	3.3 - 23	10.6	NA - NA	39	1000	94.6	MG/KG			
Cobalt (Co)			7	7	0.29 - 30.6	6.02	NA - NA	470	12000	19	MG/KG			1
Copper (Cu)			7	7	2.5 - 28.4	14.7	NA - NA	310	8200	66	MG/KG			
Iron (Fe)	N		7	7	1360 - 19500	8047.1	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)			7	7	3.4 - 84.3	29.1	NA - NA	400	1300	265	MG/KG			
Magnesium (Mg)	N		7	7	58.2 - 3320	967.7	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)			7	7	5.4 - 200	68.0	NA - NA	180	4700	302	MG/KG	1		
Mercury (Hg)			2	7	0.03 - 0.35	0.19	0.02 - 0.02	2.3	61	2.6	MG/KG			
Nickel (Ni)			7	7	2.6 - 13.2	6.04	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N		5	7	651 - 1760	999.2	121 - 611	NA	NA	NA	MG/KG			
Silver (Ag)			1	7	0.28 - 0.28	0.28	0.22 - 0.66	39	1000	NA	MG/KG			
Sodium (Na)	N		7	7	105 - 2340	940.3	NA - NA	NA	NA	NA	MG/KG			
Tin (Sn)			5	7	2.4 - 6.1	3.36	2.2 - 6.6	4700	100000	59.4	MG/KG			
Vanadium (V)			7	7	2.2 - 44.5	15.9	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)			7	7	2.6 - 478	103.1	NA - NA	2300	61000	827	MG/KG			

Table 10.15.6.1
Chemicals Present in Site Samples
SWMU 106; AOC 603 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Pesticides												
4,4'-DDT	1	7	8.23 - 8.23	8.23	2.69 - 3.3	1900	24000	NA	UG/KG			
alpha-Chlordane	1	7	3.01 - 3.01	3.01	1.4 - 1.7	470	2200	NA	UG/KG			
Endrin aldehyde	1	7	3.55 - 3.55	3.55	2.69 - 3.3	2300	61000	NA	UG/KG			
Semivolatile Organics												
Acenaphthene	1	7	220 - 220	220.0	710 - 820	470000	12000000	NA	UG/KG			
Benzo(g,h,i)perylene	6	7	100 - 430	248.3	740 - 740	310000	8200000	NA	UG/KG			
Benzoic acid	2	7	120 - 180	150.0	3600 - 4200	31000000	100000000	NA	UG/KG			
4-Chloro-3-methylphenol	1	7	100 - 100	100.0	710 - 860	NA	NA	NA	UG/KG			
Fluoranthene	3	7	79 - 240	163.0	710 - 820	310000	8200000	NA	UG/KG			
Phenanthrene	3	7	88 - 130	109.3	710 - 770	310000	8200000	NA	UG/KG			
Pyrene	5	7	120 - 680	274.0	740 - 740	230000	6100000	NA	UG/KG			
Volatile Organics												
Acetone	2	7	28 - 58	43.0	11 - 32	780000	20000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.15.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 106/AOC 603
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
106	B001	Antimony (Sb)	0.64	MG/KG	NA		0.0219	1.76
106	B001	Arsenic (As)	26.80	MG/KG	70.0016	92.59	1.2250	98.24
106	B001	B(a)P Equiv.	338.33	UG/KG	5.6029	7.41	NA	
		Total			75.6045		1.2469	
106	B002	Antimony (Sb)	0.51	MG/KG	NA		0.0175	6.39
106	B002	Arsenic (As)	5.60	MG/KG	14.6272	86.88	0.2560	93.61
106	B002	B(a)P Equiv.	133.34	UG/KG	2.2082	13.12	NA	
		Total			16.8354		0.2734	
106	B003	Antimony (Sb)	0.52	MG/KG	NA		0.0178	7.66
106	B003	Arsenic (As)	4.70	MG/KG	12.2764	100.00	0.2148	92.34
106	B003	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			12.2764		0.2327	
603	B001	Antimony (Sb)	3.30	MG/KG	NA		0.1131	67.35
603	B001	Arsenic (As)	1.20	MG/KG	3.1344	48.60	0.0548	32.65
603	B001	B(a)P Equiv.	200.18	UG/KG	3.3150	51.40	NA	
		Total			6.4494		0.1680	
603	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
603	B002	Arsenic (As)	0.61	MG/KG	1.5933	42.84	0.0279	100.00
603	B002	B(a)P Equiv.	128.35	UG/KG	2.1255	57.16	NA	
		Total			3.7188		0.0279	
603	B003	Antimony (Sb)	1.20	MG/KG	NA		0.0411	11.84
603	B003	Arsenic (As)	6.70	MG/KG	17.5004	84.12	0.3062	88.16
603	B003	B(a)P Equiv.	199.48	UG/KG	3.3035	15.88	NA	
		Total			20.8039		0.3474	
603	B004	Antimony (Sb)	0.61	MG/KG	NA		0.0209	7.68
603	B004	Arsenic (As)	5.50	MG/KG	14.3660	100.00	0.2514	92.32
603	B004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			14.3660		0.2723	

Table 10.15.6.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 106/AOC 603
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
106	B001	Arsenic (As)	26.80	MG/KG	9.9028	100.00	0.0616	100.00
		Total			9.9028		0.0616	
106	B002	Arsenic (As)	5.60	MG/KG	2.0692	100.00	0.0129	100.00
		Total			2.0692		0.0129	
106	B003	Arsenic (As)	4.70	MG/KG	1.7367	100.00	0.0108	100.00
		Total			1.7367		0.0108	
603	B001	Arsenic (As)	1.20	MG/KG	0.4434	100.00	0.0028	100.00
		Total			0.4434		0.0028	
603	B002	Arsenic (As)	0.61	MG/KG	0.2254	100.00	0.0014	100.00
		Total			0.2254		0.0014	
603	B003	Arsenic (As)	6.70	MG/KG	2.4757	100.00	0.0154	100.00
		Total			2.4757		0.0154	
603	B004	Arsenic (As)	5.50	MG/KG	2.0323	100.00	0.0126	100.00
		Total			2.0323		0.0126	

Table 10.15.6.4
Chemicals Present in Site Samples
SWMU 106; AOC 603 - Groundwater
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Number Exceeding Ref.
Deep Wells											
Inorganics											
Barium (Ba)		1	1	77.3 - 77.3	77.3	NA - NA	260	218	UG/L		
Beryllium (Be)	*	1	1	1.3 - 1.3	1.3	NA - NA	0.016	1.2	UG/L	1	
Calcium (Ca)	N	1	1	429000 - 429000	429000	NA - NA	NA	NA	UG/L		
Copper (Cu)		1	1	3.9 - 3.9	3.9	NA - NA	150	NA	UG/L		
Iron (Fe)	N	1	1	1430 - 1430	1430	NA - NA	1100	NA	UG/L	1	
Magnesium (Mg)	N	1	1	1070000 - 1070000	1070000	NA - NA	NA	NA	UG/L		
Manganese (Mn)	*	1	1	949 - 949	949	NA - NA	84	869	UG/L	1	1
Nickel (Ni)		1	1	8.6 - 8.6	8.6	NA - NA	73	42.2	UG/L		
Potassium (K)	N	1	1	298000 - 298000	298000	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	8270000 - 8270000	8270000	NA - NA	NA	NA	UG/L		
Volatile Organics											
Acetone		1	1	13 - 13	13	NA - NA	370	NA	UG/L		
Shallow Wells											
Inorganics											
Arsenic (As)	*	1	1	36.3 - 36.3	36.3	NA - NA	0.045	18.7	UG/L	1	1
Calcium (Ca)	N	1	1	179000 - 179000	179000	NA - NA	NA	NA	UG/L		
Cobalt (Co)		1	1	4.1 - 4.1	4.1	NA - NA	220	2.5	UG/L		
Iron (Fe)	N	1	1	20400 - 20400	20400	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	483000 - 483000	483000	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	1	204 - 204	204	NA - NA	84	2560	UG/L	1	
Nickel (Ni)		1	1	11.9 - 11.9	11.9	NA - NA	73	15.2	UG/L		1

Table 10.15.6.4
Chemicals Present in Site Samples
SWMU 106; AOC 603 - Groundwater
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Potassium (K)	N	1	1	269000 - 269000	269000	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	7940000 - 7940000	7940000	NA - NA	NA	NA	UG/L		
Semivolatile Organics											
4-Methylphenol		1	1	1 - 1	1	NA - NA	18	NA	UG/L		

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

Table 10.15.6.5
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 106/AOC 603
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
106	G01D	Beryllium (Be)	1.30	UG/L	83.1389	100.00	0.0166	0.63
106	G01D	Manganese (Mn)	949.00	UG/L	NA		2.6377	99.37
		Total			83.1389		2.6543	
106	G001	Arsenic (As)	36.30	UG/L	809.8239	100.00	7.7352	100.00
		Total			809.8239		7.7352	

10.15.7 Corrective Measures Considerations

For SWMU 106 and AOC 603, the upper and lower soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for the shallow and deep 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 industrial exposure risk for the upper soil interval exceeds 1E-06 for arsenic. Risk associated with the upper interval is diminished due to the site being paved.

Arsenic and BEQs were identified as COCs in the upper soil interval. The soil pathway residential exposure risk ranges from 4E-05 to 8E-05 with an arithmetic mean risk of 2E-05 and the equated HI ranges from 0.03 to 1 with an arithmetic mean of 0.4. Both are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI. Since this site is covered with asphalt, no further action is recommended for soil.

Beryllium was identified in deep groundwater at a concentration that equals risk above 8E-05. Manganese was identified at a concentration that equals an HI above 2. Both are between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI. Continued monitoring is recommended.

Shallow groundwater-associated risk at monitoring well NBCE106001 is 8E-04 for arsenic with an equated HI of 7. These exceed USEPA's acceptable ranges for risk and HI. Groundwater containment and treatment is recommended.

Potential corrective measures for the impacted media and respective COCs are in Table 10.15.7.1.

Table 10.15.7.1
Potential Corrective Measures for SWMU 106 and AOC 603

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic and BEQ	a) No Action
Deep Groundwater	Arsenic and Manganese	a) No Action b) Intrinsic Remediation and Monitoring
Shallow Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment

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10.16 SWMU 145, Mercury Spill, Building 13A

SWMU 145 is a mercury spill reportedly under a portion of Building 13A. No additional information could be found regarding the date, amount, or duration of the release(s).

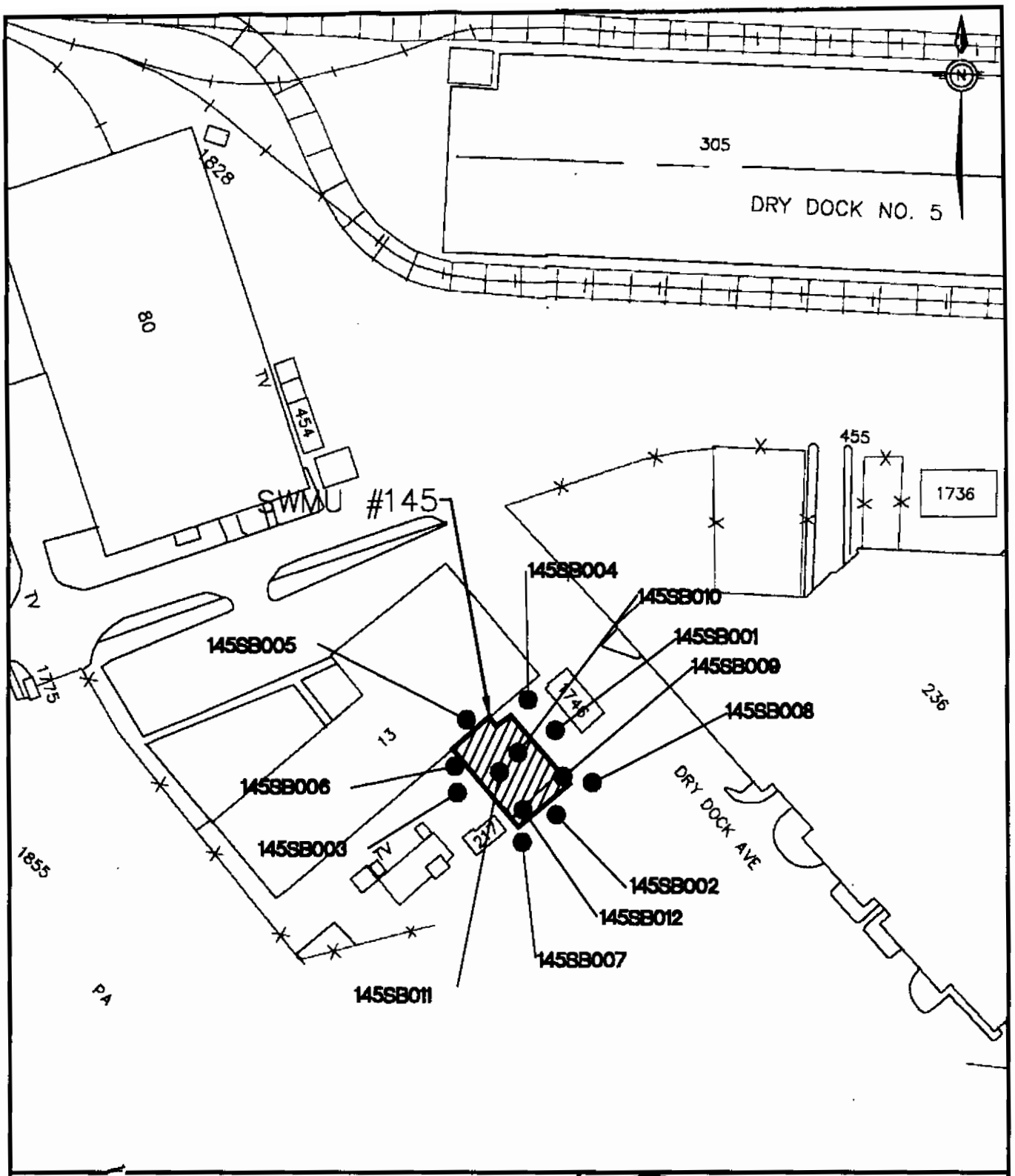
The material of concern for SWMU 145 indicated in the *Final Zone E RFI Work Plan* is mercury. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill CSI objectives for SWMU 145, soil, groundwater, and air were sampled in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.16.1 Soil Sampling and Analysis

Soil was sampled in one round at SWMU 145 from the locations shown in Figure 10.16.1. The *Final Zone E RFI Work Plan*, proposed collecting nine soil samples from the upper interval and nine samples from the lower interval. Soil samples were also collected at the upper and lower intervals for the three shallow monitoring well locations proposed for the site.

All proposed samples were collected and submitted for analysis of mercury at DQO Level III. In addition, two upper-interval samples selected as duplicates were submitted for analysis at DQO Level IV for mercury as well as Appendix IX parameters which included herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.16.1.1 summarizes soil sampling at SWMU 145.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.16.1
SOIL BORING LOCATIONS
SWMU #145
BUILDING 13A, FIRST FLOOR
MERCURY SPILL

DWG DATE: 09/02/97 | DWG NAME: 10-16-1

Table 10.16.1.1
SWMU 145
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	12	12	Mercury	Mercury	None
Lower	12	12	Mercury	Mercury	None

10.16.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.16.2.1. Inorganic analytical results for soil are summarized in Table 10.16.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.16.2.1
SWMU 145
Organic Compounds Detected in Soil (ng/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins						
Dioxin Equiv.	Upper	2/2	0.0156 - 44.7	22.4	1,000	0
1234678-HpCDD	Upper	1/2	7.27	7.27	NA	NA
1234678-HpCDF	Upper	1/2	9.36	9.36	NA	NA
123478-HxCDF	Upper	1/2	99.7	99.7	NA	NA
234678-HxCDF	Upper	1/2	4.37	4.37	NA	NA
OCDD	Upper	2/2	15.6 - 43.6	29.6	NA	NA
23478-PeCDF	Upper	1/2	40.6	40.6	NA	NA
2378-TCDF	Upper	1/2	138	138	NA	NA

Notes:
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.16.2.2
SWMU 145
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Chromium (Hexavalent)	Upper	1/2	0.122	0.122	1,000	NA	0
Mercury (Hg)	Upper	6/12	0.0500 - 0.610	0.157	61.0	2.60	0
	Lower	3/12	0.0400 - 0.0800	0.0633	NA	1.59	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Pesticides in Soil

No organophosphorus pesticides were detected in soil samples collected at SWMU 145.

Other Organic Compounds in Soil

Seven dioxins were detected in the two duplicate soil samples collected at SWMU 145. Eight detections occurred in the upper interval. No industrial RBCs have been established for these parameters. No lower-interval samples were collected and analyzed for dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for the upper-interval samples. The TEQ was calculated for two samples with a range of 0.0156 to 44.7 ng/kg and a mean of 22.4 ng/kg. The calculated TEQ did not exceeded the industrial RBC of 1,000 ng/kg.

Inorganic Elements in Soil

Two metals were detected in soil samples collected at SWMU 145. Seven detections occurred in the upper interval and three in the lower interval. No metal exceeded both its respective industrial RBC and RC in the upper interval or respective SSL and RC in the lower interval.

10.16.3 Groundwater Sampling and Analysis

One deep monitoring well and three shallow monitoring wells were installed and sampled to assess groundwater quality at SWMU 145 as shown in Figure 10.16.2. The wells were installed as follows:

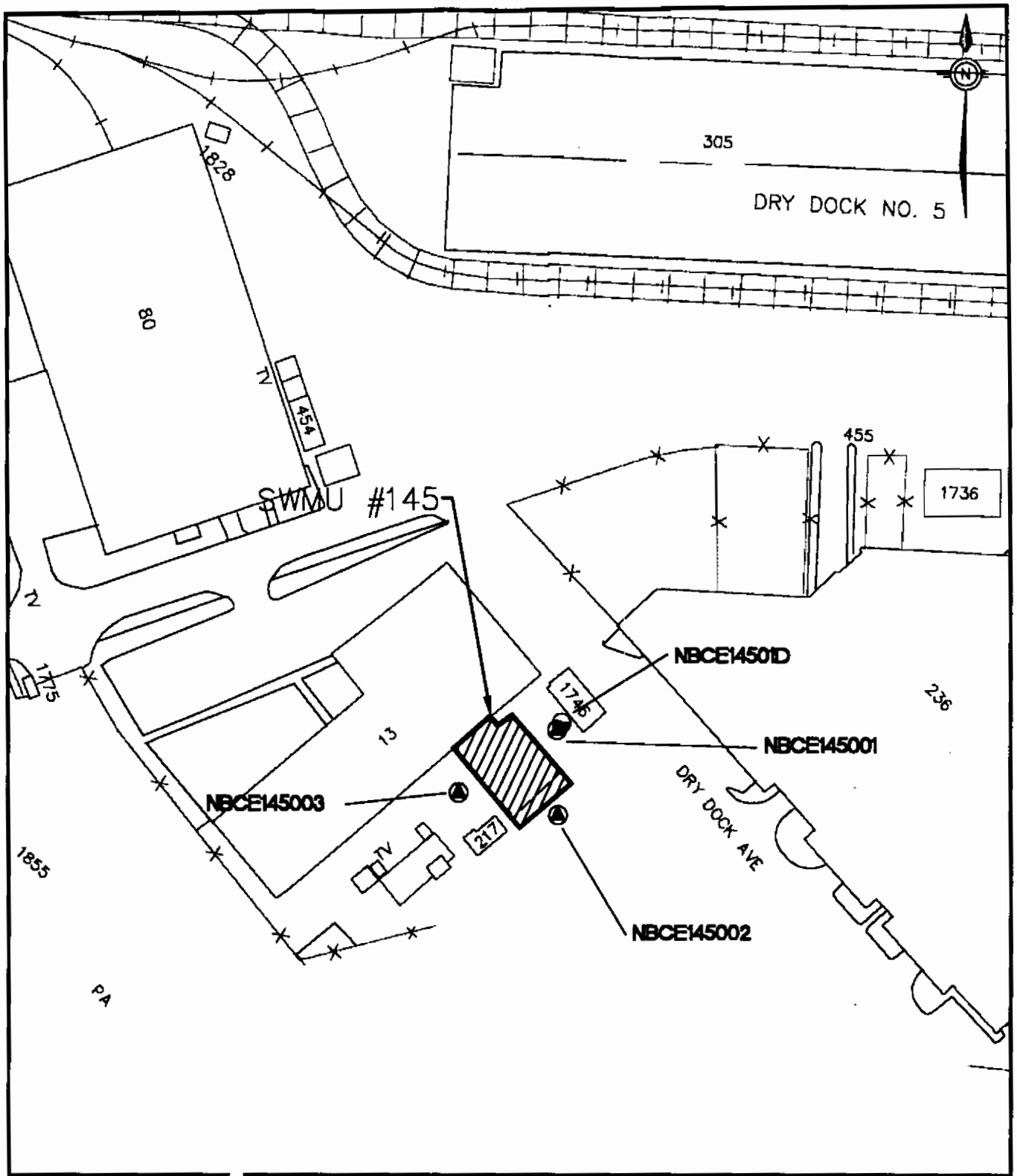
- Shallow Wells — NBCE145001, NBCE145002, and NBCE145003
- Deep Well — NBCE14501D

Groundwater samples were submitted for analysis at DQO Level III for mercury, chlorides, sulfates, and TDS. One shallow groundwater sample was selected as a duplicate and submitted for analysis at DQO Level IV for the suite of parameters listed above, plus herbicides, organophosphorus pesticides, dioxin and hexavalent chromium. Table 10.16.3.1 summarizes groundwater sampling and analysis at SWMU 145.

Table 10.16.3.1
SWMU 145
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	3	3	Mercury, chlorides, sulfates, and TDS	Mercury, chlorides, sulfates, and TDS	None
Deep	1	1	Mercury, chlorides, sulfates, and TDS	Mercury, chlorides, sulfates, and TDS	None

The shallow monitoring wells were installed at 12 feet bgs in the surficial aquifer. The deep well was installed at 31 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◓ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.16.2
MONITORING WELL LOCATIONS
SWMU #145
BUILDING 13A, FIRST FLOOR
MERCURY SPILL

DWG DATE: 09/02/97 | DWG NAME: 10-16-2

10.16.4 Nature of Contamination in Groundwater

Organic compound analytical results for the duplicate shallow groundwater sample are summarized in Table 10.16.4.1. The sample from the deep monitoring well was not analyzed for organic compounds. No mercury was detected in shallow or deep groundwater. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.16.4.1
SWMU 145
Organic Compounds Detected in First Quarter Groundwater (pg/L)
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
Dioxins						
Dioxin Equiv.	1/1	0.00900	0.00900	0.4	NA	0
OCDD	1/1	8.98	8.98	NA	NA	NA

Notes:
pg/L = Picograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level

Other Organic Compounds in Groundwater

Shallow Groundwater

One dioxin — OCDD — was detected in the duplicate shallow groundwater sample collected from SWMU 145. No tap-water RBC or MCL has been established for OCDD.

In accordance with recent dioxin guidance, a TEQ (dioxin equivalent) was calculated for the sample from well NBCE145002 (0.00900 pg/L). The sample did not exceed the 2,3,7,8-TCDD tap-water RBC of 0.43 pg/L. No MCL has been established for the dioxin equivalent.

10.16.5 Air Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed screening the ambient air at SWMU 145 with a mercury vapor analyzer. Both the number and location of screening samples were to be determined in the field. Table 10.16.5.1 summarizes air sampling activity for SWMU 145.

Table 10.16.5.1
SWMU 145
Air Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
TBD	Site Screening	EPA Metals	Mercury Vapor	No deviation from proposed strategy

10.16.6 Nature of Contamination in Air

No mercury vapors were detected at SWMU 145. Suitable sampling locations were determined in the field and were biased in an attempt to identify worst case situations.

10.16.7 Fate and Transport Assessment for SWMU 145

SWMU 145 consists of a mercury spill area reportedly under a portion of Building 13A. Ground surface exposures at the site consist of a concrete foundation inside Building 13A and asphalt pavement outside of it. Environmental media sampled as part of the SWMU 145 CSI include surface soil, subsurface soil, shallow and deep groundwater, and air. The mercury spill was the primary focus of the SWMU 145 CSI and, as a result, most of the environmental media were analyzed for mercury only. Potential constituent migration pathways investigated for SWMU 145 include soil to groundwater and groundwater to surface water. The migration pathway involving emission of VOCs from surface soil to air was not evaluated because VOCs were not analyzed in soil samples. Screening of ambient air for mercury vapor was conducted with none detected.

10.16.7.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.16.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

No organic compounds were detected in SWMU 145 soil at concentrations greater than groundwater protection SSLs. Dioxin equivalents, calculated from the trace concentrations of dioxin congeners (mainly OCDD), were present in a duplicate surface soil sample (145SB010), but at concentrations of less than 5% of its generic SSL.

All soil samples were analyzed for mercury. Duplicates were analyzed for hexavalent chromium. Both metals were detected at concentrations below their respective groundwater protection SSLs. Hexavalent chromium was detected in a single duplicate surface soil sample (145SB009). Mercury was detected in six surface soil samples and three subsurface samples at concentrations below its RC of 2.6 mg/kg. Neither of these metals was detected in groundwater samples.

10.16.7.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.16.7.1 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs 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) RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic compounds were detected in groundwater samples at concentrations above tap water RBCs or saltwater surface water screening levels. A single duplicate first-round sample from shallow well NBCE145002 was analyzed for dioxins, pesticides, and organophosphate pesticides. Dioxin congeners were present in the duplicate sample (TCDD TEQ of 0.009 pg/L). Preliminary analysis of subsequent sampling round results indicate that dioxin congener concentrations decreased in well NBCE145002; however, a second-round deep groundwater sample from well NBCE14501D reported a dioxin TCDD TEQ value of 1.62 pg/L, which is nearly four times greater than its tap water RBC of 0.43 pg/L. No third or fourth-quarter dioxin analyses were conducted.

No inorganic constituents were detected in first-round groundwater samples above their respective tap water RBCs or saltwater surface water screening levels. However, arsenic was detected in deep groundwater at well NBCE14501D at concentrations of 45.5 and 98.6 μg/L during the third and fourth rounds. These concentrations exceeded both the arsenic RC and saltwater surface water chronic screening values; the fourth-round value also exceeded arsenic's MCL of 50 μg/L. The presence of arsenic at elevated concentrations in deep groundwater in the vicinity of SWMU 145 is discussed in Section 10.10.9. Other than mercury (all samples) and hexavalent chromium (one shallow duplicate sample), no other metals were analyzed for during the first and second-round sampling.

No first-tier constituents at SWMU 145 exceeded initial screening concentrations, therefore, no second-tier analysis using adjusted screening levels was required.

10.16.7.3 Fate and Transport Summary

No organic compounds or inorganic constituents exceeded their generic SSLs or groundwater screening criteria in the first-tier screen. However, third and fourth-round arsenic concentrations, which exceeded its tap water RBC and saltwater surface water chronic screening values, were not subject to the screening analysis. Based on first-round sampling results, there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.16.7.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 145
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Dioxin Compounds												
Dioxin (TCDD TEQ)	44.7	ND	0.009	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Chromium (hexavalent)	0.122	ND	ND	NA	19	180	50	MG/KG	UG/L	NO	NO	NO
Mercury	0.61	0.08	ND	ND	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

10.16.8 Fixed-Point Risk Evaluation for SWMU 145

10.16.8.1 Site Background and Investigative Approach

SWMU 145 is the site of a mercury spill beneath a portion of Building 13A. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of 12 surface soil samples were considered in the SWMU 145 FRE. All 12 surface soil samples were analyzed for mercury only, while two surface soil duplicates were analyzed for herbicides, hexavalent chromium, mercury, dioxin, and organophosphorous pesticides. Four monitoring wells were installed as part of the 1995 RFI. Three monitoring wells were installed into the shallow aquifer and one monitoring well was installed into the deep aquifer. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the SWMU 145 FRE. Sections 10.16.1 and 10.16.3 contain summaries of the sampling effort for SWMU 145 soil and groundwater.

10.16.8.2 Fixed-Point Risk Evaluation for Soil

Table 10.16.8.1 provides CPSS summaries for SWMU 145 soil and identifies COPCs based on comparison to residential and industrial RBCs and RCs. No COPCs were identified for SWMU 145 soil for either the residential or industrial scenarios.

10.16.8.3 Fixed-Point Risk Evaluation for Groundwater

SWMU 145 first quarter groundwater samples were analyzed for mercury, chloride, sulfate, and total dissolved solids. Mercury was not detected in the first quarter groundwater sample collected from the deep aquifer. One first quarter shallow groundwater duplicate was also analyzed for herbicides, hexavalent chromium, dioxin, and organophosphorous pesticides. Table 10.16.8.2 provides CPSS summaries for SWMU 145 shallow groundwater. No COPCs were identified for SWMU 145 groundwater (shallow and deep).

10.16.8.4 FRE Summary

Data collected for SWMU 145 were screened according to the process presented in Section 7.3.4. No COPCs were identified subsequent to this screening. Subsequent quarterly groundwater sampling resulted in concentrations of arsenic above its MCL in deep groundwater. This coincides with concentrations of arsenic above its MCL in deep groundwater at adjacent sites, including combined SWMU 83, AOC 576, and AOC 580.

Table 10.16.8.1
Chemicals Present in Site Samples
SWMU 145 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Number Exceeding Ind. RB	Ref.
Dioxin Equiv.	2	2	0.02 - 44.72	22.37	NA - NA	1000	1000	NA	NG/KG			
Chromium (Hexavalent)	1	2	0.12 - 0.12	0.12	0.062 - 0.062	39	1000	NA	MG/KG			
Mercury (Hg)	6	12	0.05 - 0.61	0.16	0.04 - 0.04	2.3	61	2.6	MG/KG			

Notes:
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.16.8.2
Chemicals Present in Site Samples
SWMU 145 - Shallow Groundwater
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter	Frequency of Detection	Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Screening Conc. Reference	Units	Number Exceeding Res.	Number Exceeding Ref.
TCDD Equivalents									
Dioxin Equiv.	1 / 1	0.009 - 0.009	0.009	NA - NA	0.43	NA	PG/L		

Notes:
PG/L - picograms per liter
SQL - Sample quantitation limit
NA - Not applicable

10.16.9 Corrective Measures Considerations

For SWMU 145, the upper and lower soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the FRE, no COCs requiring further evaluation through the CMS process were identified.

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.

Arsenic has been identified in deep groundwater at a concentration above its MCL during fouth quarter sampling. This coincides with high concentrations of arsenic above the MCL in deep groundwater at adjacent sites, including combined SWMU 83, AOC 576, and AOC 580. Continued monitoring is recommended.

Potential corrective measures for the impacted medium and respective COC are in Table 10.16.9.1.

Table 10.16.9.1
Potential Corrective Measures for SWMU 145

Medium	Compounds	Potential Corrective Measures
Deep Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment

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10.17 SWMU 170, PCB Removal Operations, Drydock 1 Area; and SWMU 171, PCB Removal Operations, Drydock 2 Area

SWMUs 170 and 171 consist of storage areas immediately west of drydock (DD) 1 and DD 2, respectively. Missile launching tubes removed from decommissioned ballistic missile submarines were stored in these areas for removal of PCB-containing components. The missile tube dismantling areas have no secondary containment. It is estimated that missile tube dismantling began around the late 1980s.

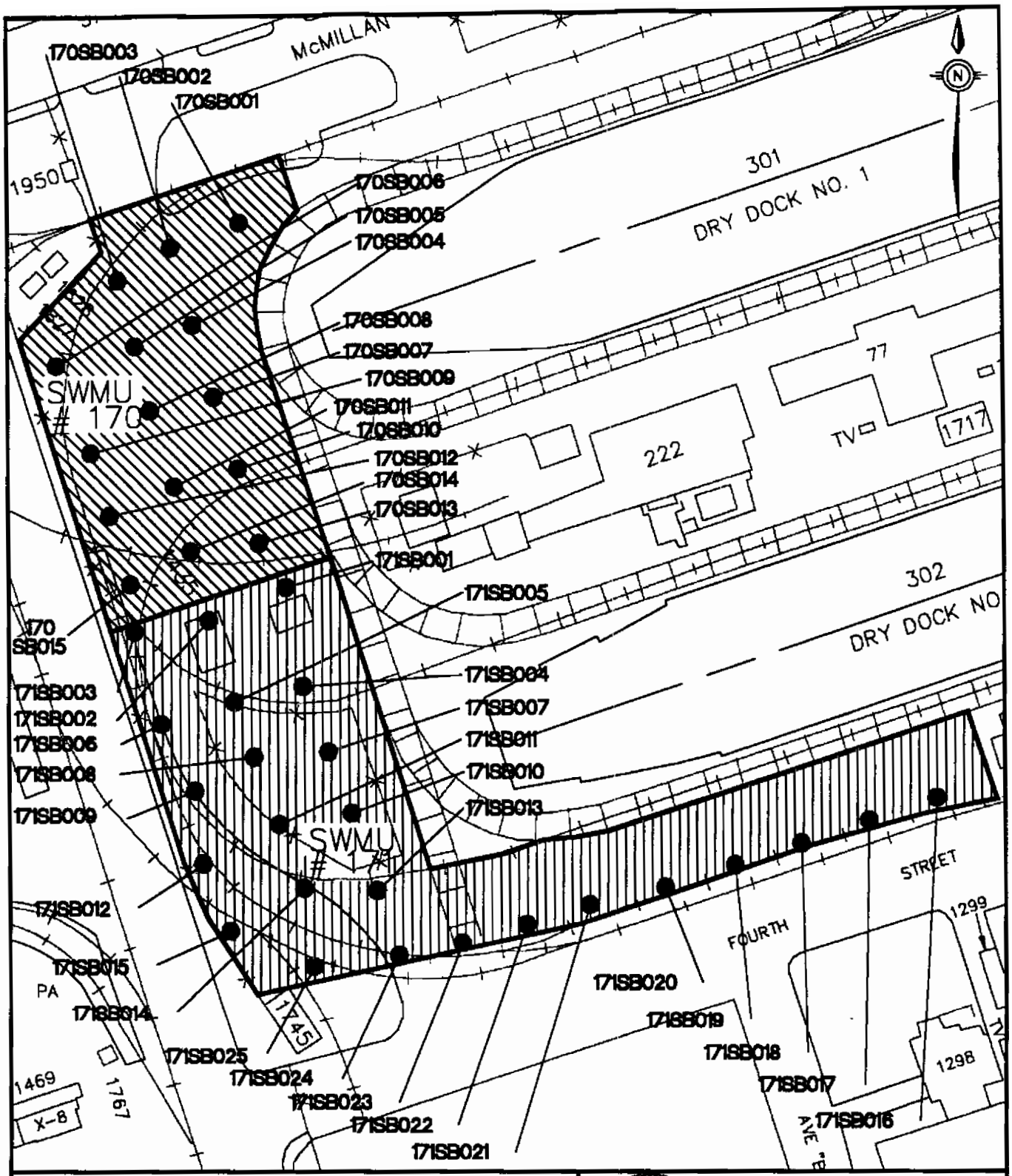
The materials of concern at SWMUs 170 and 171 indicated in the *Final Zone E RFI Work Plan* are PCBs. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for SWMUs 170 and 171, soil, sediment and asphalt core samples were collected in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.17.1 Soil Sampling and Analysis

Soil was sampled in one round at SWMUs 170 and 171 from the locations shown in Figure 10.17.1. The *Final Zone E RFI Work Plan*, proposed collecting 40 soil samples from the upper interval and 40 from the lower interval. Thirty-five of the proposed 40 upper and twenty-seven of the proposed 40 lower-interval samples were collected.

At SWMU 170, five lower-interval samples were not collected due to subsurface obstructions in the form of large rocks and metal pipes at a depth of two to three feet bgs. At SWMU 171, five upper-interval samples were not collected due to gravel used as a base for railroad and crane tracks. Eight lower-interval samples were not collected at SWMU 171 due to either gravel, concrete or brick subsurface obstructions.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ⊖ – DEEP MONITORING WELLS
- ⊕ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
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CHARLESTON, S.C.

FIGURE 10.17.1
SOIL BORING LOCATIONS
SWMU #170, DD #1 AREA
SWMU #171, DD #2 AREA
PCB REMOVAL OPERATIONS

DWG DATE: 09/02/97 | DWG NAME: 10-17-1

All samples were submitted for analysis at DQO Level III for PCBs. In addition, nine of these samples were analyzed for VOCs due to high OVA readings and/or petroleum odor in the sample. Also, one sample was submitted to be analyzed for VOC and TPH due to the possible presence of free product in the sample. Seven samples (four upper interval and three lower-interval) selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters, which includes PCBs, herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.17.1.1 summarizes soil sampling at SWMUs 170 and 171.

Table 10.17.1.1
SWMUs 170 and 171
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	40	35	PCBs	PCBs	Five upper-interval samples could not be collected due to gravel layer at surface
Lower	40	27	PCBs	PCBs	Thirteen lower-interval samples could not be collected due to subsurface obstructions

10.17.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.17.2.1. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.17.2.1
SWMUs 170 and 171
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	4/4	73.0 - 4,400	1,250	20,000,000	0
	Lower	5/5	16.0 - 470	115	NA	NA
Pesticides/PCBs (μg/kg)						
gamma-Chlordane	Upper	1/2	1.50	1.50	4,400	0
4,4'-DDE	Upper	1/2	14.0	14.0	17,000	0
4,4'-DDT	Upper	1/2	25.0	25.0	17,000	0
Aroclor-1260	Upper	13/35	11.0 - 480	144	740	0
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	4/4	0.0279 - 0.826	0.267	1,000	0
	Lower	3/3	0.00380 - 0.0788	0.0313	NA	NA
1234678-HpCDD	Upper	4/4	1.11 - 29.1	8.66	NA	NA
	Lower	1/3	3.24	3.24	NA	NA
1234678-HpCDF	Upper	4/4	0.805 - 11.1	5.25	NA	NA
	Lower	2/3	0.498 - 2.60	1.55	NA	NA
123678-HxCDF	Upper	1/4	1.62	1.62	NA	NA
OCDD	Upper	4/4	6.80 - 246	81.7	NA	NA
	Lower	3/3	3.79 - 16.6	8.69	NA	NA
OCDF	Upper	3/4	1.13 - 16.2	8.23	NA	NA
	Lower	2/3	0.786 - 3.76	2.27	NA	NA
	Lower	1/27	480	480	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Volatile Organic Compounds in Soil

One VOC — acetone — was detected in soil samples collected at SWMUs 170 and 171. The VOC did not exceed its respective industrial RBC in the upper-interval or respective SSL in the lower-interval.

Pesticides and PCBs in Soil

Three pesticides were detected in soil samples collected at SWMUs 170 and 171. No pesticide exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

One PCB, Aroclor-1260, was detected in soil samples collected at SWMUs 170 and 171. Thirteen detections occurred in the upper interval and one in the lower interval. None of the detections exceeded the Aroclor-1260 industrial RBC in the upper interval or Aroclor-1260 SSL in the lower interval.

Other Organic Compounds in Soil

Five dioxins were detected in soil samples collected at SWMUs 170 and 171. Sixteen detections occurred in the upper-interval and eight occurred in the lower-interval. No industrial RBCs or SSLs have been established for these parameters.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated. The upper-interval TEQ was calculated for four samples with a range of 0.0279 to 0.826 ng/kg and a mean of 0.267 ng/kg. None of the TEQ calculations exceeded the industrial RBC of 1,000 ng/kg.

Samples were submitted for laboratory analysis for TPH-GRO and TPH-DRO at SWMUs 170 and 171; however, no concentrations were detected.

10.17.3 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting six sediment samples at SWMUs 170 and 171 from the locations shown in Figure 10.17.2. Six sediment samples were collected and submitted for analysis at DQO Level III for PCBs. No samples were selected as duplicates at this site. Table 10.17.3.1 summarizes sediment sampling and analysis at SWMUs 170 and 171.

Table 10.17.3.1
SWMUs 170 and 171
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
6	6	PCBs	PCBs	None

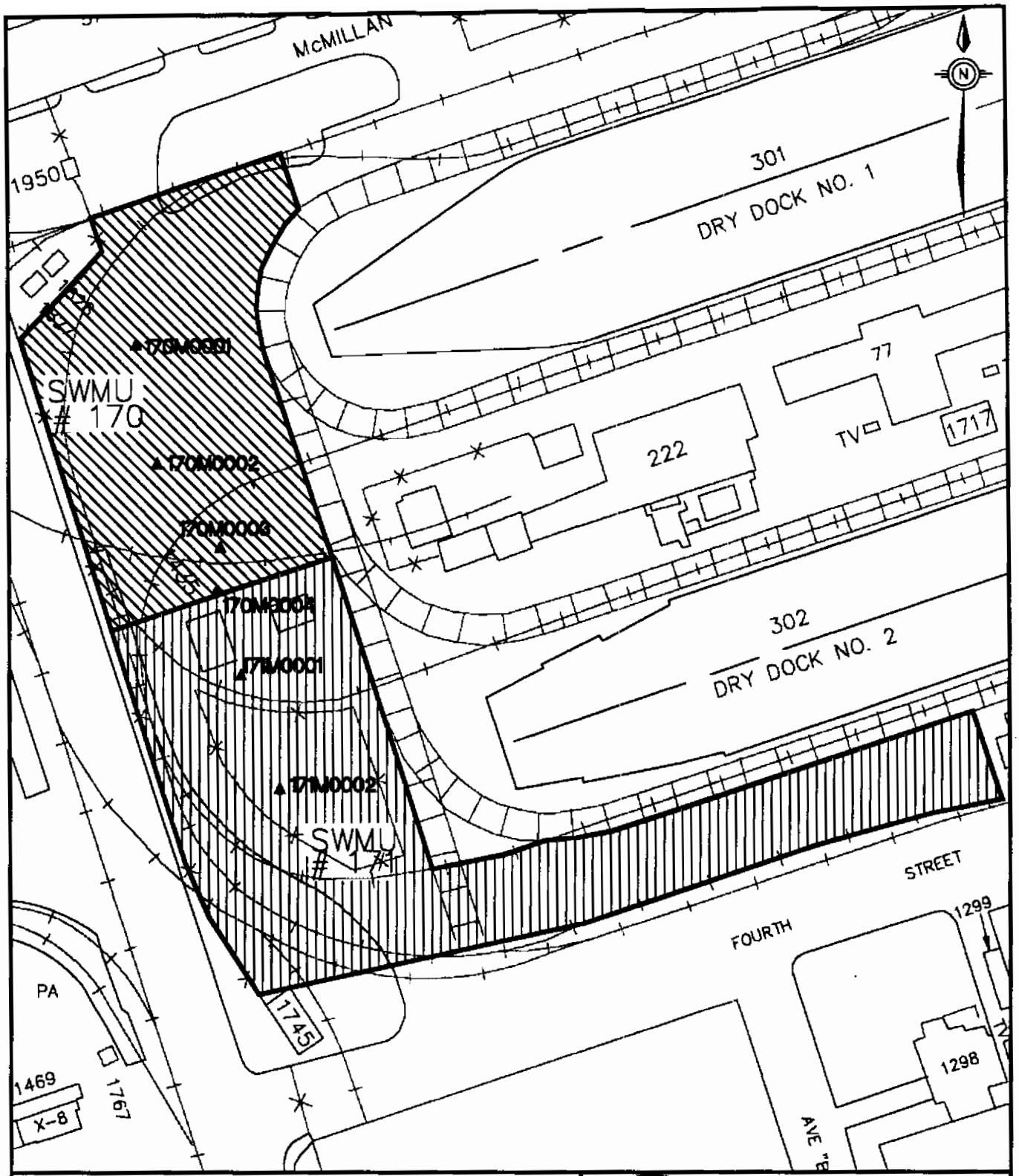
10.17.4 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.17.4.1. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.17.4.1
SWMUs 170 and 171
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
PCBs						
Aroclor-1260	Upper	6/6	46.0 - 200	119	740	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS SSVs.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
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GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.17.2
SEDIMENT SAMPLE LOCATIONS
SWMU #170, DD #1 AREA
SWMU #171, DD #2 AREA
PCB REMOVAL OPERATIONS

DWG DATE: 09/02/97 | DWG NAME: 10-17-2

PCBs in Sediment

One PCB — Aroclor-1260 — was detected in six of six sediment samples with a range of 46 μg/kg to 200 μg/kg, and a mean of 119 μg/kg. None of the detections exceeded the Aroclor-1260 industrial RBC of 740 μg/kg.

10.17.5 Asphalt Core Sampling and Analysis

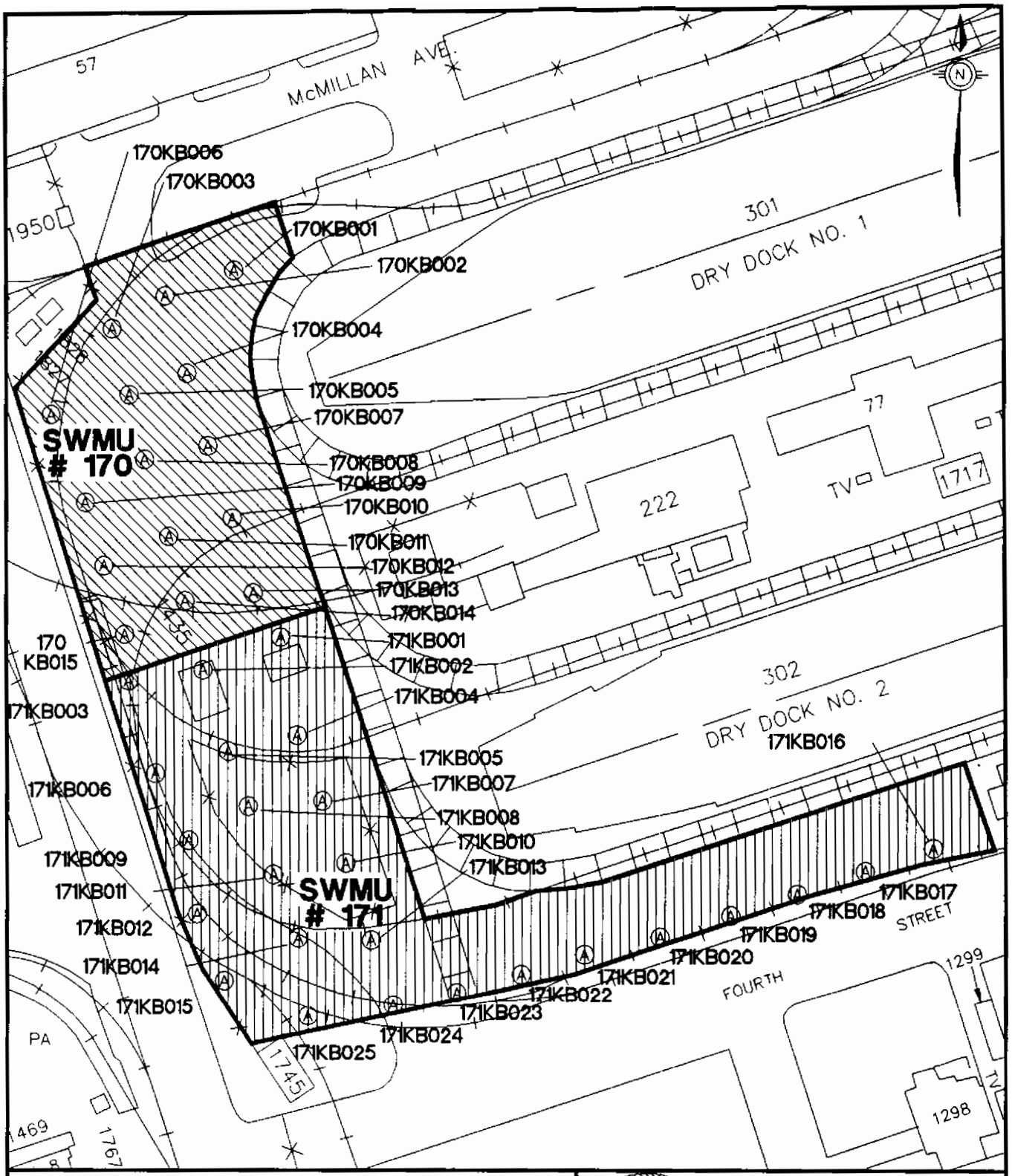
The *Final Zone E RFI Work Plan* proposed collecting 40 asphalt core samples at SWMUs 170 and 171 from the locations shown in Figure 10.17.3. Thirty-two asphalt core samples were collected and submitted for analysis at DQO Level III for PCBs. Eight samples were not collected at SWMU 171 because asphalt did not cover the sampling location. No samples were selected as duplicates at this site. Table 10.17.5.1 summarizes asphalt core sampling and analysis at SWMUs 170 and 171.

Table 10.17.5.1
SWMUs 170 and 171
Asphalt Core Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
40	32	PCBs	PCBs	Eight samples were not collected due to absence of matrix

10.17.6 Nature of Contamination in Asphalt

PCB analytical results for asphalt are summarized in Table 10.17.6.1. Appendix H contains the complete data report for all samples collected in Zone E.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
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GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.17.3
ASPHALT SAMPLE LOCATIONS
SWMU #170, DD #1 AREA
SWMU #171, DD #2 AREA
PCB REMOVAL OPERATIONS

DWG DATE: 09/02/97 | DWG NAME: 10-17-3

Table 10.17.6.1
SWMUs 170 and 171
PCB Detections in Asphalt (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	RBC	Number of Samples Exceeding RBC
PCBs						
Aroclor-1260	Upper	7/32	3.70 - 480	81.5	NA	NA

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = Industrial soil RBC does not apply to asphalt samples

PCBs in Asphalt

One PCB — Aroclor-1260 — was detected in seven of 32 asphalt samples with a range of 3.70 to 480 μg/kg, and a mean of 81.5 μg/kg. Industrial RBCs do not apply to Aroclor-1260 in asphalt.

10.17.7 Fate and Transport Assessment for SWMUs 170 and 171

Combined SWMU 170 consists of storage areas for PCB-containing components from decommissioned ballistic missile submarines located immediately west of Drydocks 1 and 2. Ground surface at the site is entirely covered with asphalt and concrete. Environmental media sampled as part of the combined SWMU 170 CSI include surface soil, subsurface soil, catch-basin sediment, and asphalt. Potential constituent migration pathways investigated for combined SWMU 170 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of VOCs from surface soil to air.

10.17.7.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.17.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to groundwater protection SSLs. For inorganics, maximum

concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Six organic compounds — acetone, Aroclor-1260, gamma-Chlordane, 4,4'-DDE, 4,4'-DDT, and dioxin TEQs — were detected in soil sample collected at combined SWMU 170 at concentrations below groundwater protection SSLs. Maximum Aroclor-1260 concentrations in surface and subsurface soil occurred at the same location (171SB012) and were approximately half of the generic SSL for Aroclor-1260. Aroclor-1260 was the most prevalent of the six organics as it was detected in 12 surface soil samples and one subsurface soil sample. Dioxins were detected in four surface soil samples and three subsurface soil samples. The maximum dioxin TEQ value of 0.826 ng/kg is more than three orders of magnitude below its generic SSL. The detections of 4,4'-DDE, 4,4'-DDT, and gamma-Chlordane were confined to a single duplicate surface soil sample at location 171SB019.

Hexavalent chromium was the only inorganic analyzed for in duplicate samples; hexachrome was not detected.

10.17.7.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.17.7.1 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs 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) RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the applicable standards.

The supplemental well pair, NBCEGDE016 and NBCEGDE16D, were the only monitoring wells installed within combined SWMU 170. None of the six organic compounds detected in soil samples were also detected in first-round groundwater samples. However, there was a fourth-round detection of heptachlor (0.051 μg/L) which is 22 times greater than its tap water RBC and 14 times greater than its saltwater surface water chronic screening value.

Arsenic is the only inorganic detected in shallow and deep groundwater above its tap water RBC and saltwater surface water chronic screening values. During the four sampling rounds, arsenic concentrations in shallow groundwater ranged from 33.8 to 85.3 μg/L while arsenic concentrations in deep groundwater concentrations ranged from 6.2 to 13.9 μg/L.

10.17.7.3 Soil-to-Sediment Cross-Media Transport

Tables 10.17.4.1 and 10.17.6.1 present the organic compounds detected in the six sediment samples and 32 asphalt samples collected at combined SWMU 170. Aroclor-1260 was detected in all six catch-basin sediment samples in concentrations from 46 to 200 μg/kg. Aroclor-1260 was also detected in seven asphalt samples at concentrations from 3.70 to 480 μg/kg. Aroclor-1260 (PCB) detections are likely related to previous site activities associated with PCB removal.

Since no first-tier constituent at combined SWMU 170 exceeded initial screening concentrations, no second-tier analysis using adjusted screening levels was required.

10.17.7.4 Soil-to-Air Cross-Media Transport

Table 10.17.7.2 lists the single VOC (acetone) detected in surface soil samples collected at combined SWMU 170 along with its corresponding soil-to-air volatilization screening level. No exposed soil is present at the site. In addition, acetone's reported maximum concentration did not exceed its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at combined SWMU 170.

10.17.7.5 Fate and Transport Summary

Combined SWMU 170 was investigated as a PCB site with potential chemical contamination largely confined to surface soil, catch-basin sediment, and asphalt. Six organic compounds (one VOC, one PCB, three pesticides, and dioxin TEQs) were detected in collected soil samples; however, no constituent exceeded groundwater protection SSLs. The PCB, Aroclor-1260, was the most widespread organic compound as it was detected in six sediment samples, seven asphalt samples, twelve surface soil samples, and one subsurface soil sample. The three pesticides were detected in a duplicate sample from a single sample location. Since no compounds exceeded first-tier screening levels, the site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River through the associated migration pathway.

Although no monitoring wells were installed specifically to monitor contamination related to former activities at SWMUs 170 and 171, chemical analyses from the grid-well pair NBCEGDE016 and NBCEGDE16D were used to assess groundwater contamination since they lie within the area of concern. These analyses indicate that arsenic is prevalent in shallow groundwater at concentrations above its tap water RBC and saltwater surface water chronic screening values. Due to extensive clay deposits comprising the shallow subsurface, dissolved arsenic would tend to adsorb to clay particles within the aquifer, further limiting any threat to human health or the environment in the Cooper River.

Table 10.17.7.1
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: SWMUs 170 and 171
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	4400	470	NA	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	480	480	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	1.5	ND	NA	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	14	ND	NA	NA	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	25	ND	NA	NA	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.826	0.0788	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.17.7.2
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMU 170
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	4400	62000000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.17.8 Fixed-Point Risk Evaluation for SWMU 170 and SWMU 171

10.17.8.1 Site Background and Investigative Approach

SWMU 170 is a PCB removal operation near drydock number 1 and SWMU 171 is a PCB removal operation near drydock number 2. The following refers to these sites as combined SWMU 170. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of 35 surface soil samples were considered in the combined SWMU 170 FRE. All 35 surface soil samples were analyzed for PCBs. Additionally, four duplicates were analyzed for herbicides, hexavalent chromium, dioxin, and organophosphorous pesticides, and two duplicates were analyzed for chlorinated pesticides. Groundwater was not sampled as part of the RFI. Section 10.17.1 contains summaries of the sampling effort for combined SWMU 170 soil.

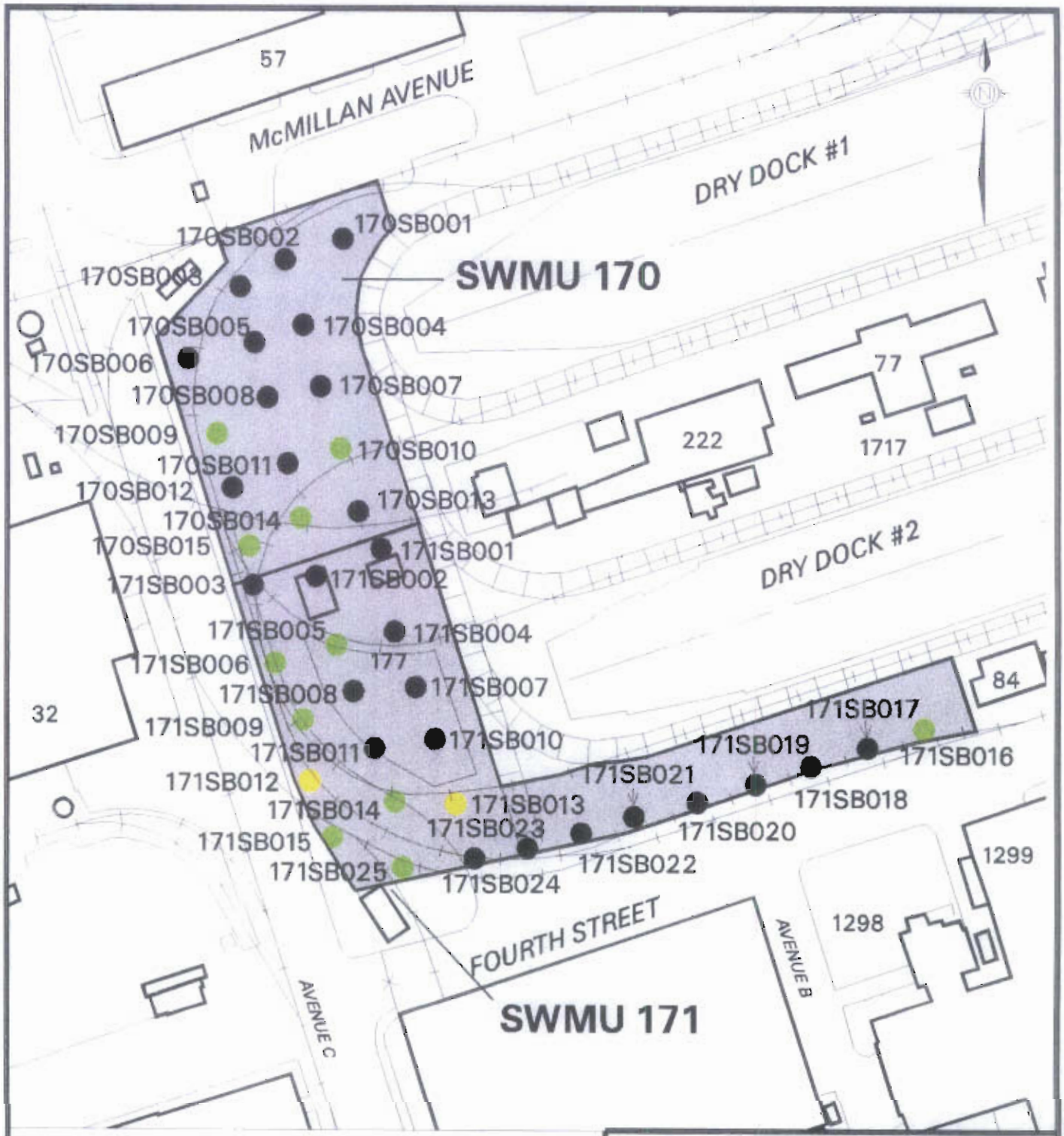
10.17.8.2 Fixed-Point Risk Evaluation for Soil

Table 10.17.8.1 provides CPSS summaries for combined SWMU 170 soil and identifies COPCs based on comparison to residential and industrial RBCs. Based on residential RBCs, Aroclor-1260 was identified as a COPC for combined SWMU 170.

Residential Scenario

Table 10.17.8.2 summarizes the residential COPCs detected at each combined SWMU 170 sample location with contribution to risk and hazard. As shown, Aroclor-1260 contributes to risk for combined SWMU 170, exceeding 1E-06 at two of 35 locations. Twenty-two of the 35 samples were nondetects for Aroclor-1260. For those sample locations with detected concentrations of Aroclor-1260, risk estimate ranged from 5E-08 to 2E-06, with a arithmetic mean risk of 3E-07, assuming a deminimus risk of 1E-07 for sample locations that were nondetect. Figure 10.17.4 is a spatial presentation of residential risk estimates for combined SWMU 170 soil.

No soil COPC were identified for soil that would have contributed to HI.



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 200

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

FIGURE 10.17.4
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
SWMU 170, 171

Industrial Scenario

Based on industrial RBCs, no COPCs were identified for combined SWMU 170 soil.

10.17.8.3 Uncertainty

SWMU 170 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Frequency and Spatial Distribution

Aroclor-1260 detections in surface soil that are associated with risk estimates above 1E-06 were isolated to only two sample locations (171SB012 and 171SB013). Chronic exposure to the limited area represented by these two sample locations is highly unlikely. Assuming a worse-case

exposure unit area of one-half acre, as represented by sample locations 171SB007, 171SB008, 171SB009, 171SB010, 171SB011, 171SB012, 171SB013, 171SB014, 171SB015, and 171SB025, the mean risk was calculated to be 7E-07.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for combined SWMU 170. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

10.17.8.4 FRE Summary

The risk and hazard posed by contaminants at combined SWMU 170 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. Risk and HI estimates are presented on Table 10.17.8.2 such that a risk (E-06) that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO. Section 7, Tables 7.3.1, and 7.3.2 provide residential and industrial RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Aroclor-1260 was detected in combined SWMU 170 surface soil locations 171SB012 and 171SB013 at concentrations above its residential RGO, however, the area of contamination is

highly limited. Point risk estimates are 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. Furthermore, the mean risk as calculated in Section 10.17.2 and the mean risk in the worst-case one-half acre exposure unit area were both below 1E-06.

Soil — Site Worker Scenario

No industrial scenario COPCs were identified for surface soil at combined SWMU 170.

Table 10.17.8.1
Chemicals Present in Site Samples
SWMU 170, SWMU 171 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Number Exceeding Ind. RB	Ref.
Pesticides/PCBs													
Aroclor-1260	*	13	35	11 - 480	144.4	73 - 90	83	740	NA	UG/KG	8		
gamma-Chlordane		1	2	1.5 - 1.5	1.5	1.8 - 1.8	490	4400	NA	UG/KG			
4,4'-DDT		1	2	25 - 25	25	3.4 - 3.4	1900	17000	NA	UG/KG			
4,4'-DDE		1	2	14 - 14	14	3.4 - 3.4	1900	17000	NA	UG/KG			
TCDD Equivalents													
Dioxin Equiv.		4	4	0.0279 - 0.8262	0.2674	NA - NA	1000	1000	NA	NG/KG			
Volatile Organics													
Acetone		4	4	73 - 4400	1248	NA - NA	780000	20000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
SQL - Sample Quantitation Limit
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
NA - Not Applicable

Table 10.17.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 170 and 171
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
170	B001	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B002	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B003	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B004	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B005	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B006	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B007	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B008	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		M	
170	B009	Aroclor-1260	30.00	UG/KG	0.1361	100.00	NA	
		Total			0.1361		NA	
170	B010	Aroclor-1260	11.00	UG/KG	0.0499	100.00	NA	
		Total			0.0499		NA	
170	B011	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B012	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B013	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
170	B014	Aroclor-1260	29.00	UG/KG	0.1316	100.00	NA	
		Total			0.1316		NA	
170	B015	Aroclor-1260	89.00	UG/KG	0.4038	100.00	NA	
		Total			0.4038		NA	

Table 10.17.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 170 and 171
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
171	B002	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B003	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B005	Aroclor-1260	140.00	Ug/KG	0.6352	100.00	NA	
		Total			0.6352		NA	
171	B006	Aroclor-1260	89.00	UG/KG	0.4038	100.00	NA	
		Total			0.4038		NA	
171	B007	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B008	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B009	Aroclor-1260	55.00	UG/KG	0.2495	100.00	NA	
		Total			0.2495		NA	
171	B010	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B011	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B012	Aroclor-1260	480.00	UG/KG	2.1778	100.00	NA	
		Total			2.1778		NA	
171	B013	Aroclor-1260	480.00	UG/KG	2.1778	100.00	NA	
		Total			2.1778		NA	
171	B014	Aroclor-1260	150.00	UG/KG	0.6806	100.00	NA	
		Total			0.6806		NA	
171	B015	Aroclor-1260	67.00	UG/KG	0.3040	100.00	NA	
		Total			0.3040		NA	
171	B016	Aroclor-1260	77.00	UG/KG	0.3494	100.00	NA	
		Total			0.3494		NA	
171	B019	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	

Table 10.17.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 170 and 171
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
171	B020	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B021	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B022	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B023	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
171	B025	Aroclor-1260	180.00	UG/KG	0.8167	100.00	NA	
		Total			0.8167		NA	

10.17.9 Corrective Measures Considerations

For SWMUs 170 and 171, the upper and lower soil intervals were investigated. Based on the analytical results and the risk assessment, a single COC requiring further evaluation through the CMS process was identified for the upper soil interval.

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 concrete or asphalt. Eight soil samples were collected from gravel-covered areas.

Aroclor-1260 was the only COC identified in the upper soil interval. The equated risk for Aroclor-1260 for sample locations 171SB0012 and 171SB0013 is 2E-6. The equated risk for Aroclor-1260 for all other sampling locations is less than 1E-6. Sample 171SB0012 was collected beneath a gravel area and sample 171SB0013 was collected from beneath an asphalt-covered area. The risk associated with Aroclor-1260 for these two sample locations is within USEPA's acceptable ranges of 1E-06 and 1E-04. Therefore, no further action is recommended for the soil interval.

Groundwater was not analyzed.

Potential corrective measure of no further action for soil and respective COC is presented in Table 10.17.9.1.

Table 10.17.9.1
Potential Corrective Measures for SWMU 170 and SWMU 171

Medium	Compounds	Potential Corrective Measures
Soil	Polychlorinated biphenyls	No Action

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10.18 SWMU 173, Building 1297 Storage Area

SWMU 173 consists of separate storage areas for lead ingots and hazardous materials in Building 1297. The building is divided into two storage areas, each accessed through an exterior door. Each area also has an opening in the roof, used to transfer materials. One area is used to store lead ingots and its roof is protected by a non-watertight wooden cover. Another area was previously a hazardous materials storage area, but is currently empty. Three storm drains are located close to the building.

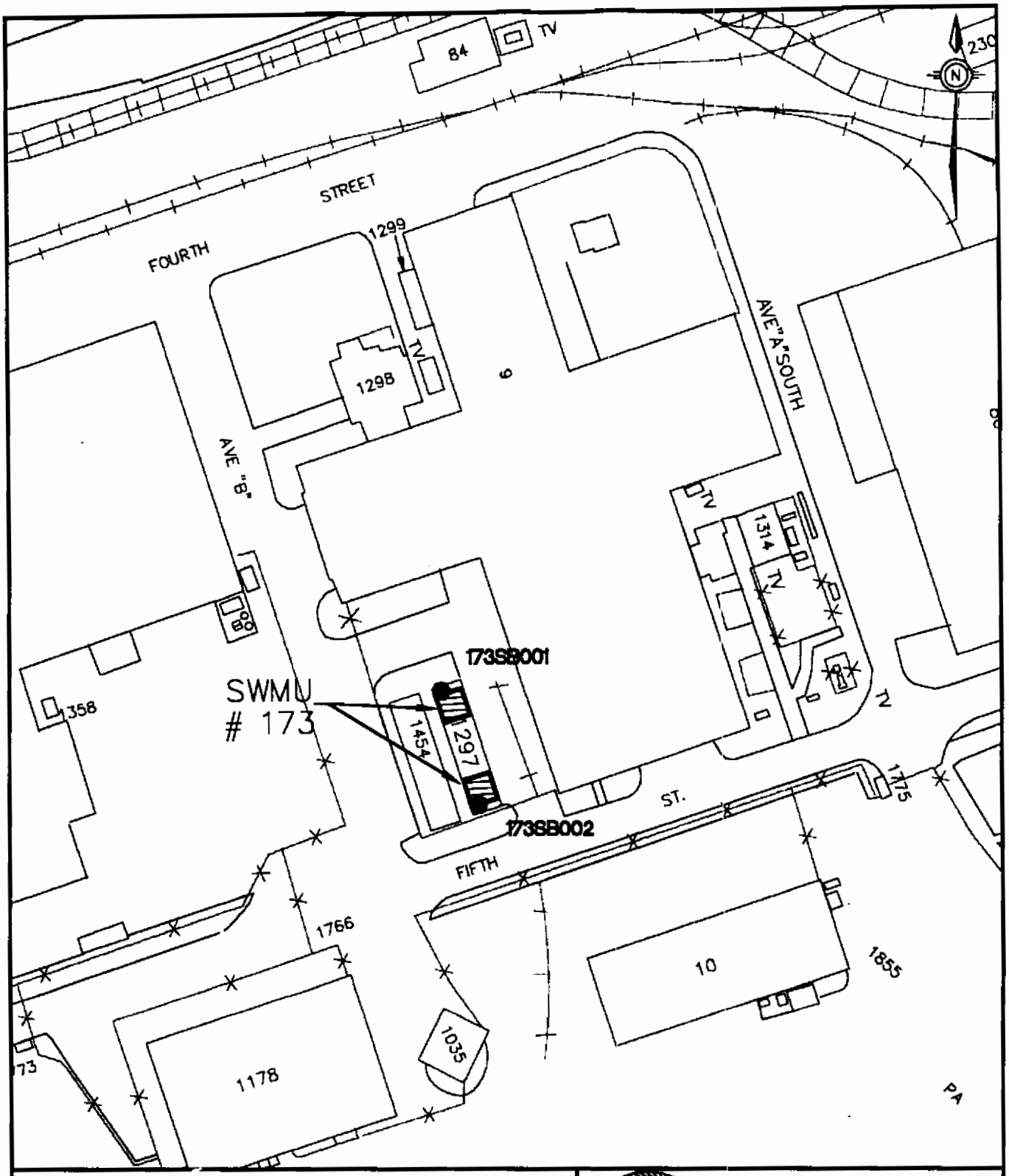
Materials of concern identified for SWMU 173 in the *Final Zone E RFI Work Plan* include metals (lead) and hazardous materials. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for SWMU 173, soil and sediment were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.18.1 Soil Sampling and Analysis

Soil was sampled in one round at SWMU 173 from the locations shown in Figure 10.18.1. The *Final Zone E RFI Work Plan*, proposed collecting two soil samples from the upper interval and two samples from the lower interval.

All proposed samples were collected and submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. No duplicate samples were collected at SWMU 173. Table 10.18.1.1 summarizes soil sampling at SWMU 173.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.18.1
SOIL BORING LOCATIONS
SWMU #173
BUILDING 1297
STORAGE AREA

DWG DATE: 09/02/97 DWG NAME: 10-18-1

Table 10.18.1.1
SWMU 173
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	2	2	Standard Suite[a], organotins	Standard Suite[a], organotins	None
Lower	2	2	Standard Suite[a], organotins	Standard Suite[a], organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCB

10.18.2 Nature of Contamination in Soil

No organic compounds were detected in soil. Inorganic analytical results for soil are summarized in Table 10.18.2.1. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.18.2.1
SWMU 173
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	2/2	1,670 - 5,600	3,640	100,000	26,600	0
	Lower	2/2	6,570 - 6,800	6,690	NA	41,100	NA
Arsenic (As)	Upper	2/2	0.670 - 5.80	3.24	3.80	23.9	0
	Lower	2/2	5.60 - 6.20	5.90	NA	19.9	NA
Barium (Ba)	Upper	2/2	21.9 - 25.5	23.7	14,000	130	0
	Lower	2/2	37.8 - 38.9	38.4	NA	94.1	NA
Beryllium (Be)	Upper	2/2	0.170 - 0.190	0.180	1.30	1.70	0
	Lower	2/2	0.160 - 0.370	0.265	NA	2.71	NA

Table 10.18.2.1
SWMU 173
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Calcium (Ca)	Upper	2/2	462 - 1540	1,000	NA	NA	NA
	Lower	2/2	1,210 - 3,080	2,150	NA	NA	NA
Chromium (Cr)	Upper	1/2	10.8	10.8	1,000	94.6	0
	Lower	2/2	10.4 - 13.9	12.2	NA	75.2	NA
Cobalt (Co)	Upper	2/2	10.7 - 23.1	16.9	12,000	19.0	0
	Lower	2/2	2.50 - 9.90	6.20	NA	14.9	NA
Copper (Cu)	Upper	2/2	1.10 - 40.9	21.0	8,200	66.0	0
	Lower	2/2	0.830 - 60.6	30.7	NA	152	NA
Iron (Fe)	Upper	2/2	1,570 - 12,600	7,090	61,000	NA	0
	Lower	2/2	11,000 - 12,900	12,000	NA	NA	NA
Lead (Pb)	Upper	2/2	3.00 - 3.40	3.20	1,300	265	0
	Lower	2/2	4.10 - 6.10	5.10	NA	173	NA
Magnesium (Mg)	Upper	2/2	107 - 517	312	NA	NA	NA
	Lower	2/2	608 - 743	676	NA	NA	NA
Manganese (Mn)	Upper	2/2	48.9 - 90.0	69.5	4,700	302	0
	Lower	2/2	28.0 - 113	70.5	NA	881	NA
Mercury (Hg)	Upper	1/2	0.0300	0.0300	61	2.60	0
	Lower	1/2	0.0300	0.0300	NA	1.59	NA
Nickel (Ni)	Upper	2/2	1.60 - 2.60	2.10	4,100	77.1	0
	Lower	2/2	2.10	2.10	NA	57.0	NA
Potassium (K)	Lower	1/2	429	429	NA	NA	NA
Selenium (Se)	Lower	1/2	0.660	0.660	NA	2.40	NA
Sodium (Na)	Upper	1/2	63.1	63.1	NA	NA	NA
Vanadium (V)	Upper	2/2	1.70 - 20.2	11.0	1,400	94.3	0
	Lower	2/2	15.6 - 25.3	20.5	NA	155	NA

Table 10.18.2.1
SWMU 173
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Zinc (Zn)	Upper	2/2	5.70 - 25.5	15.6	61,000	827	0
	Lower	2/2	5.90 - 42.4	24.2	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

No VOCS were detected in soil samples submitted for laboratory analysis from SWMU 173.

Semivolatile Organic Compounds in Soil

No SVOCS were detected in soil samples submitted for laboratory analysis from SWMU 173.

Pesticides and PCBs in Soil

No pesticides or PCBs were detected in soil samples submitted for laboratory analysis from SWMU 173.

Other Organic Compounds in Soil

No other organic compounds were detected in soil samples submitted for laboratory analysis from SWMU 173.

Inorganic Elements in Soil

Nineteen metals were detected in soil samples collected at SWMU 173. Thirty-one detections occurred in the upper-interval and 32 occurred in the lower-interval. No metals were detected

above both their respective industrial RBC and RC in the upper interval or respective SSL and RC in the lower interval.

10.18.3 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting three sediment samples at SWMU 173 from the locations shown in Figure 10.18.2. Three sediment samples were collected and submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. No samples were selected as duplicates at this site. Table 10.18.3.1 summarizes sediment sampling and analysis at SWMU 173.

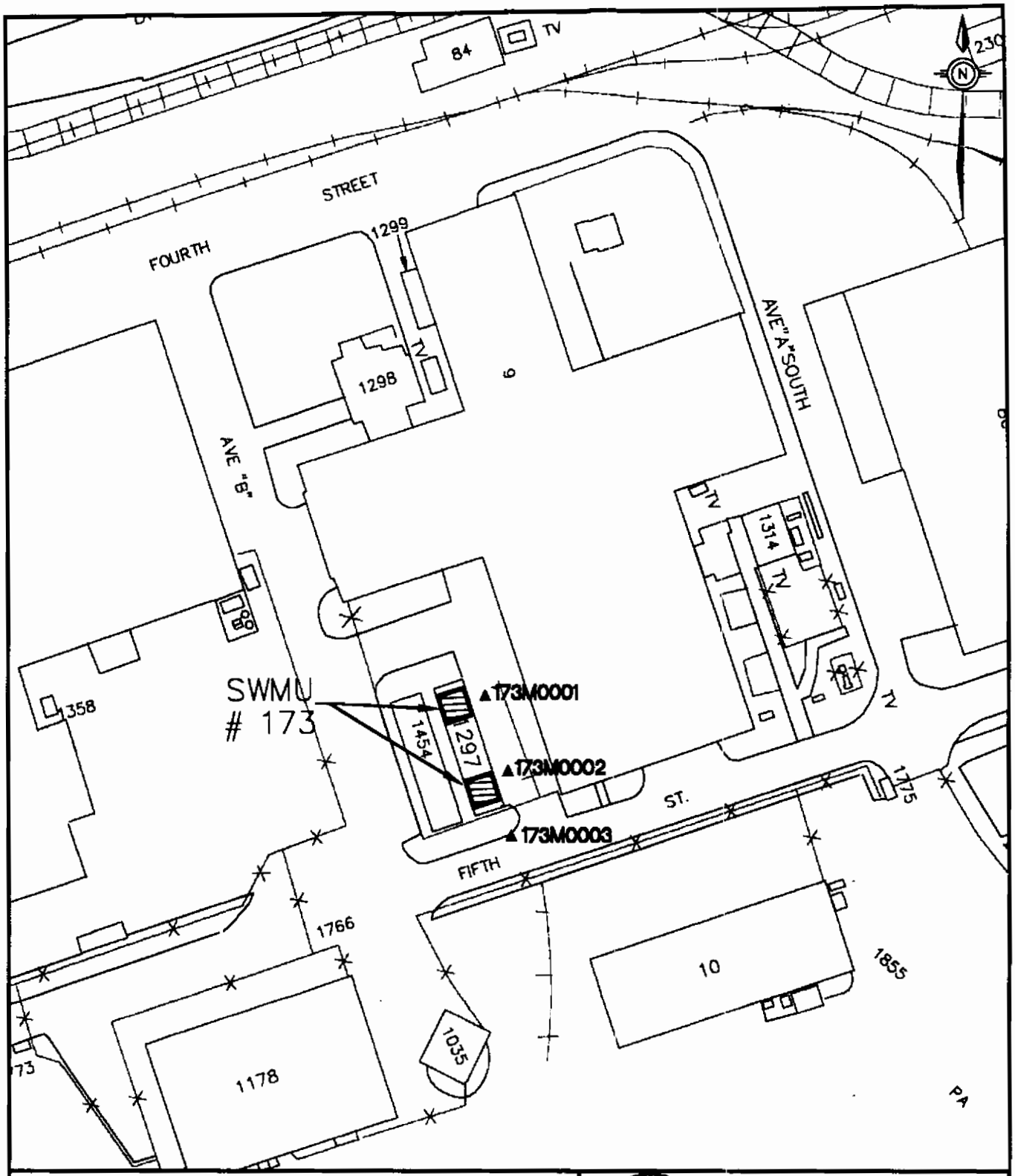
Table 10.18.3.1
SWMU 173
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
3	3	Standard Suite[a], organotins	Standard Suite[a], organotins	None

Note:
a = Standard suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

10.18.4 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.18.4.1. Inorganic analytical results for groundwater are summarized in Table 10.18.4.2. Appendix H contains the complete data report for all samples collected in Zone E.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.18.2
SEDIMENT SAMPLE LOCATIONS
SWMU #173
BUILDING 1297
STORAGE AREA

DWG DATE: 09/02/97 | DWG NAME: 10-18-2

Table 10.18.4.1
SWMU 173
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
VOCs						
Toluene	Upper	1/3	1.000	1.000	410,000	0
SVOCs						
Acenaphthene	Upper	1/3	160	160	470,000	0
Anthracene	Upper	1/3	97.0	97.0	61,000,000	0
Benzo(g,h,i)perylene	Upper	1/3	340	340	8,200,000	0
Benzoic acid	Upper	1/3	220	220	100,000,000	0
bis(2-Ethylhexyl)phthalate	Upper	3/3	330 - 720	477	410,000	0
Butylbenzylphthalate	Upper	1/3	110	110	41,000,000	0
4-Chloro-3-methylphenol	Upper	2/3	200 - 320	260	NA	NA
Di-n-butylphthalate	Upper	1/3	87.0	87.0	NA	NA
Fluoranthene	Upper	3/3	120 - 450	233	8,200,000	0
Fluorene	Upper	1/3	110	110	8,200,000	0
Phenanthrene	Upper	2/3	110 - 640	375	410,000	0
Pyrene	Upper	3/3	130 - 930	400	6,100,000	0
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	3/3	9.39 - 533	261	780	0
Benzo(b)fluoranthene	Upper	2/3	93.0 - 300	197	7,800	0
Benzo(k)fluoranthene	Upper	1/3	260	260	78,000	0
Benzo(a)pyrene	Upper	2/3	240 - 500	370	780	0
Chrysene	Upper	1/3	94.0	94.0	780,000	0
Pesticides/PCBs						
gamma-Chlordane	Upper	2/3	2.00 - 2.10	2.05	4,400	0
4,4'-DDD	Upper	1/3	8.50	8.50	24	0

Table 10.18.4.1
SWMU 173
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Pesticides/PCBs						
4,4'-DDE	Upper	2/3	3.60 - 5.10	4.35	17	0
4,4'-DDT	Upper	1/3	8.20	8.20	17	0
Aroclor-1260	Upper	2/3	110	110	740	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.18.4.2
SWMU 173
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Aluminum (Al)	Upper	3/3	1,320 - 2,110	1,690	100,000	0
Antimony (Sb)	Upper	3/3	1.30 - 14.9	6.20	82	0
Arsenic (As)	Upper	3/3	5.80 - 15.9	9.73	3.8	3
Barium (Ba)	Upper	3/3	64.1 - 105	82.4	14,000	0
Beryllium (Be)	Upper	3/3	0.140 - 0.540	0.300	1.3	0
Cadmium (Cd)	Upper	3/3	1.30 - 3.50	2.23	100	0
Calcium (Ca)	Upper	3/3	1,830 - 43,800	17,700	NA	NA
Chromium (Cr)	Upper	3/3	42.5 - 70.1	59.1	1,000	0
Cobalt (Co)	Upper	3/3	3.80 - 8.30	6.47	12,000	0
Copper (Cu)	Upper	3/3	1,670 - 5,420	3,080	8,200	0
Cyanide (CN)	Upper	1/3	0.390	0.390	NA	NA
Iron (Fe)	Upper	3/3	21,500 - 69,700	38,100	61,000	0

Table 10.18.4.2
SWMU 173
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Lead (Pb)	Upper	3/3	721 - 4,270	1,930	400	3
Magnesium (Mg)	Upper	3/3	342 - 1,100	681	NA	NA
Manganese (Mn)	Upper	3/3	224 - 435	308	4,700	0
Mercury (Hg)	Upper	3/3	0.0300 - 0.370	0.153	61	0
Nickel (Ni)	Upper	3/3	119 - 861	441	4,100	0
Potassium (K)	Upper	1/3	208	208	NA	NA
Selenium (Se)	Upper	2/3	0.650 - 1.20	0.925	1,000	0
Silver (Ag)	Upper	1/3	1.10	1.10	1,000	0
Sodium (Na)	Upper	2/3	95.3 - 137	116	NA	NA
Tin (Sn)	Upper	3/3	73.3 - 251	134	100,000	0
Vanadium (V)	Upper	3/3	8.60 - 17.4	12.1	1,400	0
Zinc (Zn)	Upper	3/3	580 - 4,560	1,950	61,000	0

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
NA = No industrial soil RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS SSVs.

Volatile Organic Compounds in Sediment

One VOC — toluene — was detected in one of three sediment samples collected at SWMU 173. The sample did not exceed the toluene industrial soil RBC of 410,000 μg/kg.

Semivolatile Organic Compounds in Sediment

Sixteen SVOCs were detected in soil samples collected at SWMU 173, with a total of 26 detections. No SVOCs were detected above their respective industrial soil RBC.

In accordance with recent cPAH guidance, BEQs were calculated at SWMU 173. The BEQ was calculated for three samples with a range of 9.39 to 533 μg/kg and a mean of 261 μg/kg. None of the calculated BEQs exceeded the benzo(a)pyrene industrial soil RBC of 780 μg/kg.

Pesticides and PCBs in Sediment

Four pesticides were detected in sediment samples collected at SWMU 173. No pesticides exceeded their respective industrial soil RBC.

One PCB — Aroclor-1260 — was detected in sediment samples collected at SWMU 173. The sample did not exceed the Aroclor-1260 industrial soil RBC.

Other Organic Compounds in Sediment

Based on the COPCs associated with SWMU 173, no samples were submitted for laboratory analysis for other organic compounds. Samples were submitted for laboratory analysis for organotins at SWMU 173; no detections were recorded.

Inorganic Elements in Sediment

Twenty-four metals were detected in sediment samples collected at SWMU 173, with a total of 64 detection. The detected concentration of two metals — arsenic and lead — exceeded their respective industrial soil RBCs.

Arsenic was detected in three of three upper-interval samples with a range of 5.80 to 15.9 mg/kg and a mean of 9.73 mg/kg. Three samples (173M0001, 15.9 mg/kg; 173M0002, 5.8 mg/kg; and 173M0003, 7.5 mg/kg) exceeded the arsenic industrial soil RBC of 3.8 mg/kg.

Lead was detected in three of three upper-interval samples with a range of 721 to 4,270 mg/kg and a mean of 1,930 mg/kg. Three samples (173M0001, 4,270 mg/kg; 173M0002, 811 mg/kg; and 173M0003, 721 mg/kg) exceeded the lead industrial soil RBC of 400 mg/kg.

10.18.5 Fate and Transport Assessment for SWMU 173

SWMU 173 is a series of storage compartments used for lead ingots and hazardous materials (Building 1297). Each compartment has an opening in the roof, which is used to transfer materials. The ground surface around the building is entirely paved with concrete except for a small grassy area roughly 60 feet to the north. Environmental media sampled as part of the SWMU 173 CSI included surface soil, subsurface soil, and catch-basin sediment. Potential constituent migration pathways investigated for SWMU 173 include soil to groundwater and surface soil to sediment. The emission of VOCs from surface soil to air pathway was not assessed since no VOCs were reported in surface soil samples.

10.18.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.18.5.1 compares maximum inorganic concentrations in soil to the greater of (a) risk-based SSLs, or (b) RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Cobalt was the only constituent detected in SWMU 173 soil above groundwater protection SSLs. It was detected in one surface soil sample at a concentration marginally above its RC (EPA does not list a generic SSL for cobalt). Subsurface soil concentrations of cobalt did not exceed its RC.

10.18.5.2 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.18.5.2 provides a second screening tier for constituents detected in soil at concentrations exceeding the first-tier screening level. Constituent concentrations in soil are compared to

calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined SWMU 173 is 158,000:1 (see Table 6.2.1).

Cobalt, the single first-tier constituent exceeding a screening concentration, did not exceed the adjusted screening levels of the second tier, indicating that site constituents in soil pose no threat to human health or the environment in the Cooper River.

10.18.5.3 Surface Soil-to-Sediment Cross-Media Transport

Tables 10.18.4.1 and 10.18.4.2 summarize the constituent concentrations detected in sediment samples at SWMU 173. It is unlikely that constituents reported in surface soil are a source of contamination in catch basin sediment since the ground surface is entirely paved. Organic constituents detected in sediment samples collected from the catch basins at SWMU 173 included VOCs, SVOCs, pesticides, and PCBs. No organic constituents were detected in SWMU 173 soil samples. Inorganic concentrations were generally higher in sediment samples than in soil samples. These inorganics consist of chromium, copper, iron, lead, nickel, and zinc. Concentrations of these inorganics are potentially related to the site's uses which include lead storage. Fate and transport for constituents detected in sediments from catch basins will be examined in the Zone L RFI report.

10.18.5.4 Fate and Transport Summary

No organic compounds were detected in samples collected at SWMU 173. Cobalt was reported in one surface soil sample at a concentration marginally exceeding its RC, but it was not above the adjusted screening value of the second-tier comparison. Consequently, there is no apparent threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.18.5.1
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: SWMU 173
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Inorganic Compounds												
Aluminum	5600	6800	NA	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	5.8	6.2	NA	NA	23.9	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	25.5	38.9	NA	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.19	0.37	NA	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Chromium (total)	10.8	13.9	NA	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	23.1	9.9	NA	NA	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	40.9	60.6	NA	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	3.4	6.1	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	90	113	NA	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.03	0.03	NA	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	2.6	2.1	NA	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	ND	0.66	NA	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Vanadium	20.2	25.3	NA	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	25.5	42.4	NA	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.18.5.2
Chemicals Detected in Surface Soil or Subsurface Soil at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMU 173
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Inorganic Compounds																
Cobalt	23.1	9.9	NA	NA	1040	2200	NA	2200	3.48E+08	2200	1.58E+05	1.00E+06	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 158,000; GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

10.18.6 Fixed-Point Risk Evaluation for SWMU 173

10.18.6.1 Site Background and Investigative Approach

SWMU 173 consists of two separate areas used to store lead ingots and other hazardous materials and is located in Building 1297. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

Two surface soil samples were considered in the SWMU 173 FRE. Groundwater was not sampled as part of the SWMU 173 RFI. Section 10.18.1 contain summaries of the sampling effort for SWMU 173.

10.18.6.2 Fixed-Point Risk Evaluation for Soil

Table 10.18.6.1 provides CPSS summaries for SWMU 173 soil and identifies COPCs based on comparison to residential and industrial RBCs and RCs. No COPCs were identified for SWMU 173 soil for either the residential or industrial scenarios. Arsenic was detected at a concentration above both its residential and its industrial RBCs, and beryllium was detected at a concentration above its residential RBC. Both arsenic and beryllium were eliminated from consideration based on comparison to their RCs. Wilcoxon rank sum analysis was not performed for SWMU 173 surface soil since there were only two samples collected.

10.18.6.3 FRE Summary

Data collected for SWMU 173 were screened according to the process presented in Section 7.3.4. No COPCs were identified subsequent to this screening.

Table 10.18.6.1
Chemicals Present in Site Samples
SWMU 173 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Screening Concentration: Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Inorganics													
Aluminum (Al)		2	2	1670 - 5600	3635	NA - NA	7800	100000	26600	MG/KG			
Arsenic (As)		2	2	0.67 - 5.8	3.235	NA - NA	0.43	3.8	23.9	MG/KG	2	1	
Barium (Ba)		2	2	21.9 - 25.5	23.7	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		2	2	0.17 - 0.19	0.18	NA - NA	0.15	1.3	1.7	MG/KG	2		
Calcium (Ca)	N	2	2	462 - 1540	1001	NA - NA	NA	NA	NA	MG/KG	2		
Chromium (Cr)		1	2	10.8 - 10.8	10.8	1.5 - 1.5	39	1000	94.6	MG/KG			
Cobalt (Co)		2	2	10.7 - 23.1	16.9	NA - NA	470	12000	19	MG/KG			1
Copper (Cu)		2	2	1.1 - 40.9	21	NA - NA	310	8200	66	MG/KG			
Iron (Fe)	N	2	2	1570 - 12600	7085	NA - NA	NA	NA	NA	MG/KG	1		
Lead (Pb)		2	2	3 - 3.4	3.2	NA - NA	400	400	265	MG/KG			
Magnesium (Mg)	N	2	2	107 - 517	312	NA - NA	NA	NA	NA	MG/KG	2		
Manganese (Mn)		2	2	48.9 - 90	69.45	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)		1	2	0.03 - 0.03	0.03	0.02 - 0.02	2.3	61	2.6	MG/KG			
Nickel (Ni)		2	2	1.6 - 2.6	2.1	NA - NA	160	4100	77.1	MG/KG			
Sodium (Na)	N	1	2	63.1 - 63.1	63.1	54.8 - 54.8	NA	NA	NA	MG/KG	1		
Vanadium (V)		2	2	1.7 - 20.2	10.95	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		2	2	5.7 - 25.5	15.6	NA - NA	2300	61000	827	MG/KG			

Notes:
N - Essential nutrient
MG/KG - milligrams per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

10.18.7 Corrective Measures Considerations

For SWMU 173, the upper and lower soil intervals were investigated. Based on the analytical results and the FRE, no COC requiring further evaluation through the CMS process was identified for the soil intervals.

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 paved with concrete. No further action is recommended for the soil interval. Groundwater was not analyzed.

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10.10 SWMU 83, Foundry, Building 9; SWMU 84, Lead Storage, Building 9; and AOC 574, Building 9 Fuel Tank

SWMU 83 is a former foundry in Building 9. The foundry operations have been discontinued since at least 1991, and currently the building contains electrical power supply equipment, capacitors, transformers, rectifiers, furnaces, and ovens. The building is also used to repair hydraulic equipment. The foundry was built in 1906 and was used to cast metal parts in refitting ships. The primary industrial process associated with this facility was melting and casting copper alloy parts. Two fuel oil above-ground storage tanks (ASTs), which have not been decommissioned, are adjacent to the building. An abandoned oven was posted as containing PCBs. An approximately 10-cubic-foot pit of soot and metal scraps was observed below the electric furnace. The smoldering pots contain friable asbestos. Lead bricks and drums of hazardous materials from previous operations are present in the building. Most recently, the foundry was used to repair hydraulic equipment and as a power substation (providing electricity for smoldering activities). Several foundry-related air emissions sources remain within the unit. These include the following:

- The foundry furnace, designated as company point I.D. No. 53 on the Bureau of Air Quality Control Permit No. 0560-0002, has an associated 67-foot stack with no continuous emission monitors.

- The foundry mold's cyclone, designated as company point I.D. No. 54 on the Bureau of Air Quality Control Permit No. 0560-0002, has a 30-foot high, 2-foot inside diameter stack with no continuous emission monitors.

SWMU 84 consists of an area outside of Building 9 used to store lead blankets and shielding. The majority of the lead is encased in either rubber or fabric; however, uncovered lead materials have been stored here. The lead-containing materials are placed either on pallets or directly on the

concrete pavement. No containment structures are associated with this unit. No information could be found regarding the period of operation.

AOC 574 is the site of a 3,700-gallon AST east of Building 9. The inactive fuel tank formerly contained fuel oil for the furnaces and torches in Building 9. The tank is in an unpaved area and has no secondary containment. No information could be found regarding the period of operation.

SWMU 84 and AOC 574 have not been investigated previously. The following incidents and/or investigations occurred at SWMU 83:

- In a hand-written Department of the Navy memorandum, a transformer oil spill is reported to have occurred on August 22, 1979, in Building 9. The spill occurred while removing transformers. More than 100 gallons of transformer oil spilled on the ground and concrete pavement southeast of Building 9. The oil was sampled and submitted for PCB analysis; no documentation concerning the results has been found. The spill area was covered with absorbent materials, roped off, and posted with signs limiting access due to the presence of PCBs. No other spill cleanup activities are known to have occurred.

- According to Hazardous Material Incident Report No. 84-55, a capacitor in an electrical power supply exploded on September 18, 1984, spraying burned Pyranol oil residue inside an 8' x 6' x 7' containment room. The containment room was subsequently sealed and posted with PCB warning labels. The damaged capacitor was removed on October 3, 1984, and the room was cleaned up on October 19, 1984. The capacitor and cleanup debris were containerized in a 55-gallon drum and submitted for disposal through a Defense Logistics Agency (DLA) contract.

- Environmental Incident Report No. 88-68 states that a half gallon of oil mixed with soot spilled in August 1988. The spill area included an electrical rectifier and concrete foundation. On August 26, 1988, a composite sample from three locations in the spill area was collected and analyzed for PCBs; the results showed 124 ppm of Aroclor-1260. Following cleanup, the debris was placed in a drum and transferred to Building 246, a NAVBASE hazardous waste storage facility, for disposal. Two wipe samples were subsequently taken and analyzed for PCBs. The wipe sample from the rectifier indicated 120 micrograms per swab (μg/swab) of Aroclor-1254; the wipe sample from the concrete pad indicated 347 μg/swab of Aroclor-1254. Based upon these results, a double-rinse cleanup was conducted on September 7, 1988.

- Wipe samples were collected in January 1989 from around the drain plug and the cement foundation for the transformer NS 1A cabinet. The PCB analysis indicated 1,290 μg/swab of Aroclor-1260 (drain plug area) and 19,000 μg/swab of Aroclor-1260 (cement pad). The same two areas were sampled in early February 1989 with PCB results of 125 μg/swab and 5,620 μg/swab Aroclor-1260, respectively. The analytical results necessitated further cleaning to meet the USEPA requirements of 100 micrograms per 100 square centimeters (μg/100 cm^2). The spill area was recleaned and resampled on April 15, 1989, with results of 78 μg/swab in the drain plug area and 132 μg/swab of Aroclor-1260 on the concrete pad. Sampling on May 27, 1989, indicated <10 μg/swab of Aroclor-1260 on the cement pad.

- Environmental Incident Report No. 91-83 states a fire was discovered in the generating station at the foundry on May 23, 1991. The generating station provided the electricity to operate the induction heaters which operated the foundry's ovens. The generating station contained PCB capacitors. It was determined that an air-cooled transformer overheated

and caught fire. The PCB capacitors were not damaged. No known PCB investigation or cleanup is known to have been conducted.

- On September 19, 1988, three wipe samples were collected from the interior of the foundry Ajax oven and analyzed for PCBs. One sample was a wipe of a 100 cm^2 area on top of the second capacitor from the left in the bottom bank; analysis indicated 386.32 micrograms per wipe (μg/wipe) of Aroclor-1254. The other two samples are not based on a per unit area due to the large amount of dirt and grease also incidentally collected. One sample from the wooden base under the bottom bank of the capacitor indicated 235.29 milligrams per gram (mg/g) of Aroclor-1254. The second was taken from the floor behind the capacitor banks, and indicated 26.28 mg/g of Aroclor-1254.

- On October 27, 1988, airborne PCB (Aroclors-1254 and 1242) monitoring was conducted inside an Ajax Oven Control Center in the foundry while the oven was operating. Three areas were monitored approximately three hours; only one area had a reported PCB concentration (0.0029 milligrams per cubic meter [mg/m^3] Aroclor-1254) above the laboratory quantitation limit of 0.0020 mg/m^3.

Materials of concern identified in the *Final Zone E RFI Work Plan* are as follows: SWMU 83, lead, paints, solvents, friable asbestos, dielectric fluid, and petroleum hydrocarbons; at SWMU 84, lead; and at AOC 574, petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the RFI objectives at SWMUs 83 and 84 and AOC 574, air, soil, groundwater, and wipe samples were collected in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.10.1 Soil Sampling and Analysis

Soil was sampled in two rounds at SWMUs 83 and 84 and AOC 574 from the locations shown in Figure 10.10.1. The *Final Zone E RFI Work Plan*&H proposed collecting 12 soil samples from the upper interval and 12 from the lower interval. Soil samples were also collected at both intervals from the seven shallow monitoring well locations proposed at this site. During the first round of sampling, all 19 proposed upper-and 19 proposed lower-interval samples locations were collected.

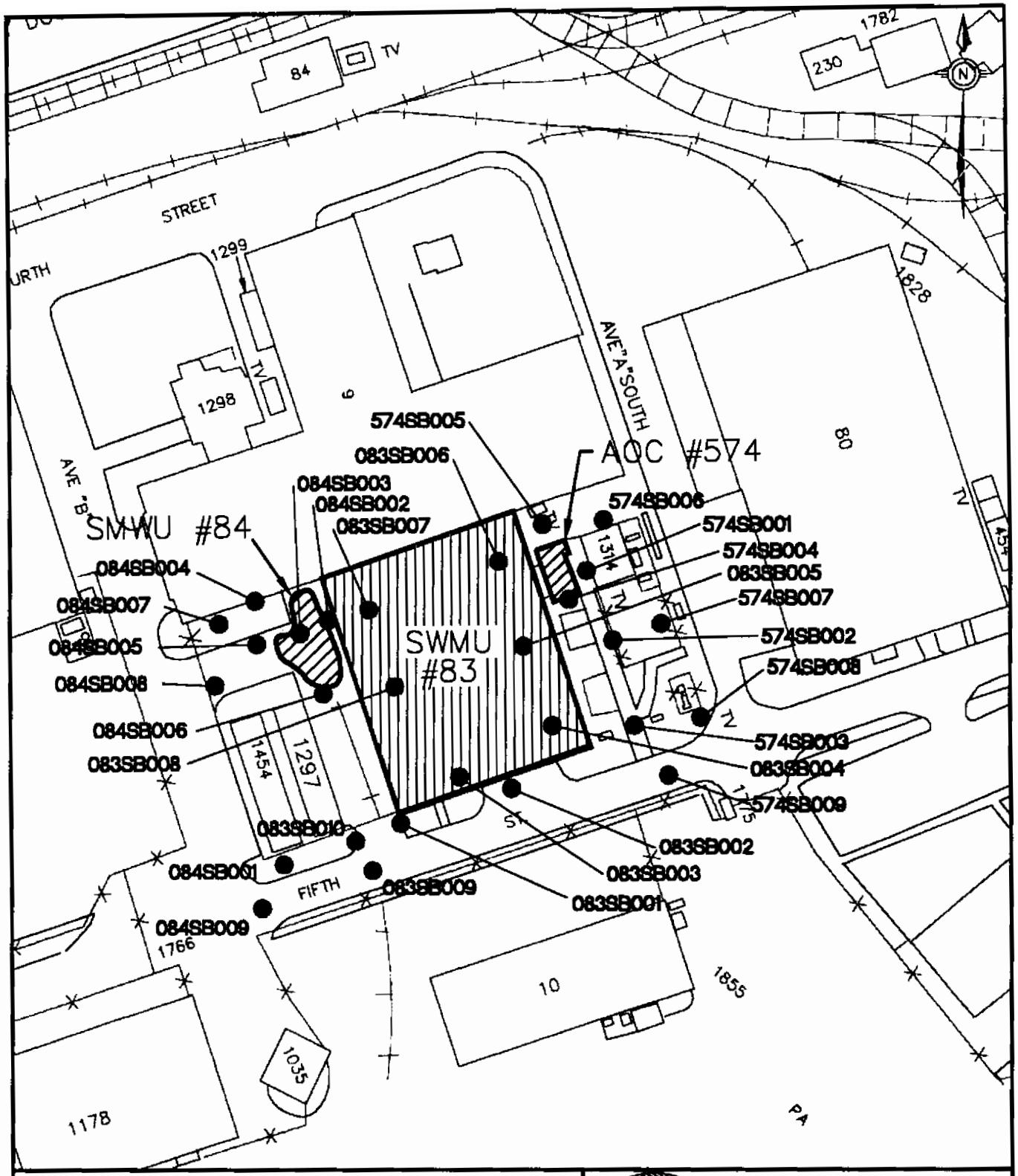
First-round Sampling — First-round samples were submitted for analysis at DQO Level III for organotins and the standard suite of parameters, which includes VOCs, SVOCs, pesticides/PCBs, metals and cyanide at DQO Level III. Five upper-interval and six lower-interval samples were also submitted for TPH analysis due to high OVA readings at SWMU 83 and surface staining around AOC 574. No duplicate samples were collected at this site. Table 10.10.1.1 summarizes the first round of soil sampling at SWMU 83 and associated sites.

Table 10.10.1.1
SWMUs 83 and 84 and AOC 574
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	19	19	Standard Suite[a], organotins	Standard Suite[a], organotins	Five samples were analyzed for TPH
Lower	19	19	Standard Suite[a], organotins	Standard Suite[a], organotins	Six samples were analyzed for TPH

Note:
a = Standard Suite includes VOCs, SVOCs, pesticides/PCB, metals, and cyanide

Second-round Sampling — Second-round sampling was performed at SWMUs 83 and 84 and AOC 574 after first-round analytical results were compared to the USEPA Region III RBCs



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10.1
SOIL BORING LOCATIONS
SWMU#83, BUILDING 9
SWMU #84, LEAD STORAGE, BLDG 9
AOC #574, BUILDING 9, SAA

DWG DATE: 09/02/97 | DWG NAME: 10-10-1

and SSLs (April 1996). The second round included nine upper- and nine lower-interval samples to determine the extent of constituents detected during first-round sampling. Eight of nine proposed upper-interval samples and eight of nine lower-interval soil samples were collected. One upper-interval sample was not collected due to surface obstructions and one lower-interval sample was not collected due to sample saturation, or subsurface obstructions such as wood or rocks. Parameters exceeding RBCs included SVOCs, metal, and pesticides/PCBs. Section 10.10.2 details specific parameters and locations which exceeded RBCs.

All second-round samples at SWMUs 83 and 84 and AOC 574 were submitted for analysis of SVOCs and VOCs. One upper-interval duplicate sample was collected and analyzed for Appendix IX SVOCs, pesticides, metals, and cyanide. Table 10.10.1.2 summarizes the second round of soil sampling at SWMU 83 and associated sites.

Table 10.10.1.2
SWMUs 83 and 84 and AOC 574
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	9	8	Metals, SVOCs	Metals, SVOCs	One sample was not collected due to surface obstructions. Four samples were also analyzed for VOCs, pesticides, PCBs
Lower	9	8	Metals, SVOCs	Metals, SVOCs	One sample was not collected due to subsurface obstructions. Four samples were also analyzed for VOCs, pesticides, and PCBs.

10.10.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.10.2.1. Inorganic analytical results for soil are summarized in Table 10.10.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.10.2.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Acetone	Upper	12/23	6.00 - 200	75.2	20,000,000	0
	Lower	11/23	13.0 - 730	117	NA	NA
2-Butanone (MEK)	Upper	1/23	6.00	6.00	100,000,000	0
Carbon disulfide	Lower	1/23	4.00	4.00	NA	NA
Chlorobenzene	Lower	1/23	2.00	2.00	NA	NA
2-Hexanone	Upper	1/23	20.0	20.0	NA	NA
Methylene chloride	Upper	6/23	1.000 - 14.0	4.33	760,000	0
	Lower	5/23	2.00 - 7.00	5.20	NA	NA
Toluene	Upper	4/23	1.000	1.000	41,000,000	0
	Lower	1/23	2.00	2.00	NA	NA
1,1,1-Trichloroethane	Upper	2/23	1.000	1.000	7,200,000	0
Trichloroethene	Upper	1/23	37.0	37.0	520,000	0
Xylene (Total)	Upper	2/23	2.00 - 6.00	4.00	100,000,000	0
	Lower	2/23	2.00 - 5.00	3.50	NA	NA
SVOCs						
Acenaphthene	Upper	9/27	94.0 - 8,800	2,020	12,000,000	0
	Lower	4/27	140 - 2,400	1,170	NA	NA

Table 10.10.2.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs						
Acenaphthylene	Upper	7/27	84.0 - 290	157	8,200,000	0
	Lower	2/27	43.0 - 190	117	NA	NA
Anthracene	Upper	15/27	95.0 - 18,000	2,430	61,000,000	0
	Lower	8/27	79.0 - 3,400	814	NA	NA
Benzo(g,h,i)perylene	Upper	20/27	50.0 - 8,400	1,830	8,200,000	0
	Lower	7/27	100 - 2,900	854	NA	NA
Benzoic acid	Upper	1/27	89.0	89.0	100,000,000	0
bis(2-Ethylhexyl)phthalate	Upper	3/27	140 - 680	380	410,000	0
Butylbenzylphthalate	Upper	4/27	130 - 300	215	41,000,000	0
	Lower	1/27	110	110	NA	NA
Carbazole	Upper	1/10	130	130	290,000	0
	Lower	1/8	200	200	NA	NA
2-Chlorophenol	Upper	1/27	100	100	1,000,000	0
Dibenzofuran	Upper	6/27	47.0 - 5,600	1,920	820,000	0
	Lower	5/27	45.0 - 1,700	627	NA	NA
Di-n-butylphthalate	Upper	1/27	74.0	74.0	20,000,000	0
	Lower	1/27	140	140	NA	NA
Diethylphthalate	Upper	2/27	790 - 5,900	3,350	100,000,000	0
	Lower	3/27	210 - 370	267	NA	NA
Dimethylphthalate	Upper	1/27	2,400	2,400	100,000,000	0
Di-n-octyl phthalate	Upper	2/27	52.0 - 170	111	4,100,000	0
Fluoranthene	Upper	20/27	100 - 73,000	8,330	8,200,000	0
	Lower	12/27	70.0 - 7,700	1,650	NA	NA

Table 10.10.2.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs						
Fluorene	Upper	10/27	100 - 8,200	2,210	8,200,000	0
	Lower	7/27	140 - 3,700	1,630	NA	NA
2-Methylnaphthalene	Upper	12/27	51.0 - 5,500	1,170	8,200,000	0
	Lower	10/27	47.0 - 62,000	9,300	NA	NA
4-Methylphenol (p-Cresol)	Upper	3/27	44.0 - 110	83.3	1,000,000	0
Naphthalene	Upper	9/27	64.0 - 6,900	1,560	8,200,000	0
	Lower	6/27	74.0 - 1,800	651	NA	NA
Pentachlorophenol	Upper	1/27	320	320	48,000	0
	Lower	1/27	270	270	NA	NA
Phenanthrene	Upper	21/27	96.0 - 83,000	8,200	8,200,000	0
	Lower	14/27	120 - 11,000	2,190	NA	NA
Pyrene	Upper	21/27	120 - 59,000	6,590	6,100,000	0
	Lower	14/27	84.0 - 8,600	1,330	NA	NA
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	20/27	86.3 - 29,000	4,670	780	15
	Lower	9/27	140 - 7,830	1,680	NA	NA
Benzo(a)anthracene	Upper	19/27	79.0 - 26,000	3,680	7,800	3
	Lower	8/27	130 - 4,900	1,360	NA	NA
Benzo(b)fluoranthene	Upper	18/27	100 - 21,000	3,290	7,800	2
	Lower	8/27	120 - 5,200	1,180	NA	NA
Benzo(k)fluoranthene	Upper	17/27	290 - 17,000	3,200	78,000	0
	Lower	8/27	120 - 3,400	955	NA	NA
Benzo(a)pyrene	Upper	20/27	64.0 - 20,000	3,070	780	13
	Lower	9/27	140 - 5,700	1,190	NA	NA

Table 10.10.2.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents)						
Chrysene	Upper	19/27	99.0 - 21,000	3,560	780,000	0
	Lower	8/27	150 - 4,500	1,210	NA	NA
Dibenz(a,h)anthracene	Upper	14/27	83.0 - 3,600	1,040	780	4
	Lower	4/27	170 - 700	390	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	19/27	43.0 - 10,000	2,060	7,800	1
	Lower	6/27	94.0 - 3,800	1,140	NA	NA
Pesticides						
gamma-BHC (Lindane)	Lower	1/27	2.30	2.30	NA	NA
alpha-Chlordane	Upper	1/27	20.0	20.0	4,400	0
gamma-Chlordane	Upper	3/27	3.40 - 60.0	25.1	4,400	0
	Lower	2/27	2.00 - 2.20	2.10	NA	NA
4,4'-DDD	Upper	2/27	3.00 - 33.0	18.0	24,000	0
	Lower	1/27	40.0	40.0	NA	NA
4,4'-DDE	Upper	6/27	3.30 - 250	48.7	17,000	0
	Lower	1/27	5.20	5.20	NA	NA
4,4'-DDT	Upper	5/27	4.50 - 290	67.1	17,000	0
	Lower	1/27	16.0	16.0	NA	NA
Dieldrin	Upper	1/27	9.40	9.40	360	0
	Lower	2/27	4.60 - 6.50	5.55	NA	NA
Endosulfan sulfate	Lower	1/27	36.0	36.0	NA	NA
Endrin	Upper	6/27	3.30 - 19.0	12.0	61,000	0
	Lower	3/27	5.60 - 23.0	13.9	NA	NA
Endrin aldehyde	Upper	1/27	14.0	14.0	61,000	0
	Lower	2/27	5.60 - 32.0	18.8	NA	NA

Table 10.10.2.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides						
Endrin ketone	Upper	1/27	4.80	4.80	61,000	0
	Lower	1/27	6.30	6.30	NA	NA
Heptachlor	Upper	3/27	1.80 - 2.30	2.03	1,300	0
	Lower	2/27	1.80 - 2.50	2.15	NA	NA
Heptachlor epoxide	Upper	2/27	3.90 - 33.0	18.5	630	0
Methoxychlor	Lower	4/27	21.0 - 27.0	24.3	NA	NA
TPH						
Gasoline	Upper	2/5	124 - 5,460	2,790	NA	NA
	Lower	5/6	1.15 - 23,200	5,100	NA	NA

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.10.2.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	27/27	1,350 - 6,640	4,370	100,000	26,600	0
	Lower	27/27	1,340 - 13,700	6,190	NA	41,100	NA
Antimony (Sb)	Upper	15/27	0.590 - 10.7	4.27	82.0	1.77	0
	Lower	9/27	0.660 - 7.70	2.53	NA	1.60	NA
Arsenic (As)	Upper	26/27	0.870 - 25.0	6.10	3.80	23.9	1
	Lower	27/27	0.810 - 16.7	5.76	NA	19.9	NA
Barium (Ba)	Upper	25/27	10.7 - 142	45.1	14,000	130	0
	Lower	25/27	6.90 - 84.8	28.0	NA	94.1	NA

Table 10.10.2.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Beryllium (Be)	Upper	27/27	0.110 - 0.760	0.386	1.30	1.70	0
	Lower	26/27	0.140 - 1.10	0.491	NA	2.71	NA
Cadmium (Cd)	Upper	18/27	0.170 - 2.50	0.971	100	1.50	0
	Lower	13/27	0.230 - 2.20	0.484	NA	0.960	NA
Calcium (Ca)	Upper	27/27	123 - 26,700	8,310	NA	NA	NA
	Lower	25/27	617 - 49,000	13,800	NA	NA	NA
Chromium (Cr)	Upper	27/27	1.90 - 39.6	10.9	1,000	94.6	0
	Lower	27/27	2.80 - 31.5	14.7	NA	75.2	NA
Cobalt (Co)	Upper	27/27	1.000 - 61.6	9.03	12,000	19.0	0
	Lower	27/27	0.640 - 11.2	2.74	NA	14.9	NA
Copper (Cu)	Upper	27/27	4.20 - 1,260	355	8,200	66.0	0
	Lower	26/27	1.10 - 761	112	NA	152	NA
Cyanide (CN)	Upper	4/27	0.340 - 0.570	0.420	4,100	0.500	0
	Lower	2/27	0.250 - 20.7	10.5	NA	NA	NA
Iron (Fe)	Upper	27/27	1,250 - 60,000	11,900	61,000	NA	0
	Lower	27/27	1,270 - 25,200	9,970	NA	NA	NA
Lead (Pb)	Upper	27/27	2.90 - 1,400	231	1,300	265	1
	Lower	26/27	2.90 - 675	69.9	NA	173	NA
Magnesium (Mg)	Upper	27/27	66.6 - 9,220	1,030	NA	NA	NA
	Lower	26/27	106 - 6,470	1,420	NA	NA	NA
Manganese (Mn)	Upper	27/27	22.5 - 441	126	4,700	302	0
	Lower	27/27	4.60 - 267	75.6	NA	881	NA
Mercury (Hg)	Upper	19/27	0.0300 - 19.4	1.22	61.0	2.60	0
	Lower	14/27	0.0300 - 12.3	0.949	NA	1.59	NA
Nickel (Ni)	Upper	27/27	1.40 - 83.0	16.2	4,100	77.1	0
	Lower	27/27	1.20 - 38.7	7.55	NA	57.0	NA

Table 10.10.2.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Potassium (K)	Upper	20/27	308 - 1,060	719	NA	NA	NA
	Lower	20/27	436 - 3470	1,160	NA	NA	NA
Selenium (Se)	Upper	8/27	0.580 - 0.740	0.651	1,000	1.70	0
	Lower	8/27	0.750 - 3.10	1.53	NA	2.40	NA
Silver (Ag)	Upper	8/27	0.250 - 3.00	1.03	1,000	NA	0
Sodium (Na)	Upper	14/27	38.0 - 559	167	NA	NA	NA
	Lower	15/27	35.7 - 774	363	NA	NA	NA
Thallium (Tl)	Upper	3/27	0.590 - 2.80	1.73	16.0	2.80	0
	Lower	1/27	0.720	0.720	NA	NA	NA
Tin (Sn)	Upper	15/27	4.00 - 148	47.8	100,000	59.4	0
	Lower	8/27	4.40 - 61.1	15.9	NA	9.23	NA
Vanadium (V)	Upper	27/27	1.80 - 21.9	10.3	1,400	94.3	0
	Lower	27/27	3.00 - 37.8	16.6	NA	155	NA
Zinc (Zn)	Upper	27/27	12.3 - 1,210	334	61,000	827	0
	Lower	26/27	5.10 - 1,300	158	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Ten VOCs were detected in soil samples collected at SWMUs 83 and 84 and AOC 574. Twenty-nine detections occurred in the upper interval and 21 in the lower interval. No VOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty-nine SVOCs were detected in soil samples collected at SWMUs 83 and 84 and AOC 574. Two hundred and ninety-six detections occurred in the upper-interval and 147 in the lower interval. Five SVOCs — benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene — exceeded their respective industrial RBC in the upper interval. Additionally, four SVOCs — benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and chrysene — exceeded their respective SSL in the lower interval.

Benzo(a)anthracene was detected in 19 of 27 upper-interval samples with a range of 79.0 to 26,000 μg/kg and a mean of 3,680 μg/kg. Three upper-interval samples (084SB004, 11,000 μg/kg; 574SB005, 26,000 μg/kg; and 574SB008, 9,300 μg/kg) exceeded the benzo(a)anthracene industrial RBC of 7,800 μg/kg. Benzo(a)anthracene was detected in eight of 27 lower-interval samples with a range of 130 to 4,900 μg/kg and a mean of 1,360 μg/kg. Three lower-interval samples (083SB001, 4,900 μg/kg; 083SB006, 3,600 μg/kg; and 574SB005, 840 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

Benzo(b)fluoranthene was detected in 18 of 27 samples with a range of 100 to 21,000 μg/kg and a mean of 3,290 μg/kg. Two upper-interval samples (084SB004, 8,500 μg/kg; and 574SB005, 21,000 μg/kg) exceeded the benzo(b)fluoranthene industrial RBC of 7,800 μg/kg. Benzo(b)fluoranthene was detected in eight of 27 lower-interval samples with a range of 120 to 5,200 μg/kg and a mean of 1,180 μg/kg. One lower-interval sample (083SB001, 5,200 μg/kg) exceeded the benzo(b)fluoranthene SSL of 4,000 μg/kg.

Benzo(a)pyrene was detected in 20 of 27 upper-interval samples with a range of 64.0 to 20,000 μg/kg and a mean of 3,070 μg/kg. The following thirteen upper-interval samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg:

083SB001	(860 μg/kg)	084SB004	(9,300 μg/kg)	574SB003	(2,600 μg/kg)
083SB006	(2,900 μg/kg)	084SB005	(3,400 μg/kg)	574SB005	(20,000 μg/kg)
083SB010	(1,100 μg/kg)	084SB007	(1,200 μg/kg)	574SB007	(1,300 μg/kg)
084SB001	(4,100 μg/kg)	574SB001	(3,100 μg/kg)	574SB008	(7,600 μg/kg)
084SB003	(1,700 μg/kg)				

Benzo(a)pyrene was detected in nine of 27 lower-interval samples with a range of 140 to 5,700 μg/kg and a mean of 1,190 μg/kg. One lower-interval sample (083SB001, 5,700 μg/kg) exceeded the benzo(a)pyrene SSL of 4,000 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at SWMUs 83 and 84 and AOC 574. BEQs were calculated for 20 of 27 upper-interval samples with a range of 86.3 to 29,000 μg/kg and a mean of 4,670 μg/kg. The following fifteen samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

083SB001	(1,280 μg/kg)	084SB004	(15,629 μg/kg)	574SB002	(874 μg/kg)
083SB006	(4,281 μg/kg)	084SB005	(5,491 μg/kg)	574SB003	(3,458 μg/kg)
083SB010	(1,523 μg/kg)	084SB007	(2,070 μg/kg)	574SB005	(29,000 μg/kg)
084SB001	(5,904 μg/kg)	084SB008	(788 μg/kg)	574SB007	(2,191 μg/kg)
084SB003	(2,824 μg/kg)	574SB001	(4,517 μg/kg)	574SB008	(12,438 μg/kg)

Chrysene was detected in eight of 27 lower-interval samples with a range of 150 to 4,500 μg/kg and a mean of 1,210 μg/kg. Two lower-interval samples (083SB001, 4,500 μg/kg; 083SB006, 2,800 μg/kg) exceeded the chrysene SSL of 1,000 μg/kg.

Dibenz(a,h)anthracene was detected in 14 of 27 upper-interval samples with a range of 83.0 to 3,600 μg/kg and a mean of 1,040 μg/kg. Four samples (084SB004, 3,600 μg/kg; 084SB005,

1,200 μg/kg; 574SB005, 3,100 μg/kg; and 574SB008, 2,700 μg/kg) exceeded the dibenz(a,h)anthracene industrial RBC of 780 μg/kg.

Indeno(1,2,3-cd)pyrene was detected in 19 of 27 upper-interval samples with a range of 43.0 to 10,000 μg/kg and a mean of 2,060 μg/kg. One upper-interval sample (574SB005, 10,000 μg/kg) exceeded the indeno(1,2,3-cd)pyrene industrial RBC of 7,800 μg/kg.

Pesticides and PCBs in Soil

Fourteen pesticides were detected in soil samples collected at SWMUs 83 and 84 and AOC 574. Thirty-one detections occurred in the upper interval and 21 occurred in the lower interval. No pesticide exceeded its respective industrial RBC in the upper interval. However, one pesticide — dieldrin — exceeded its respective SSL in the lower interval.

Dieldrin was detected in two of 27 lower-interval samples with a range of 4.60 to 6.50 μg/kg and a mean of 5.55 μg/kg. Two lower-interval samples (574SB005, 4.6 μg/kg; 574SB007, 6.5 μg/kg) exceeded the dieldrin SSL of 1.0 μg/kg.

No PCBs were detected in soil samples collected at SWMUs 83 and 84 and AOC 574.

Other Organic Compounds in Soil

No other organic compounds were detected in the soil samples collected at SWMUs 83 and 84 and AOC 574.

Inorganic Elements in Soil

Twenty-five metals were detected in soil samples collected at SWMUs 83 and 84 and AOC 574. Five hundred and twenty-six detections occurred in the upper interval and 486 in the lower interval. Two metals — arsenic and lead — exceeded both their respective industrial RBC and

background RC in the upper interval. No metal exceeded both its respective SSL and background RC in the lower interval.

Arsenic was detected in 26 of 27 upper-interval samples with a range of 0.870 to 25.0 mg/kg and a mean of 6.10 mg/kg. One upper-interval sample (084SB007, 25.0 mg/kg) exceeded both the arsenic industrial RBC of 3.80 mg/kg and the arsenic background RC of 23.9 mg/kg.

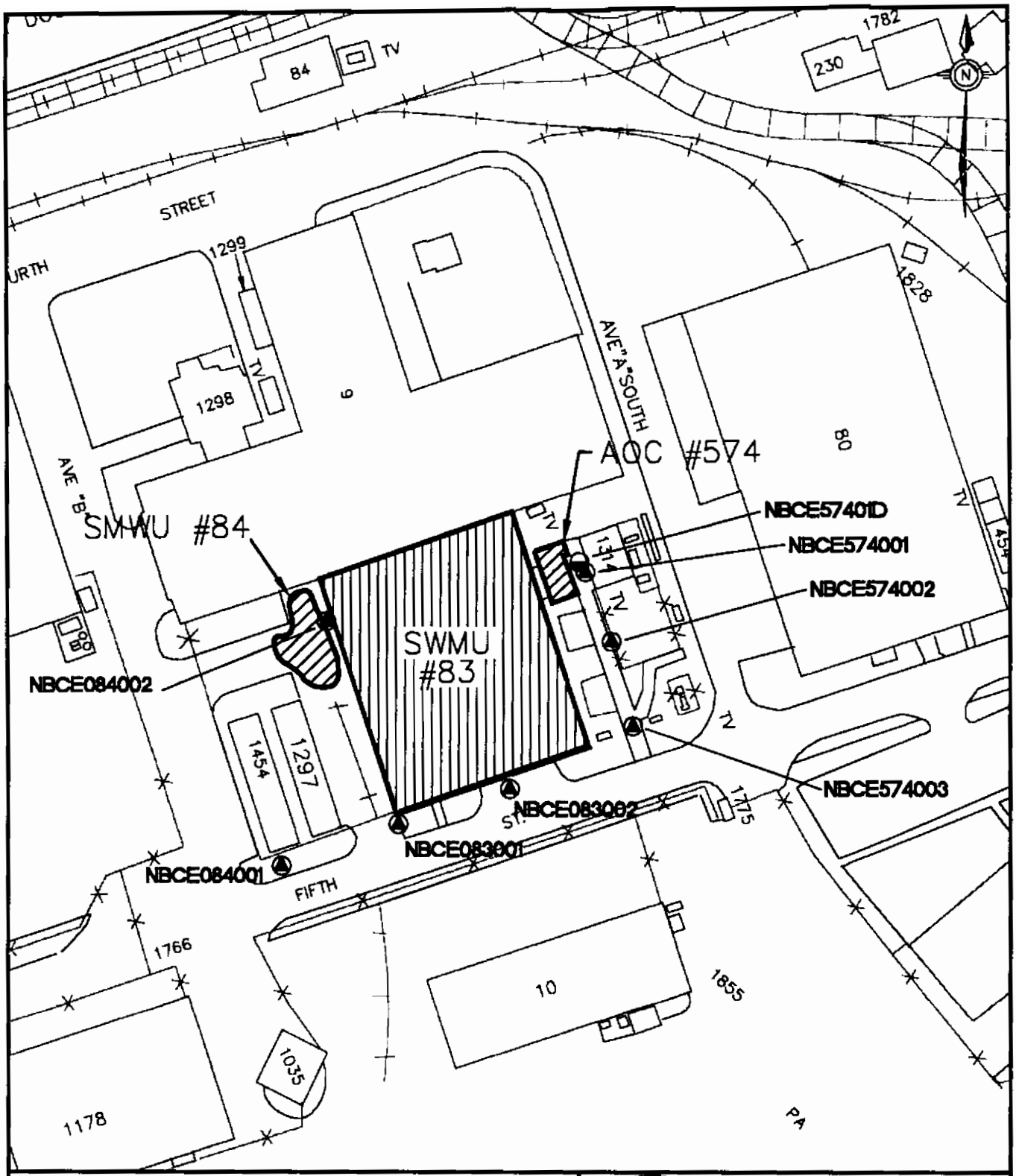
Lead was detected in 27 of 27 upper-interval samples with a range of 2.90 to 1,400 mg/kg and a mean of 231 mg/kg. The following upper-interval sample exceeded the lead industrial RBC of 1,300 mg/kg and the lead background RC of 265 mg/kg: 083SB010 (1,400 mg/kg).

10.10.3 Groundwater Sampling and Analysis

One deep monitoring well and seven shallow monitoring wells were installed and sampled to assess groundwater quality at SWMUs 83 and 84 and AOC 574 as shown in Figure 10.10.2. The wells were installed as follows:

- Shallow Wells installed at SWMU 83 — NBCE083001 and NBCE083002
- Shallow Wells installed at SWMU 84 — NBCE084001 and NBCE084002
- Shallow Wells installed at AOC 574 — NBCE574001, NBCE574002, and NBCE574003
- Deep Well installed at AOC 574 — NBCE57401D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. One sample was duplicated and submitted for analysis at DQO Level IV for the suite of parameters listed above plus a more comprehensive list of VOCs and SVOCs, as well as herbicides, organophosphorus pesticides, dioxin and hexavalent chromium. Table 10.10.3.1 summarizes groundwater sampling and analysis at SWMUs 83 and 84 and AOC 574.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ▲ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10.2
MONITORING WELL LOCATIONS
SWMU#83, BUILDING 9
SWMU #84, LEAD STORAGE, BLDG 9
AOC #574, BUILDING 9, SAA

DWG DATE: 09/02/97 | DWG NAME: 10-10-2

Table 10.10.3.1
SWMUs 83 and 84 and AOC 574
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	7	7	Standard Suite[a], chlorides, TDS, sulfates, and organotins	Standard Suite[a], chlorides, TDS, sulfates, and organotins	None
Deep	1	1	Standard Suite[a], chlorides, TDS, sulfates, and organotins	Standard Suite[a], chlorides, TDS, sulfates, and organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides/PCBs

The shallow monitoring wells were installed at 12.5 feet bgs in the surficial aquifer. The deep well was installed at 29.7 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.10.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow groundwater are summarized in Table 10.10.4.1. No organic compounds were detected in deep groundwater at this site. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.10.4.2 and 10.10.4.3, respectively. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.10.4.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in First-Quarter Groundwater
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs (μg/L)						
Acenaphthene	1/7	2.00	2.00	220	NA	0
Benzoic acid	1/7	3.00	3.00	15,000	NA	0

Table 10.10.4.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in First-Quarter Groundwater
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs (μg/L)						
Dibenzofuran	1/7	3.00	3.00	15,000	NA	0
Fluorene	1/7	5.00	5.00	150	NA	0
2-Methylnaphthalene	1/7	75.0	75.0	150	NA	0
Naphthalene	1/7	7.00	7.00	150	NA	0
Phenanthrene	1/7	3.00	3.00	150	NA	0
Dioxins (pg/L)						
Dioxin Equiv.	1/1	0.0455	0.0455	0.4	NA	0
1234678-HpCDF	1/1	3.50	3.50	NA	NA	NA
OCDD	1/1	10.5	10.5	NA	NA	NA
Organotin (μg/L)						
Tributyltin	1/7	24.0	24.0	NA	NA	NA

Notes:
μg/L = Micrograms per liter
pg/L = Picograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No RBC or MCL established

Table 10.10.4.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections for First-Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC
Aluminum (Al)	5/7	54.7 - 695	270	3,700	2,810	NA	0
Arsenic (As)	3/7	7.70 - 36.9	21.2	0.0450	18.7	50.0	2
Barium (Ba)	4/7	9.70 - 32.0	16.7	260	211	2,000	0
Calcium (Ca)	5/7	10,300 - 81,200	37,700	NA	NA	NA	NA
Chromium (Cr)	1/7	2.40	2.40	18.0	12.3	100	0
Cobalt (Co)	1/7	2.70	2.70	220	2.5	NA	0
Copper (Cu)	1/7	3.00	3.00	150	2.7	1,300	0

Table 10.10.4.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections for First-Quarter Groundwater (µg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC
Iron (Fe)	7/7	167 - 11,400	3,350	1,100	NA	NA	6
Magnesium (Mg)	5/7	6,730 - 46,300	18,100	NA	NA	NA	NA
Manganese (Mn)	7/7	34.2 - 383	191	84.0	2,560	NA	0
Nickel (Ni)	3/7	1.50 - 2.20	1.90	73.0	15.2	100	0
Potassium (K)	5/7	6,510 - 24,200	13,900	NA	NA	NA	NA
Silver (Ag)	1/7	2.10	2.10	18.0	NA	NA	0
Sodium (Na)	5/7	24,600 - 1,130,000	315,000	NA	NA	NA	NA
Vanadium (V)	5/7	1.40 - 3.20	2.12	26.0	11.4	NA	0
Zinc (Zn)	2/7	4.10 - 8.70	6.40	1,100	27.3	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Table 10.10.4.3
SWMUs 83 and 84 and AOC 574
Inorganic Detections for First-Quarter Groundwater (µg/L)
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/1	32.7	32.7	3,700	319	NA	0
Arsenic (As)	1/1	67.5	67.5	0.0450	16.4	50.0	1
Barium (Ba)	1/1	198	198	260	218	2,000	0
Calcium (Ca)	1/1	227,000	227,000	NA	NA	NA	NA
Cobalt (Co)	1/1	2.30	2.30	220	12.9	NA	0
Iron (Fe)	1/1	37,000	37,000	1,100	NA	NA	1
Magnesium (Mg)	1/1	125,000	125,000	NA	NA	NA	NA
Manganese (Mn)	1/1	3,380	3,380	84.0	869	NA	1
Nickel (Ni)	1/1	4.30	4.30	73.0	42.2	100	0

Table 10.10.4.3
SWMUs 83 and 84 and AOC 574
Inorganic Detections for First-Quarter Groundwater (µg/L)
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Potassium (K)	1/1	51,500	51,500	NA	NA	NA	NA
Sodium (Na)	1/1	1,290,000	12,90,000	NA	NA	NA	NA
Vanadium (V)	1/1	1.90	1.90	26.0	5.3	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

Seven SVOCs were detected in shallow groundwater samples collected at SWMUs 83 and 84 and AOC 574. No SVOC exceeded its respective tap-water RBC. No MCLs have been established for the detected SVOCs.

Other Organic Compounds in Groundwater

Shallow Groundwater

One organotin — tributylin — was detected in one of seven shallow groundwater samples at SWMU 83. No tap-water RBC or MCL has been established for this parameter.

Two dioxins were detected in shallow groundwater samples collected at SWMUs 83 and 84 and AOC 574. No tap-water RBCs or MCLs have been established for these parameters.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for the samples. The TEQ was calculated for one sample at 0.0455 pg/L, below the 2,3,7,8-TCDD tap-water RBC of 0.4 pg/L. No MCL has been established for the dioxin equivalent.

Inorganic Elements in Groundwater

Shallow Groundwater

Sixteen metals were detected in shallow groundwater samples collected at SWMUs 83 and 84 and AOC 574. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and shallow groundwater RC.

Arsenic was detected in three of seven samples with a range of 7.70 to 36.9 μg/L and a mean of 21.2 μg/L. Two samples from wells NBCE083001 (18.9 μg/L) and NBCE084002 (36.9 μg/L) exceeded both the arsenic tap-water RBC of 0.0450 μg/L and the arsenic shallow groundwater RC of 18.7 μg/L. Neither sample exceeded the arsenic MCL of 50.0 μg/L.

Iron was detected in seven of seven samples with a range of 167 to 11,400 μg/L and a mean of 3,350 μg/L. Samples from the following six wells exceeded the iron tap-water RBC of 1,100 μg/L:

NBCE083001 (11,400 μg/L)	NBCE084002 (2,230 μg/L)	NBCE574002 (1,650 μg/L)
NBCE083002 (2,470 μg/L)	NBCE574001 (4,220 μg/L)	NBCE574003 (1,310 μg/L)

No shallow groundwater RC or MCL has been established for iron.

Deep Groundwater

Twelve metals were detected in the deep groundwater sample collected at AOC 574 (no deep groundwater wells were installed at SWMUs 83 and 84). Three metals — arsenic, iron, and

manganese — exceeded both their respective tap-water RBC and deep groundwater RC. One metal — arsenic — also exceeded its MCL.

Arsenic was detected in well NBCE57401D (67.5 μg/L), exceeding both its tap-water RBC of 0.0450 μg/L and its deep groundwater RC of 16.4 μg/L. The detection also exceeded the arsenic MCL of 50.0 μg/L.

Iron was detected in well NBCE57401D (37,000 μg/L), exceeding its tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

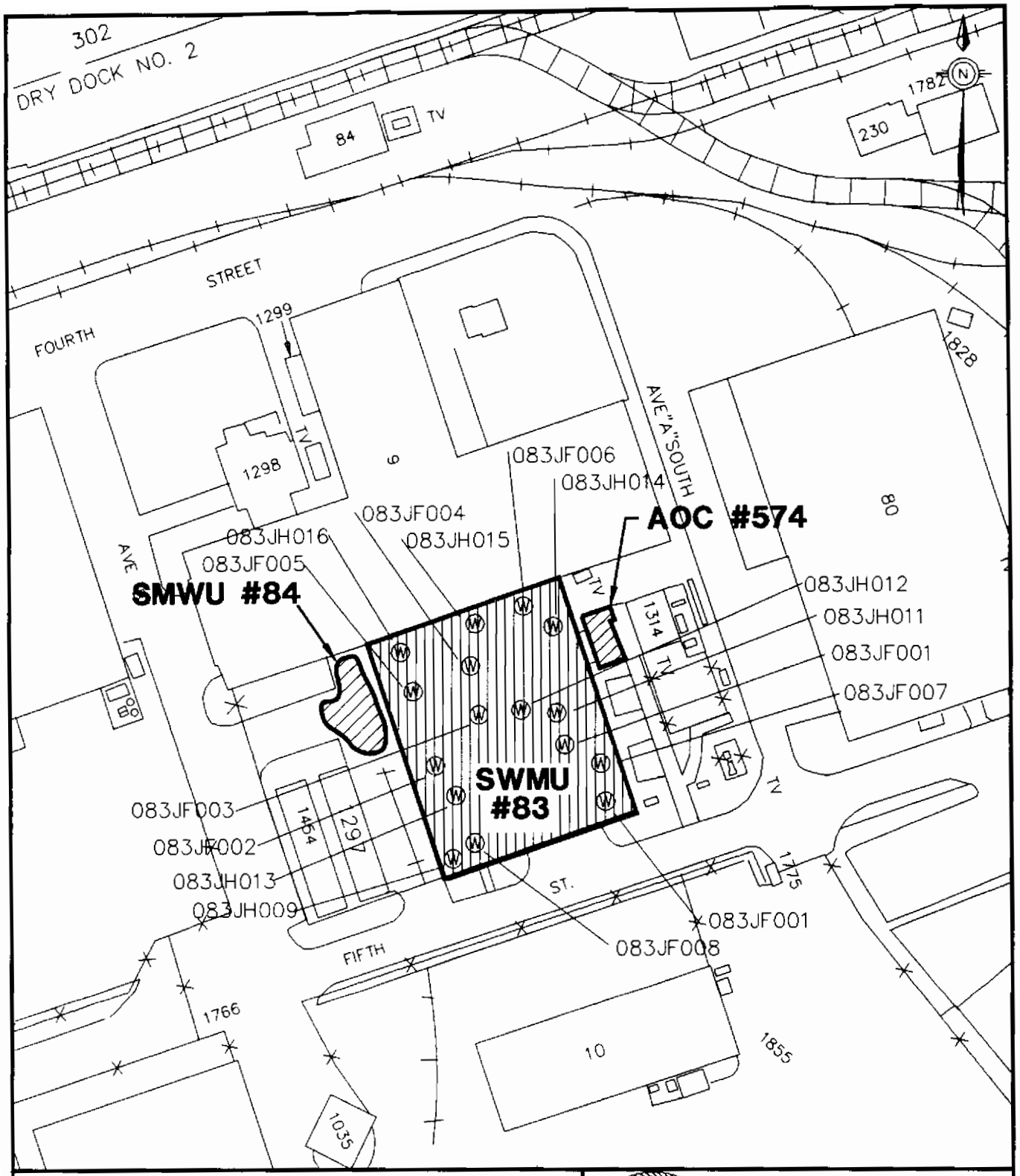
Manganese was detected in well NBCE57401D (3,380 μg/L), exceeding both its tap-water RBC of 84.0 μg/L and its deep groundwater RC of 869 μg/L. No MCL has been established for manganese.

10.10.5 Wipe Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed the collection of sixteen wipe samples at SWMUs 83, 84, and AOC 574. All sixteen wipe samples were collected. Sample locations were determined in the field and are shown on Figure 10.10.3. Table 10.10.5.1 summarizes wipe sampling activity for SWMU 83.

Table 10.10.5.1
SWMU 83
Wipe Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
16	16	Metals, SW-846	Metals, SW-846	No deviation from proposed strategy



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10.3
WIPE SAMPLE LOCATIONS
SWMU #83, BUILDING 9
SWMU #84, LEAD STORAGE, BLDG 9
AOC #574, BUILDING 9, SAA

DWG DATE: 09/02/97 | DWG NAME: 10-10-3

10.10.6 Nature of Contamination in Dust

Organic compound analytical results for wipe samples are summarized in Table 10.10.6.1. Inorganic analytical results for wipe samples are summarized in Table 10.10.6.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.10.6.1
SWMUs 83 and 84 and AOC 574
Organic Compounds Detected in Wipe Samples

Element	Freq. of Detection	Range of Detected Conc. (μg/wipe)	Mean of Detected Conc. (μg/wipe)
PCBs			
Aroclor-1242	1/3	9.80	9.8

Note:
μg/wipe = Micrograms per wipe sample

Table 10.10.6.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections in Wipe Samples

Element	Freq. of Detection	Range of Detected Conc. (mg/wipe)	Mean of Detected Conc. (mg/wipe)
Aluminum (Al)	16/16	554 - 47,000	4,870
Antimony (Sb)	16/16	1.30 - 74.8	11.5
Arsenic (As)	14/16	1.10 - 59.8	7.74
Barium (Ba)	16/16	13.6 - 308	95.0
Beryllium (Be)	3/16	0.200 - 0.220	0.213
Cadmium (Cd)	16/16	0.850 - 15.6	5.07
Calcium (Ca)	16/16	1,150 - 12,500	5,810
Chromium (Cr)	16/16	6.50 - 300	55.7
Cobalt (Co)	16/16	0.620 - 116	10.3
Copper (Cu)	16/16	956 - 594,000	42,900

Table 10.10.6.2
SWMUs 83 and 84 and AOC 574
Inorganic Detections in Wipe Samples

Element	Freq. of Detection	Range of Detected Conc. (mg/wipe)	Mean of Detected Conc. (mg/wipe)
Iron (Fe)	16/16	1,660 - 167,000	18,500
Lead (Pb)	16/16	84.5 - 11,500	1,120
Magnesium (Mg)	16/16	77.0 - 1,750	419
Manganese (Mn)	16/16	57.0 - 3,640	460
Mercury (Hg)	15/16	0.0500 - 1.80	0.446
Nickel (Ni)	16/16	120 - 74,500	5370
Potassium (K)	16/16	238 - 1,160	708
Selenium (Se)	3/16	1.000 - 2.40	1.90
Silver (Ag)	11/16	0.460 - 52.3	6.07
Sodium (Na)	4/16	1,130 - 4,840	2,340
Tin (Sn)	16/16	74.6 - 25,100	1,930
Vanadium (V)	16/16	0.970 - 39.5	8.36
Zinc (Zn)	16/16	339 - 21,300	2,790

Note:
mg/wipe = Milligrams per wipe sample

Inorganic Elements Detected on Surfaces

Twenty-three metals were detected in wipe samples collected at SWMUs 83 and 84 and AOC 574. Thallium was not detected in the collected samples. No residential or industrial RBCs exist for wipe samples.

PCBs Detected on Surfaces

Three wipe samples were collected from SWMUs 83 and 84 and AOC 574 and analyzed for PCBs. Aroclor-1242 was detected in one of three samples at 9.80 mg/wipe. No residential or industrial RBCs exist for wipe samples.

10.10.7 Air Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting 17 air samples at SWMU 83. Sample locations were determined in the field. A total of fifteen air samples were collected. Table 10.10.7.1 summarizes air sampling activity at SWMU 83.

Table 10.10.7.1
SWMU 83
Air Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
17	15	Metals, SW-846	Metals, SW-846	Collected 15 rather than 17 air samples

10.10.8 Nature of Contamination in Air

Table 10.10.8.1 summarizes the analytical results of air samples collected at SWMU 83. Sample locations were biased in an attempt to identify worst case situations.

Table 10.10.8.1
SWMU 83
Air Sample Results

Element	Frequency of Detection	Range of Detections ($\mu g/m^3$)
Aluminum	15/15	0.012 - 0.060
Arsenic	10/15	0.0012 - 0.0022
Barium	15/15	0.0013 - 0.0027
Beryllium	8/15	0.0001 - 0.0001
Cadmium	10/15	0.0001 - 0.0002
Calcium	15/15	0.05 - 0.112
Chromium	15/15	0.0004 - 0.0016
Cobalt	4/15	0.0001 - 0.0002

Table 10.10.8.1
SWMU 83
Air Sample Results

Element	Frequency of Detection	Range of Detections ($\mu g/m^3$)
Copper	14/15	0.0103 - 0.060
Iron	15/15	0.021 - 0.164
Lead	11/15	0.0009 - 0.0034
Magnesium	15/15	0.016 - 0.0352
Manganese	15/15	0.0014 - 0.0038
Mercury	15/15	0.0001 - 0.0006
Nickel	15/15	0.0009 - 0.0774
Potassium	15/15	0.022 - 0.088
Selenium	10/15	0.0010 - 0.0022
Sodium	15/15	0.10 - 0.22
Thallium	2/15	0.0015 - 0.0023
Vanadium	15/15	0.0010 - 0.0070
Zinc	15/15	0.0066 - 0.021
Alkalinity		
Total Alkalinity	15/15	4.3 - 30.4

Note:
$\mu g/m^3$ = Micrograms per cubic meter

Metals Detected in Air

Metals were detected in nearly all air samples. No residential or industrial RBCs exist for comparison to the air sampling results.

10.10.9 Fate and Transport Assessment for SWMUs 83 and 84 and AOC 574

Combined SWMU 83 is comprised of a former foundry at Building 9, which more recently has been used as a power substation, a lead blanket and shielding storage facility, and an AST location. Most of the ground around the site is covered by asphalt or thick concrete, but the AST (AOC 574) is in an unpaved area on the east side of Building 9. There are also small grassy strips along Fifth Street on the south side of the foundry building and along Avenue "A" to the west. Environmental media sampled as part of the combined SWMU 83 RFI include surface soil, subsurface soil, shallow groundwater, deep groundwater, air, and dust. Potential constituent migration pathways investigated for combined SWMU 83 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.10.9.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.10.9.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based SSLs considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) background RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF = 10).

Nine organic compounds — methylene chloride, trichloroethene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, pentachlorophenol, and dieldrin — were detected in combined SWMU 83 soil at concentrations greater than groundwater protection SSLs and were carried over to the second-tier screen. None of the nine compounds were detected in groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer. Maximum surface soil concentrations were all higher than concentrations in subsurface soil for these nine organics, indicating that high concentrations have not migrated deeply into subsurface soil.

Benzo(a)anthracene was the most pervasive of the nine organics as it was detected above its SSL at 12 locations in surface soil and three in subsurface soil. Of the other carcinogenic PAHs, benzo(a)pyrene was detected above its generic SSL in four surface soil samples and one subsurface sample; benzo(b)fluoranthene was detected in eight surface soil and one subsurface soil samples; dibenzo(a,h)anthracene was detected in four surface soil samples; and indeno(1,2,3-cd)pyrene was detected in one surface soil sample. Maximum concentrations of 16 SVOCs in surface soil, including six of the seven carcinogenic PAHs, were detected in sample 574SB005, located at the north end of the AST site.

Pentachlorophenol, dieldrin, and trichloroethene were detected above their respective generic SSLs in one surface soil sample each (574SB008, 574SB006, and 084SB004, respectively). Dieldrin was also reported above its SSL in two subsurface soil samples (574SB005 and 574SB007) and pentachlorophenol in one subsurface sample (084SB009). Trichloroethene was not detected above its SSL in subsurface soil samples.

Eleven inorganics — antimony, arsenic, cobalt, copper, cyanide, lead, mercury, nickel, selenium, thallium, and tin — were detected in soil at concentrations equal to or greater than their respective generic SSLs or background reference values and were carried over to the second-tier screen. Arsenic, cobalt, copper, and nickel were also detected in groundwater, indicating a completed pathway from soil to groundwater for these metals. Of these four inorganics, only arsenic was detected in groundwater at concentrations above its groundwater standard. Cyanide and selenium were the only inorganics of the eleven that were detected at higher maximum concentrations in subsurface soil samples than surface samples.

Copper was detected above its background reference value in 13 surface soil samples and five subsurface samples, the most frequent of the 11 inorganics. Relatively high copper concentrations in soil likely reflect past site use involving the casting of copper alloy parts. Antimony was the

second most commonly detected metal above its SSL, as it was detected in eight surface soil samples and two subsurface samples at concentrations exceeding its standard. Lead was detected above its *de facto* SSL of 400 mg/kg in seven surface soil samples and two subsurface samples; the maximum lead detection of 1,400 mg/kg in surface soil sample 083SB010 was twice as high as the next highest detection. Mercury detections above its SSL were confined to the two intervals at a single sample location (574SB005). Arsenic, cyanide, selenium, and thallium were detected above their respective SSLs or background reference values in only one sample each.

10.10.9.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.10.9.1 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs 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 RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Tributyltin was the only organic compound detected in the first-quarter at a concentration above its tap water RBC or its saltwater surface water chronic screening level. Due to detection in a single shallow groundwater sample (well NBCE083002), it was carried over to the second-tier screen. Preliminary evaluation of results from subsequent sampling rounds indicates that tributyltin was not detected at well NBCE083002 after the first quarter.

Arsenic and manganese were detected in first-round groundwater samples above their respective background reference values and carried over to the second-tier screen. Arsenic concentrations exceeded its background reference value of 18.7 μg/L in first-round samples in two of seven shallow wells and the single deep well at combined SWMU 83. Arsenic also exceeded its

saltwater surface water chronic screening value in the sample from deep well NBCE57401D. Arsenic was detected at elevated concentrations (above background) in both shallow and deep wells in an area approximately 600 feet across, centered roughly on SWMU 83 and including wells from SWMUs 83, 84, 145, and 172, and AOCs 563, 574, 576, and 580. Concentrations are higher in deep groundwater than in shallow groundwater, with exceedances of arsenic's MCL (50 μg/L) reported in first-round samples from wells NBCE57401D (67.5 μg/L) and NBCE58001D (84.4 μg/L). In later rounds, arsenic detections were also above its MCL in samples from deep wells NBCE14501D and NBCE57602D. Manganese was detected above its background reference value in only one deep well (NBCE57401D).

Silver was detected in shallow well NBCE574001 at a concentration greater than its saltwater surface water screening value and was carried over to the second-tier screen. Preliminary analysis of subsequent sampling round results indicates that silver concentrations decreased below its surface water standard at well NBCE574001. However, silver detections were greater than its surface water standard at two other locations during the second round: shallow well NBCE574002 and deep well NBCE57401D. Copper was detected in a single first-round shallow groundwater sample at a concentration marginally higher than its saltwater surface water chronic screening level.

10.10.9.3 Soil and Groundwater-to-Surface Water Cross-Media Transport: Tier Two

Table 10.10.9.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second

screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined SWMU 83 is 79,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River through the associated migration pathways. The elevated concentrations of several BEQs in surface and subsurface soil samples are not of concern because PAHs are not particularly mobile in soil or groundwater. The high concentrations of copper and lead in soil and arsenic in groundwater are below their respective adjusted screening levels. Maximum copper concentrations in soil samples remained 84% lower than its adjusted SSL of 8,070 mg/kg. The adjusted SSLs for combined SWMU 83 were obtained assuming a DAF of 1, which implies zero attenuation of contaminants as leachate moves downward through subsurface soil toward the shallow aquifer. Due to a combination of high clay content and a thin, localized layer of peat, combined SWMU 83 exhibits a perched water table that is approximately 2 to 3 feet higher than that of the shallow aquifer in the area around the site. Both clay particles and peat strongly attenuate any dissolved organic or inorganic constituents moving through the soil. Consequently, the margin between detected soil concentrations and levels protective of the Cooper River is actually much greater than indicated in the table.

10.10.9.4 Soil-to-Air Cross-Media Transport

Table 10.10.9.3 lists the VOCs detected in surface soil samples collected at combined SWMU 83 along with corresponding soil-to-air volatilization screening levels. Exposed soil constitutes a small portions of the surface area at the site. 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 expected to be significant at combined SWMU 83.

10.10.9.5 Fate and Transport Summary

In the first-tier screen, nine organic compounds detected at concentrations above groundwater protection SSLs in soil were not found extensively distributed vertically throughout the shallow subsurface nor were they detected in groundwater. Occurrences of trichloroethene and pentachlorophenol above SSLs in soil were isolated to single locations. Detections of BEQs in soil but not groundwater reflect the immobility of PAH compounds. Lack of detections of organic compounds in groundwater above tap water RBCs indicates that the present soil-groundwater equilibrium is protective of groundwater.

Although eleven inorganics were detected above their generic SSLs or background reference values in soil during the first-tier screen, only four were additionally detected in groundwater samples. Arsenic was the only metal of the four found to be above its groundwater standard. Vertical distribution of the eleven metals in soil appeared limited due to the greater concentrations in surface soil compared to subsurface soil. Relatively high concentrations of copper, lead, and zinc in soil, likely related to past foundry activities, have had little or no impact on groundwater.

None of the constituents exceeding first-tier screening values exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.10.9.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMUs 83 and 84 and AOC 574
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	200	730	ND	ND	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	6	ND	ND	ND	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	4	ND	ND	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	ND	2	ND	ND	350	39	105	UG/KG	UG/L	NO	NO	NO
2-Hexanone	20	ND	ND	ND	13800	2900	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	14	7	ND	ND	10	4.1	2560	UG/KG	UG/L	YES	NO	NO
Toluene	1	2	ND	ND	6000	750	37	UG/KG	UG/L	NO	NO	NO
1,1,1-Trichloroethane	1	ND	ND	ND	1000	790	312	UG/KG	UG/L	NO	NO	NO
Trichloroethene	37	ND	ND	ND	30	1.6	NA	UG/KG	UG/L	YES	NO	NO
Xylene (total)	6	5	ND	ND	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	8800	2400	2	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	290	190	ND	ND	150000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	18000	3400	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	89	ND	3	ND	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	8400	2900	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	26000	4900	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	20000	5700	ND	ND	4000	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	21000	5200	ND	ND	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	17000	3400	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	21000	4500	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	3600	700	ND	ND	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	10000	3800	ND	ND	7000	0.092	NA	UG/KG	UG/L	YES	NO	NO
Butylbenzylphthalate	300	110	ND	ND	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Carbazole	130	200	ND	ND	300	3.4	NA	UG/KG	UG/L	NO	NO	NO
2-Chlorophenol	100	ND	ND	ND	2000	180	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	5600	1700	3	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	74	140	ND	ND	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Diethylphthalate	5900	370	ND	ND	235000	29000	75.9	UG/KG	UG/L	NO	NO	NO
Dimethylphthalate	2400	ND	ND	ND	1200000	370000	580	UG/KG	UG/L	NO	NO	NO
Di-n-octylphthalate	170	ND	ND	ND	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	680	ND	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	73000	7700	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	8200	3700	5	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	5500	62000	75	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	110	ND	ND	ND	690	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	6900	1800	7	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	320	270	ND	ND	15	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Phenanthrene	83000	11000	3	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	59000	8600	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
gamma-BHC (Lindane)	ND	2.3	ND	ND	4.5	0.052	0.016	UG/KG	UG/L	NO	NO	NO
alpha-Chlordane	20	ND	ND	ND	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	60	2.2	ND	ND	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	33	40	ND	ND	8000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	250	5.2	ND	ND	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	290	16	ND	ND	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Dieldrin	9.4	6.5	ND	ND	2	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO
Endosulfan sulfate	ND	36	ND	ND	9000	220	NA	UG/KG	UG/L	NO	NO	NO
Endrin	19	23	ND	ND	500	11	0.0023	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	14	32	ND	ND	500	11	NA	UG/KG	UG/L	NO	NO	NO
Endrin ketone	4.8	6.3	ND	ND	500	11	NA	UG/KG	UG/L	NO	NO	NO
Heptachlor	2.3	2.5	ND	ND	11500	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO

Table 10.10.9.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMUs 83 and 84 and AOC 574
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Heptachlor epoxide	33	ND	ND	ND	350	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Methoxychlor	ND	27	ND	ND	80000	180	0.03	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	ND	ND	0.0455	ND	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Organotin Compounds												
Tributyltin	ND	ND	24	ND	NA	1.1	0.01	UG/KG	UG/L	NO	YES	YES
TPH - Gasoline Range Organics												
Gasoline	5460	23200	ND	ND	NA	NA	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	6640	13700	695	32.7	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	10.7	7.7	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	25	16.7	36.9	67.5	23.9	18.7	36	MG/KG	UG/L	YES	YES	YES
Barium	142	84.8	32	198	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.76	1.1	ND	ND	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	2.5	2.2	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	39.6	31.5	2.4	ND	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	61.6	11.2	2.7	2.3	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	1260	761	3	ND	152	1500	2.9	MG/KG	UG/L	YES	NO	YES
Cyanide	0.57	20.7	ND	ND	20	730	37.3	MG/KG	UG/L	YES	NO	NO
Lead	1400	675	ND	ND	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	441	267	383	3380	881	2560	NA	MG/KG	UG/L	NO	YES	NO
Mercury	19.4	12.3	ND	ND	2.6	11	0.2	MG/KG	UG/L	YES	NO	NO
Nickel	83	38.7	2.2	4.3	77.1	730	42.2	MG/KG	UG/L	YES	NO	NO
Selenium	0.74	3.1	ND	ND	2.5	180	71	MG/KG	UG/L	YES	NO	NO
Silver	3	ND	2.1	ND	17	180	0.23	MG/KG	UG/L	NO	NO	YES
Thallium	2.8	0.72	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	YES	NO	NO
Tin	148	61.1	ND	ND	59.4	22000	NA	MG/KG	UG/L	YES	NO	NO
Vanadium	21.9	37.8	3.2	1.9	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	1210	1300	8.7	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.10.9.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMUs 83 and 84 and AOC 574
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentration *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Volatile Organic Compounds																
Methylene chloride	14	7	ND	ND	10	4.1	2560	4.1	3.24E+05	5	6.48E+04	6.48E+04	ug/kg	ug/L	NO	NO
Trichloroethene	37	ND	ND	ND	30	1.6	NA	1.6	1.26E+05	5	2.53E+04	7.58E+04	ug/kg	ug/L	NO	NO
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	26000	4900	ND	ND	800	0.092	NA	0.092	7.27E+03	0.1	7.27E+04	5.81E+06	ug/kg	ug/L	NO	NO
Benzo(a)pyrene	20000	5700	ND	ND	4000	0.0092	NA	0.0092	7.27E+02	0.2	3.63E+03	1.45E+06	ug/kg	ug/L	NO	NO
Benzo(b)fluoranthene	21000	5200	ND	ND	2500	0.092	NA	0.092	7.27E+03	0.1	7.27E+04	1.04E+07	ug/kg	ug/L	NO	NO
Dibenzo(a,h)anthracene	3600	700	ND	ND	800	0.0092	NA	0.0092	7.27E+02	0.01	7.27E+04	5.81E+06	ug/kg	ug/L	NO	NO
Indeno(1,2,3-cd)pyrene	10000	3800	ND	ND	7000	0.092	NA	0.092	7.27E+03	0.1	7.27E+04	1.04E+07	ug/kg	ug/L	NO	NO
Pentachlorophenol	320	270	ND	ND	15	0.56	7.9	0.56	4.42E+04	1	4.42E+04	6.64E+04	ug/kg	ug/L	NO	NO
Pesticides/PCB Compounds																
Dieldrin	9.4	6.5	ND	ND	2	0.0042	0.0019	0.0019	1.50E+02	0.005	3.00E+04	6.00E+03	ug/kg	ug/L	NO	NO
Organotin Compounds																
Tributyltin	ND	ND	24	ND	NA	1.1	0.01	0.01	7.90E+02	1.1	7.18E+02	NA	ug/kg	ug/L	NO	NO
Inorganic Compounds																
Antimony	10.7	7.7	ND	ND	2.5	15	NA	15	1.19E+06	6	1.98E+05	4.94E+04	mg/kg	ug/L	NO	NO
Arsenic	25	16.7	36.9	67.5	14.6	0.045	36	0.045	3.56E+03	50	7.11E+01	1.04E+02	mg/kg	ug/L	NO	NO
Cobalt	61.6	11.2	2.7	2.3	1040	2200	NA	2200	1.74E+08	2200	7.90E+04	1.00E+06	mg/kg	ug/L	NO	NO
Copper	1260	761	3	ND	458	1500	2.9	2.9	2.29E+05	1300	1.76E+02	8.07E+03	mg/kg	ug/L	NO	NO
Cyanide	0.57	20.7	ND	ND	20	730	37.3	37.3	2.95E+06	200	1.47E+04	2.95E+04	mg/kg	ug/L	NO	NO
Lead	1400	675	ND	ND	400	15	8.5	8.5	6.72E+05	15	4.48E+04	1.00E+06	mg/kg	ug/L	NO	NO
Manganese	441	267	383	3380	548	840	NA	840	6.64E+07	840	7.90E+04	1.00E+06	mg/kg	ug/L	NO	NO
Mercury	19.4	12.3	ND	ND	1.04	11	0.2	0.2	1.58E+04	2	7.90E+03	8.22E+02	mg/kg	ug/L	NO	NO
Nickel	83	38.7	2.2	4.3	65	730	42.2	42.2	3.33E+06	100	3.33E+04	2.17E+05	mg/kg	ug/L	NO	NO
Selenium	0.74	3.1	ND	ND	2.5	180	71	71	5.61E+06	50	1.12E+05	2.80E+04	mg/kg	ug/L	NO	NO
Silver	3	ND	2.1	ND	17	180	0.23	0.23	1.82E+04	200	9.09E+01	1.54E+02	mg/kg	ug/L	NO	NO
Thallium	2.8	0.72	ND	ND	0.36	2.9	21.3	2.9	2.29E+05	2	1.15E+05	4.12E+03	mg/kg	ug/L	NO	NO
Tin	148	61.1	ND	ND	55000	22000	NA	22000	1.74E+09	22000	7.90E+04	1.00E+06	mg/kg	ug/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 79,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.10.9.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMUs 83 and 84 and AOC 574
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	200	62000000	UG/KG	NO
2-Butanone (MEK)	6	10000	UG/KG	NO
2-Hexanone	20	10000	UG/KG	NO
Methylene chloride	14	7000	UG/KG	NO
Toluene	1	520000	UG/KG	NO
1,1,1-Trichloroethane	1	980000	UG/KG	NO
Trichloroethene	37	3000	UG/KG	NO
Xylene (total)	6	320000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996. Values for 2-Butanone (MEK) and 2-Hexanone were estimated.

10.10.10 Human Health Risk Assessment for Combined SWMUs 83 and 84 and AOC 574

10.10.10.1 Site Background and Investigative Approach

SWMU 83 is a former foundry which is currently used to store electrical supply equipment and to repair hydraulic equipment (Building 9). SWMU 84 is a area located outside of Building 9 used to store lead blankets. AOC 574 is a currently unused 3,700-gallon AST located east of Building 9. The following refers to these sites as combined SWMU 83. Due to their proximity, the data for these sites have been combined for the HHRA.

During the RFI, a total of 27 soil samples were collected from the upper interval to identify potential impacts resulting from the activities listed above. Seven monitoring wells were installed in the shallow aquifer and one monitoring well was installed into the deep aquifer. Data from the first-quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.10.1 and 10.10.3 provide summaries of the sampling effort for combined SWMU 83 soil and groundwater.

10.10.10.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.10.10.1, the focus of this HHRA is on the following COPCs: antimony, arsenic, BEQs, copper, lead, manganese, and nickel. Thallium was detected at a maximum concentration which equaled its background RC, and was added to the list of COPCs. Beryllium and chromium were detected at concentrations above their respective RBC but were eliminated from consideration in the HHRA based on comparison to their background RCs. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameter that had been screened out based on background concentration.

Groundwater

As shown in Table 10.10.10.2, the COPCs identified in groundwater for this site were arsenic (shallow and deep) and manganese (deep). Manganese was detected in shallow groundwater at a concentration above its RBC but was eliminated from consideration in the shallow groundwater FRE based on comparison to its background RC. Wilcoxon rank sum test analyses did not result in the inclusion of any inorganic parameters that had been screened out based on background concentration.

10.10.10.3 Exposure Assessment

Exposure Setting

Combined SWMU 83 is located in the north central portion of the Controlled Industrial Area (CIA). Access to the CIA is controlled with a fence and a series of guarded check points. Land use in the CIA and combined SWMU 83 is consistent with an industrial setting. The majority of 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 and hypothetical future site residents. Future site resident and future site worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers. 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. 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 use are the same as those for the future site worker with respect to soil. Uniform exposure was assumed for all sample locations. To provide support for remedial decisions relative to groundwater, the associated pathways (ingestion and inhalation of volatiles) are addressed as fixed point risk evaluations and are presented as risk maps based on residential exposure. Table 10.10.10.3 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs were calculated for data sets consisting of at least 10 samples. UCLs calculated for surface soils are presented in Table 10.10.10.4. These UCLs were applied as exposure point concentrations for combined SWMU 83 surface soil pathways. Since the 95% UCL for copper exceeded the maximum concentration, the maximum concentration was used as the EPC. Point risk and hazard estimates have been calculated for each of the eight monitoring wells at this site. Therefore, no EPCs have been calculated for groundwater.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.10.10.5 and 10.10.10.6, respectively.

10.10.10.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.10.10.7 presents toxicological information specific to each COPC identified at combined SWMU 83. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Antimony is absorbed slowly through the gastrointestinal tract, which is the target of this element. Antimony has been experimentally shown to produce a reduction in lifespan, decreased blood glucose, and altered cholesterol levels when tested on a population of mice. 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 posted an RfDo of 0.0004 mg/kg-day based on a LOAEL of 0.35 mg/kg-day and an uncertainty factor of 1,000. (Klaassen, et al, 1986).

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 $(mg/kg/day)^{-1}$ 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.

Copper is a nutritionally essential element, necessary for many of the body's enzymes. In the past, lead pipes and solder were used for residential water pipes, and resulting lead concentrations in drinking water exceeded the guidelines set by the EPA. Copper has been used to replace water pipes in residences due to its lower toxicity to man. Short-term exposure to copper can result in anemia (the lack of iron), the breakdown of red blood cells, and liver and kidney lesions. The target organs for copper are the liver, kidney, and red blood cell. Vitamin C reduces copper uptake from the gut, and other substances can also influence copper uptake. Copper fumes can cause metal fume fever. The RfD set by the EPA is 0.04 mg/kg-day, which is 2.8 mg/day for the average adult (70 kg). In typical vitamin supplements, 2 mg/day is the approximate dose (NRC, 1989) (Klaassen, et al, 1986).

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 1,300 mg/kg cleanup standard for industrial properties. USEPA's Office of Water has established a TTAL of 15 μg/L. As listed in IRIS (search date 10/17/95), the basis for classification is 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).

Manganese is an essential nutrient. Chronic exposure to manganese, 0.8 mg/kg-day, causes mental disturbances and various central nervous system effects. 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. The oral RfD is 0.14 mg/kg-day with uncertainty and modifying factors of 1. When assessing the potential for adverse health effects from nondietary intakes (ingestion of soil or drinking water) of manganese, a modifying factor of 3 is used which gives an oral RfD of 0.047 mg/kg-day. An additional consideration for increased uptake of manganese in infants and fasted individuals further reduces the oral RfD for water ingestion to 0.023 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia, and an inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese can not be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. The typical vitamin supplement dose of manganese is 2.5 mg/day (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

Mercury The major source of this element is the degassing of the earth's crust. Target organs of mercury include the kidney, nervous system, fetus, and neonate. In other words, this inorganic can be toxic to a fetus if the mother is exposed during pregnancy. Mercury is toxic to all cells in the body- it binds to enzymes in the cells and disrupts their function, usually causing the cell to be useless or die. Because this inorganic is concentrated in the kidney prior to excretion, the

kidney is a major target organ for mercury ingestion. The primary target of mercury vapor is the brain. Some forms of mercury are drawn towards fats in the body (such as the nervous system), where the form is changed into its toxic form. This causes the nervous disorder known as Minimata disease, overexposure to mercury through ingestion of contaminated fish. The weight of evidence classification for mercury is "D" not classifiable as to human carcinogenicity. USEPA set mercury's RfD to 0.0003 mg/kg-day (mercuric chloride). Mercury is liquid at room temperature, and is poorly absorbed in this form if ingested. Typical daily exposure is less than 1 μg/l-day (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

BEQs include the following list of polynuclear aromatic hydrocarbons (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 $(mg/kg/day)^{-1}$. 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 RC 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).

10.10.10.5 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 10.10.10.8 and 10.10.10.9 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 83 surface soils is 3E-4. The dermal pathway ILCR is 1E-4. Arsenic and BEQs were the primary contributors to both the ingestion and dermal pathway.

The computed HIs for the adult resident was 0.1 for the soil ingestion pathway and 0.03 for the dermal contact pathway. The computed HIs for the child ingestion and dermal contact pathways were 1 and 0.1, respectively. The primary contributors to cumulative HI projections are antimony, arsenic, and copper.

Hypothetical Site Workers

Site worker ILCRs are 3E-5 and 4E-5 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 both projected to be 0.05 and 0.02 for the hypothetical site worker scenario.

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 for the more sensitive child receptors. Since no VOCs were identified as COPCs at combined SWMU 83, the inhalation pathway was not considered.

Future Site Residents

As mentioned in Section 10.10.10.2, the COPCs identified in combined SWMU 83 monitoring wells sampled during the first-quarter include arsenic and manganese (deep groundwater only). Table 10.10.10.10 presents the point risk and hazard associated with the COPCs identified for combined SWMU 83 groundwater. Concentrations arsenic in groundwater sampled from four monitoring wells (NBCE083001, NBCE083002, NBCE084002, and NBCE57401D) equate with HIs ranging from two to 14, and risk estimates ranging from 2E-04 to 2E-03. Manganese in the groundwater sampled from monitoring well (NBCE57401D) equates with a HI estimate of nine.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for combined SWMU 83 or other areas of Zone E. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

Lead Toxicity

Background

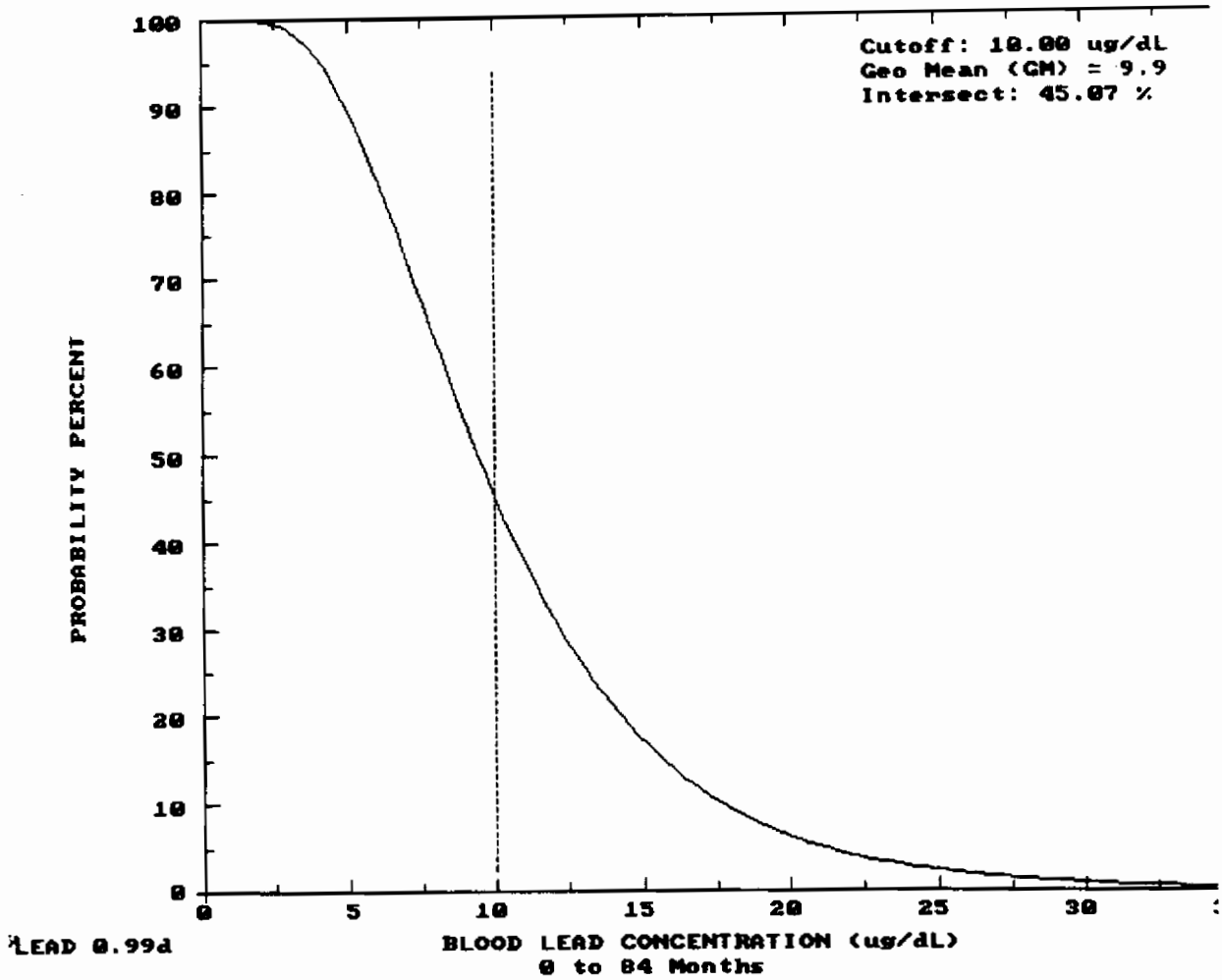
Currently, USEPA has not established an oral SF or reference dose for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic 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/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 surface soil at combined SWMU 83.

Future Residential Scenario

The Lead Model default concentrations are used for exposure to air (0.1 Pb grams per cubic meter [g/m^3]), drinking water (4μg/L), and maternal blood lead level (2.5 Pb per μg/dL). In the case of combined SWMU 83 surface soil, the 95% UCL (892 mg/kg) was used as the Lead model input for soil and house dust. The Lead Model was run for a child ages 0-7 years using the inputs listed above. Table 10.10.10.11 summarizes the lead model results under these exposure conditions.

Figure 10.10.4 shows the probability percentage of blood lead levels for a child 0 to 7 years old. Based on the model output the geometric mean blood concentrations is estimated to be 9.9 μg/dL, and the probability of blood lead concentration exceeding 10 μg/dL is 45%. USEPA generally



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

FIGURE 10.10.4
SWMUs 83, 84, AND AOC 574
LEAD MODEL RESULTS
– FUTURE RESIDENTIAL

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considers that media concentrations resulting in probability percentage estimates of 5% or less sufficiently protect potential child receptors. As a result, surface soil lead would require corrective action under this hypothetical exposure scenario.

Current Commercial/Industrial

USEPA Region IV has developed an interim approach for assessing risk due to adult exposures to lead in soil. The Adult Lead Model considers a woman of child-bearing age and sets a maternal blood lead level which is protective of a developing fetus. This model was used to evaluate the significance of lead in soil at combined SWMU 83 Using the default model parameters and the 95% UCL soil lead concentration produces central estimate of blood lead concentrations in women of child-bearing age of 2.3 μg/dL. The target maternal blood lead level below which is considered protective of a developing fetus is 3.3 μg/dL. As a result, surface soil lead at combined SWMU 83 would not require specific 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 surface soil lead concentrations at combined SWMU 83 under an future industrial scenario. This scenario involves a child (age 5 to 6) who gains access to the contaminated site for one day and is exposed. 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.

Exposure to site soil 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

TTAL of 15 μg/L. This change was made to provide a conservative estimate of daily intake from sources unrelated to combined SWMU 83.

The assumption was made that this child would ingest 0.1 grams of soil from the contaminated area, which is represented by the 95% UCL lead concentration (892 mg/kg). Within the Lead Model, an alternate source was entered to account for exposure to site soil as previously discussed. The bioavailability of lead ingested from the alternate source (combined SWMU 83 surface soil) was equal to that of lead ingested through soil ingestion from the standard residential default source. The annual alternate source exposure was estimated to be 0.244 μg lead/day. Table 10.10.10.12 summarizes the lead model results under these exposure conditions.

Figure 10.10.5 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 μg/dL, and the probability of blood lead levels in excess of 10 μg/dL is 0.46%. USEPA generally considers media concentrations that result in probability percentage estimates of 5% or less sufficiently protective of potential child receptors. As a result, surface soil lead at combined SWMU 83 would not require specific action under this hypothetical future exposure scenario.

Current exposure to child receptors is highly unlikely at combined SWMU 83 due to the industrialized nature of the area. Current exposure to site workers is highly limited since most of the site currently covered with either concrete or asphalt.

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-4 to 1E-6, and a HI 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-6 or greater and/or a

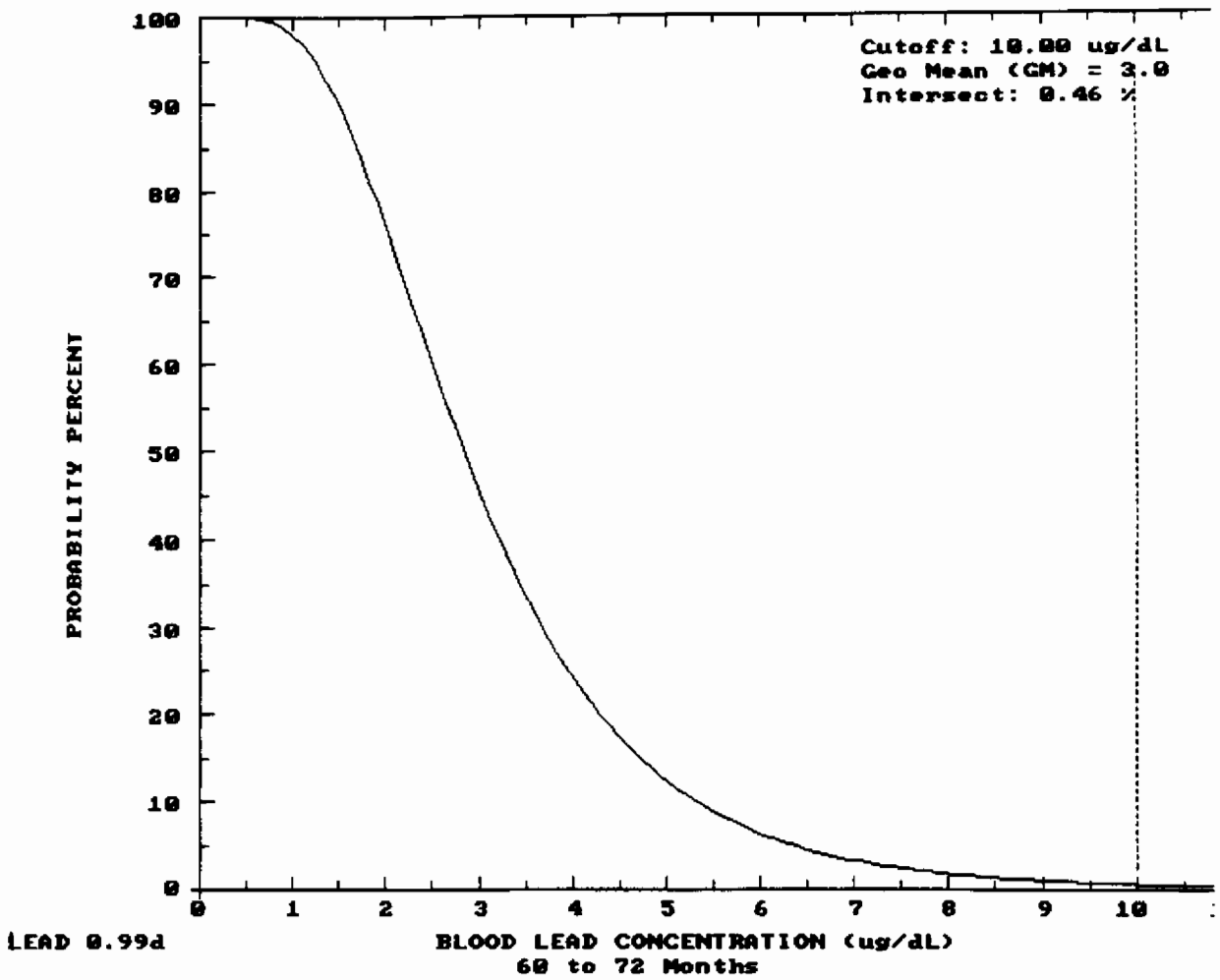

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FIGURE 10.10.5
SWMUs 83, 84, AND AOC 574
LEAD MODEL RESULTS
– FUTURE COMMERCIAL INDUSTRIAL

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cumulative HI above 1.0, and whose individual ILCR exceeds 1E-6 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because accumulative risk level of 1E-4 (and individual ILCR of 1E-6) 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 10.10.10.13 presents the COCs identified for combined SWMU 83 surface soil.

Surface Soils

Future Site Residents

Arsenic and BEQs were identified as the soil pathway COCs based on their contribution to cumulative ILCR projections. Antimony, arsenic, and copper were identified as soil pathway COCs based on their contribution to cumulative HI projections. Lead was identified as a COC based on blood lead level projections above 10 μg/dL for a 0-7 year old child.

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. Antimony was detected above its residential RBC in 7 of 27 surface soil samples. Arsenic was detected above its residential RBC in 26 of 27 surface soil samples, however, it was only detected in one sample (084SB007) above its background RC. Copper was detected above its residential RBC in 11 of 27 surface soil samples; its mean detected concentration (355 mg/kg) was only slightly above its RBC (310 mg/kg). Lead was detected above its residential RBC in 7 of 27 surface soil samples. BEQs

were detected above the residential RBC in 19 of 27 surface soil samples collected for combined SWMU 83.

First-Quarter Groundwater

Groundwater COCs have not been formally identified for combined SWMU 83, however, remedial goal options for all of the Zone E groundwater COPCs can be found in Section 7, Table 7.3.3.

Future Site Residents

Concentrations of arsenic and manganese contributed to elevated risk and/or HI in four of the eight combined SWMU 83 monitoring wells (both shallow and deep).

10.10.10.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

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

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. 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 83 for potable or industrial purposes. A basewide system provides drinking and process water to buildings throughout Zone E. 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

With the exception of copper, the 95% UCL soil concentrations were used as the exposure point concentrations for COPCs identified at this site. Use of UCL concentrations represents a conservative assumption when applied as the EPC such that it is unlikely for the true mean concentration of a constituent to exceed these levels. The maximum concentration of copper served at its EPC since its 95% UCL exceeded its maximum concentration. Groundwater risk/hazard was calculated for each monitoring well using the concentration of each COPC as an EPC. Calculating risk/hazard for each monitoring well location eases any potential bias due to sampling goals based on identifying "clean" areas of the underlying aquifer.

Frequency of Detection and Spatial Distribution

Arsenic was detected at concentrations above its RBC in 26 of 27 surface soil samples, however, it was only detected once at a concentration above its background reference. Antimony (7 of 27) and copper (11 of 27) were detected above their RBCs in less than half of the samples. BEQ compounds were detected above RBCs in 19 of 27 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.

Arsenic and manganese contributed to elevated risk/hazard estimates for the groundwater pathway. Arsenic was detected above its background RCs in two shallow and one deep groundwater samples out of eight first-quarter samples analyzed. Manganese was only detected in one first-quarter deep groundwater sample at a concentration above its background RC.

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 positively 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 83. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC).

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentrations close to its RBC.

Thallium was reported in the second, third, and fourth quarter groundwater sample from monitoring wells NBCE083001 (fourth), NBCE084002 (third), NBCE574001 (second), and NBCE57401D (second and fourth) at concentrations ranging from 3.4 to 8.3 μg/L which is higher than the thallium MCL. Thallium was not detected in any of the first-quarter groundwater samples and was therefore not considered in the groundwater FRE for combined SWMU 83. As a result, risk projections may have been underestimated with respect to thallium in groundwater. The maximum reported thallium concentration would equate with a hazard quotient of 6.

Groundwater is not currently used as a potable water source at combined SWMU 83, 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

Beryllium and chromium (assumed to be hexavalent) were detected in combined SWMU 83 surface soil at concentrations above their RBCs and manganese was detected at concentrations in combined SWMU 83 shallow groundwater above its RBC. These elements were eliminated from consideration in the risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed RBCs. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of these elements.

The maximum surface soil concentrations of beryllium (0.76 mg/kg) and chromium (39.6 mg/kg) for combined SWMU 83 equate with a risk of 6E-06 and a hazard quotient of 0.1, respectively.

The Zone E background surface soil concentration for beryllium (1.7 mg/kg) equates with a risk of 1E-05 and the Zone E background concentration of chromium (94.6 mg/kg) equates with a hazard quotient of 0.3.

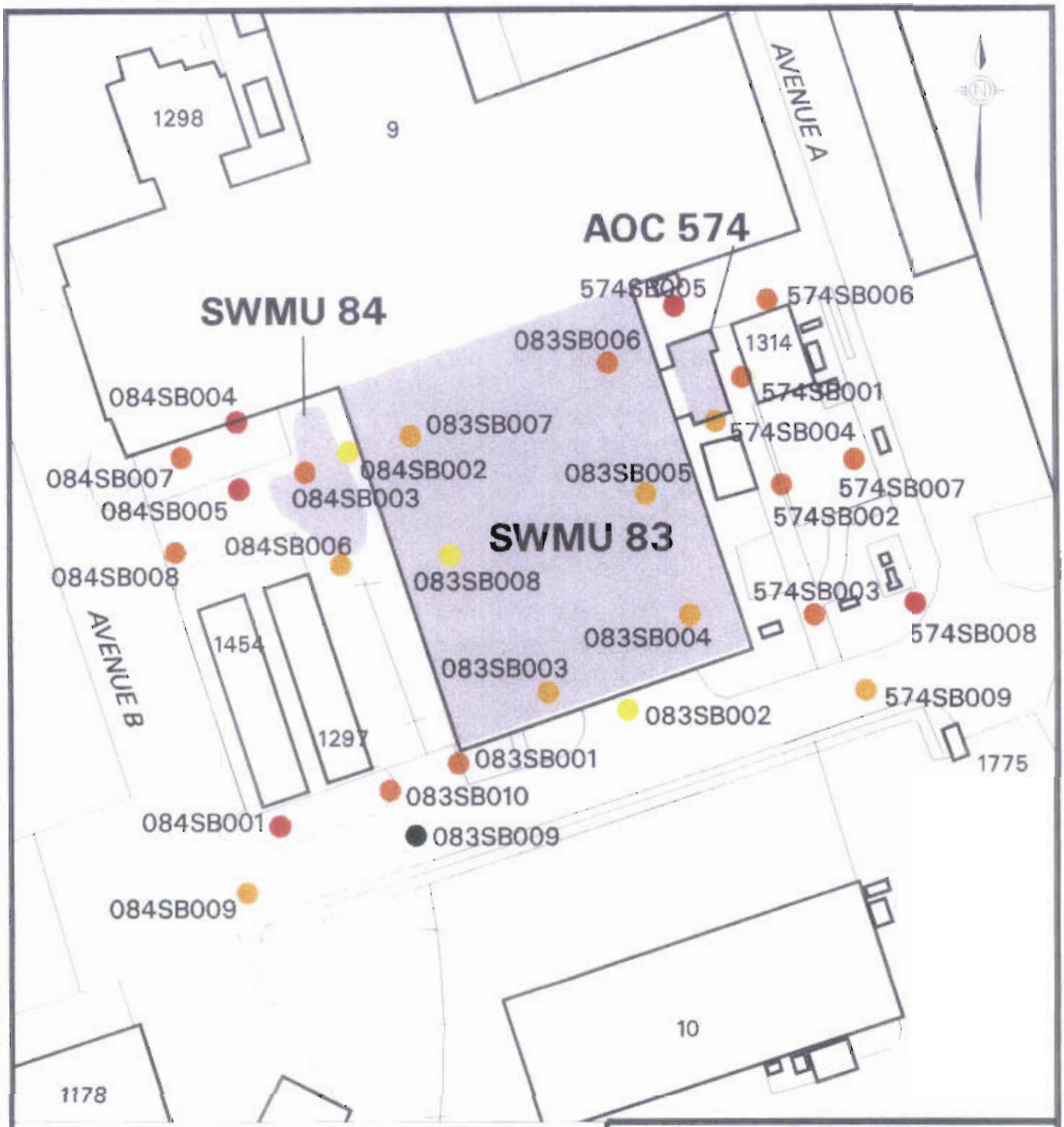
The maximum shallow groundwater manganese concentration for combined SWMU 83 (383 μg/L) equates with a hazard quotient of 1; however, the Zone E background concentration of manganese in shallow groundwater (2,560 μg/L) equates with a hazard quotient of 7.

10.10.10.7 Risk Summary

The risk and hazard posed by contaminants at combined SWMU 83 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 FRE was based on ingestion of shallow groundwater represented by first-quarter groundwater data. Table 10.10.10.14 presents the risk summary for each soil pathway/receptor group evaluated for combined SWMU 83.

Soil — Residential Scenario

Residential soil pathway COCs identified for combined SWMU 83 include antimony, arsenic, copper, and BEQs. Figures 10.10.6 and 10.10.7 illustrate point risk and HIs for combined SWMU 83 surface soil exposure by potential future site residents. Table 10.10.10.15 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.



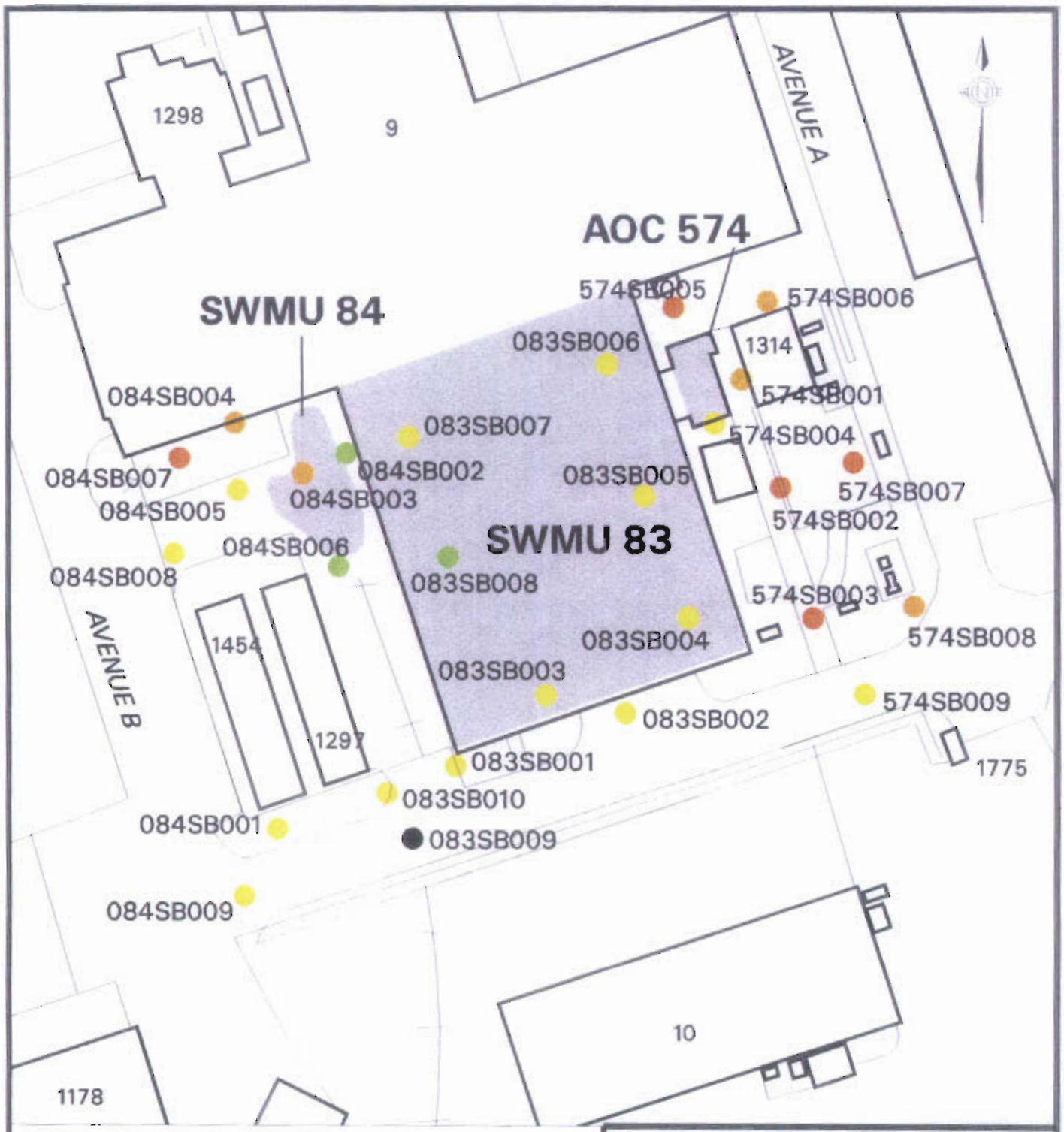
LEGEND - CUMULATIVE SOIL RISK

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

0 feet 120

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

FIGURE 10.10.6
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
SWMU 83,84 AOC 574



LEGEND - CUMULATIVE SOIL HAZARD

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

0 feet 120

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

FIGURE 10.10.7
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
SWMU 83,84 AOC 574

Arsenic and BEQs both of which were identified as COCs in the formal risk assessment, contribute to risk estimate above 1E-06 at all sample locations. Risks estimates ranged from 2E-06 (084SB002) to 5E-04 (574SB005). HIs exceed unity at five sample locations, 084SB007, 574SB002, 574SB003, 574SB005, and 574SB007, driven mostly by antimony, arsenic, and copper.

Soil — Site Worker Scenario

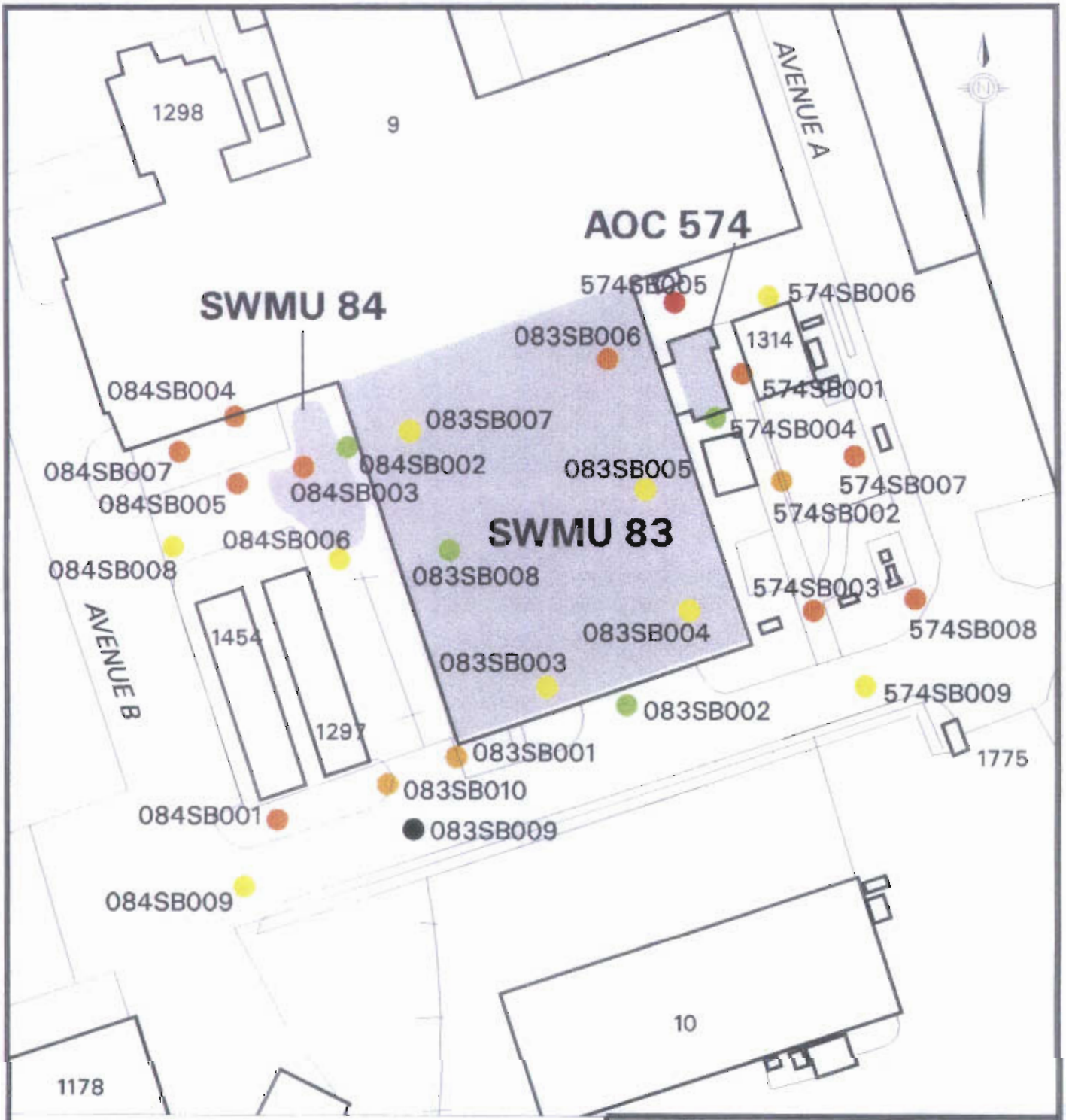
Site worker soil pathway COCs identified for combined SWMU 83 include arsenic and BEQs. Figure 10.10.8 illustrates point risk estimates for combined SWMU 83 surface soil exposure by potential future site workers. Table 10.10.10.16 summarize the risk and hazard contribution of each COPC at each sample location. As shown in Figure 10.10.8, the distribution of risk due to arsenic and BEQ compounds in soil is similar to the residential scenario with risks ranging from 3E-07 (084SB002) to 1E-04 (574SB005). HIs for the site worker scenario do not exceed unity at any sample location.

Groundwater — Residential Scenario

As shown in Table 10.10.10.10 and on Figures 10.10.9 and 10.10.10, concentrations of arsenic in groundwater sampled from four monitoring wells (NBCE083001, NBCE083002, NBCE084002 and NBCE57401D) equate with HIs ranging from two to 14, and risk estimates ranging from 2E-04 to 2E-03. Concentrations of manganese in groundwater sampled from one monitoring wells (NBCE57401D) equate with a hazard quotient of nine.

Lead Summary

The maximum surface soil lead concentration reported was 1,400 mg/kg at location 083SB010. Lead was not detected in shallow or deep groundwater through four quarters of sampling. Figure 10.10.11 shows the distribution of lead concentrations at combined SWMU 83 soil. Lead was detected in all 27 surface soil samples and exceeded the residential cleanup level of 400 mg/kg



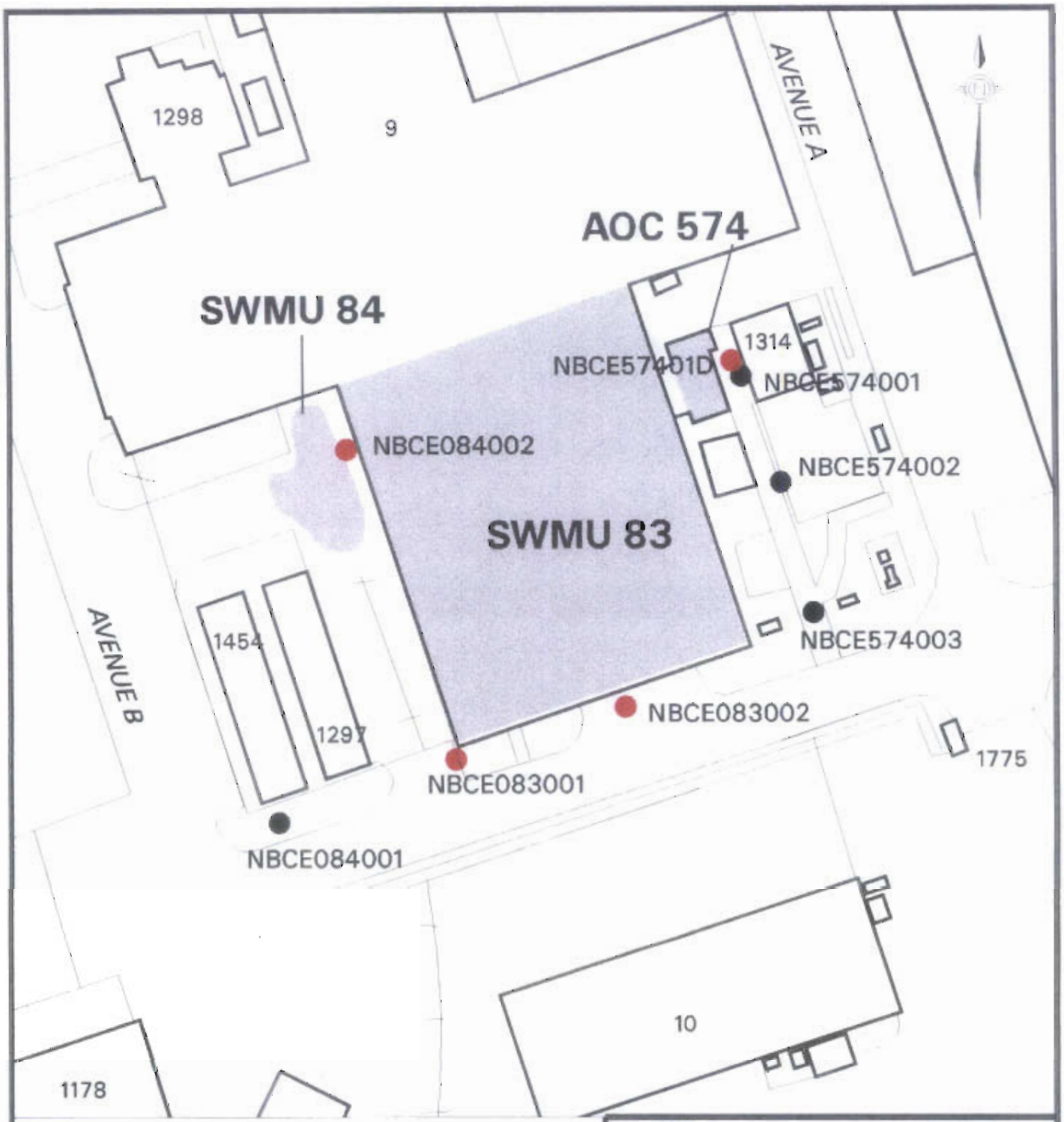
LEGEND - CUMULATIVE SOIL RISK

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

0 feet 120

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

FIGURE 10.10.8
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
SWMU 83,84 AOC 574



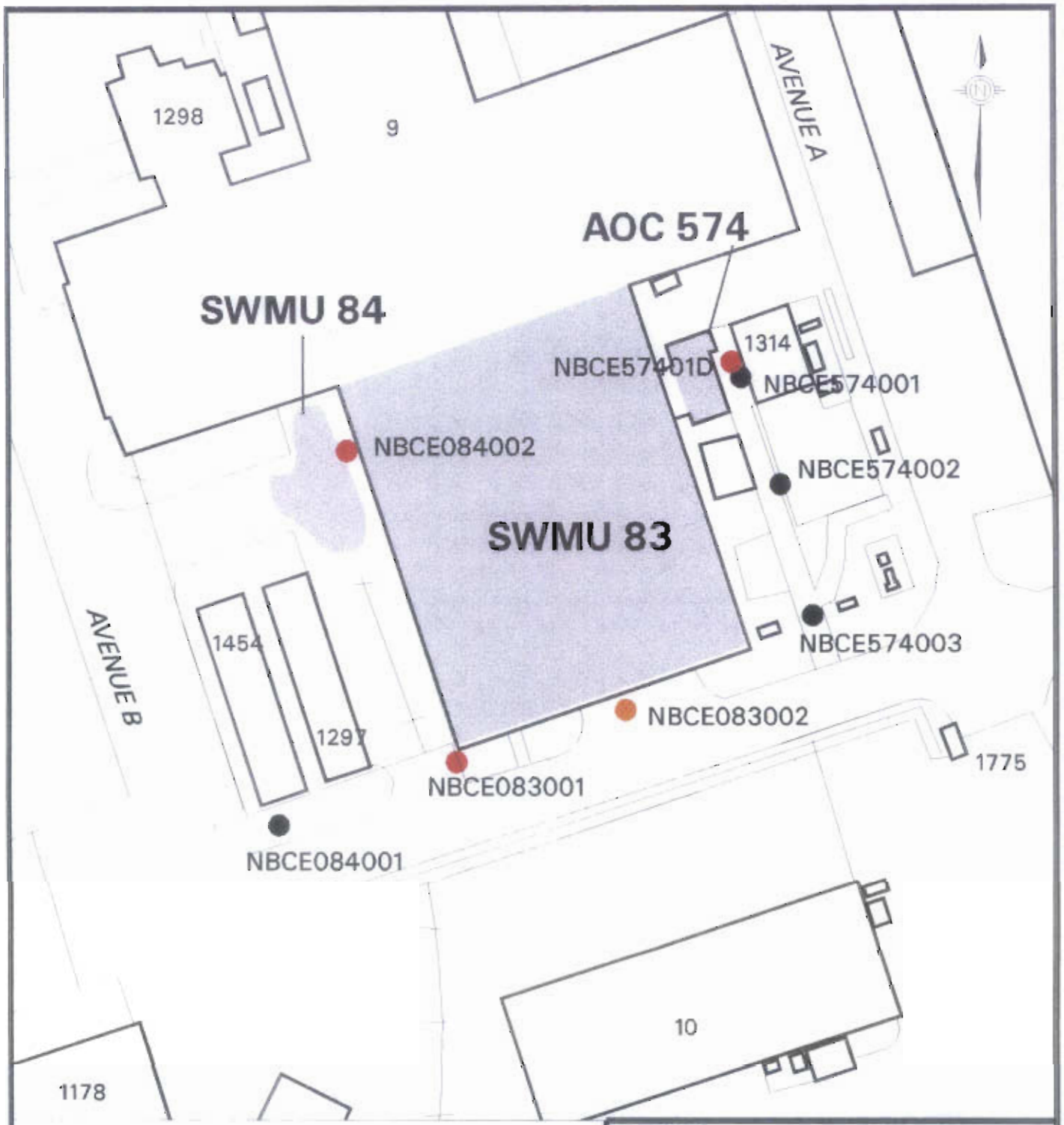
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 120

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

FIGURE 10.10.9
CUMULATIVE GROUNDWATER RISK IN WELLS
SWMU 83,84 AOC 574



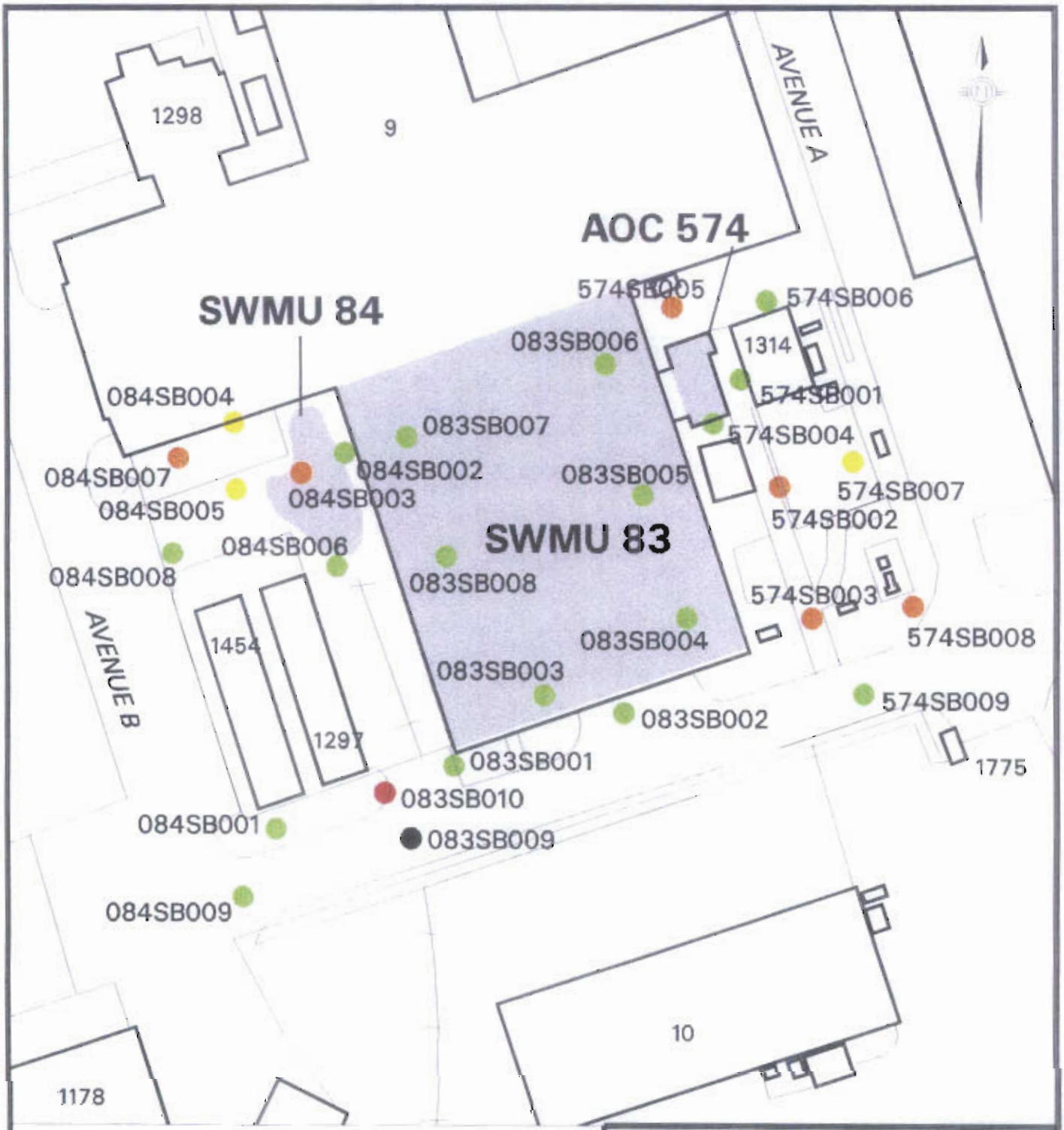
LEGEND - CUMULATIVE GROUNDWATER HAZARD

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

0 feet 120

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

FIGURE 10.10.10
CUMULATIVE GROUNDWATER HAZARD IN WELLS
SWMU 83,84 AOC 574



LEAD IN SURFACE SOIL

- NON DETECT
- < 265
- 265 - 400
- 401 - 1,300
- > 1,300

0 feet 120

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

FIGURE 10.10.11
DISTRIBUTION OF LEAD
IN SURFACE SOIL
SWMU 83,84 AOC 574

at 7 of 27 locations mainly at SWMU 84 and AOC 574. A soil cleanup/screening level for lead of 1,300 mg/kg was calculated for the Zone H RFI using the Adult Lead Model. One surface soil samples collected just to the south of SWMU 83 had lead concentrations which exceed 1,300 mg/kg. The mean surface soil concentration for combined SWMU 83 (231 mg/kg) falls below the USEPA both the child and adult cleanup/screening levels; although the levels within localized area if SWMU 84 and AOC 574 exceed this value.

10.10.10.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident or site worker as presented in Table 10.10.10.17 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.

Groundwater

Groundwater RGOs based on the generic site resident and site worker scenarios and are shown in Tables 7.3.3 and 7.3.4, respectively.

Table 10.10.10.1
Chemicals Present in Site Samples
SWMUs 83, 84; AOC 574 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Screening Concentration Reference	Units	Number Exceeding Res. RBC	Number Exceeding Ref.
Carcinogenic PAHs											
B(a)P Equiv.	*	20	27	86.3 - 28991	4674	1663.92 - 9012.9	88	NA	UG/KG	19	
Benzo(a)anthracene	*	19	27	79 - 26000	3681	720 - 3900	880	NA	UG/KG	12	
Benzo(a)pyrene	*	20	27	64 - 20000	3071	720 - 3900	88	NA	UG/KG	18	
Benzo(b)fluoranthene	*	18	27	100 - 21000	3292	720 - 3900	880	NA	UG/KG	12	
Benzo(k)fluoranthene	*	17	27	290 - 17000	3201	350 - 3900	8800	NA	UG/KG	1	
Chrysene		19	27	99 - 21000	3560	720 - 3900	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	14	27	83 - 3600	1045	350 - 3900	88	NA	UG/KG	13	
Indeno(1,2,3-cd)pyrene	*	19	27	43 - 10000	2061	720 - 3900	880	NA	UG/KG	11	
Gasoline		2	5	124 - 5460	2792	11 - 7190	NA	NA	UG/KG		
Inorganics											
Aluminum (Al)		27	27	1350 - 6640	4370.0	NA - NA	7800	26600	MG/KG		
Antimony (Sb)	*	15	27	0.59 - 10.7	4.3	0.43 - 3.5	3.1	1.77	MG/KG	7	9
Arsenic (As)	*	26	27	0.87 - 25	6.1	0.54 - 0.54	0.43	23.9	MG/KG	26	1
Barium (Ba)		25	27	10.7 - 142	45.1	30.5 - 42	550	130	MG/KG		1
Beryllium (Be)		27	27	0.11 - 0.76	0.4	NA - NA	0.15	1.7	MG/KG	24	
Cadmium (Cd)		18	27	0.17 - 2.5	1.0	0.11 - 0.47	3.9	1.5	MG/KG		4
Calcium (Ca)	N	27	27	123 - 26700	8308.1	NA - NA	NA	NA	MG/KG		
Chromium (Cr)		27	27	1.9 - 39.6	10.9	NA - NA	39	94.6	MG/KG	1	
Cobalt (Co)		27	27	1 - 61.6	9.0	NA - NA	470	19	MG/KG		3
Copper (Cu)	*	27	27	4.2 - 1260	355.2	NA - NA	310	66	MG/KG	11	17
Cyanide (CN)		4	27	0.34 - 0.57	0.4	0.21 - 0.24	160	0.5	MG/KG		1
Iron (Fe)	N	27	27	1250 - 60000	11920.7	NA - NA	2300	NA	MG/KG		
Lead (Pb)	*	27	27	2.9 - 1400	230.6	NA - NA	400	265	MG/KG	7	10
Magnesium (Mg)	N	27	27	66.6 - 9220	1025.5	NA - NA	NA	NA	MG/KG		
Manganese (Mn)	*	27	27	22.5 - 441	126.0	NA - NA	180	302	MG/KG	6	2
Mercury (Hg)	*	19	27	0.03 - 19.4	1.2	0.02 - 0.04	2.3	2.6	MG/KG	1	1
Nickel (Ni)		27	27	1.4 - 83	16.2	NA - NA	160	77.1	MG/KG		1
Potassium (K)	N	20	27	308 - 1060	719.3	159 - 442	NA	NA	MG/KG		
Selenium (Se)		8	27	0.58 - 0.74	0.7	0.52 - 0.66	39	1.7	MG/KG		
Silver (Ag)		8	27	0.25 - 3	1.0	0.21 - 0.28	39	NA	MG/KG		

Table 10.10.10.1
Chemicals Present in Site Samples
SWMUs 83, 84; AOC 574 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Reference	Units	Number Exceeding Res. RBC	Ref.
Sodium (Na)	N	14	27	38 - 559	166.7	45.4 - 412	NA	NA	MG/KG		
Thallium (Tl)		3	27	0.59 - 2.8	1.7	0.52 - 0.66	0.63	2.8	MG/KG	2	1
Tin (Sn)		15	27	4 - 148	47.8	2.2 - 22.6	4700	59.4	MG/KG		4
Vanadium (V)		27	27	1.8 - 21.9	10.3	NA - NA	55	94.3	MG/KG		
Zinc (Zn)		27	27	12.3 - 1210	333.9	NA - NA	2300	827	MG/KG		3
Pesticides											
4,4'-DDD		2	27	3 - 33	18.0	2.6 - 4	2700	NA	UG/KG		
4,4'-DDE		6	27	3.3 - 250	48.7	2.6 - 4	1900	NA	UG/KG		
4,4'-DDT		5	27	4.5 - 290	67.1	2.7 - 26	1900	NA	UG/KG		
alpha-Chlordane		1	27	20 - 20	20.0	1.4 - 2.1	470	NA	UG/KG		
Dieldrin		1	27	9.4 - 9.4	9.4	2.6 - 4	40	NA	UG/KG		
Endrin		6	27	3.3 - 19	12.0	2.7 - 4	2300	NA	UG/KG		
Endrin aldehyde		1	27	14 - 14	14.0	2.6 - 4	2300	NA	UG/KG		
Endrin ketone		1	27	4.8 - 4.8	4.8	2.6 - 4	2300	NA	UG/KG		
gamma-Chlordane		3	27	3.4 - 60	25.1	1.4 - 2.1	470	NA	UG/KG		
Heptachlor		3	27	1.8 - 2.3	2.0	1.3 - 2.1	140	NA	UG/KG		
Heptachlor epoxide		2	27	3.9 - 33	18.5	1.4 - 2.1	70	NA	UG/KG		
Semivolatile Organics											
2-Chlorophenol		1	27	100 - 100	100.0	20 - 3900	39000	NA	UG/KG		
2-Methylnaphthalene		12	27	51 - 5500	1171.8	710 - 1100	310000	NA	UG/KG		
4-Methylphenol		3	27	44 - 110	83.3	350 - 3900	39000	NA	UG/KG		
Acenaphthene		9	27	94 - 8800	2020.4	350 - 3900	470000	NA	UG/KG		
Acenaphthylene		7	27	84 - 290	157.4	350 - 3900	310000	NA	UG/KG		
Anthracene		15	27	95 - 18000	2427.0	350 - 3900	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		20	27	50 - 8400	1832.5	720 - 3900	310000	NA	UG/KG		
Benzoic acid		1	27	89 - 89	89.0	100 - 19000	31000000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate		3	27	140 - 680	380.0	20 - 3900	46000	NA	UG/KG		
Butylbenzylphthalate		4	27	130 - 300	215.0	20 - 3900	1600000	NA	UG/KG		
Carbazole		1	10	130 - 130	130.0	340 - 870	32000	NA	UG/KG		
Dibenzofuran		6	27	47 - 5600	1922.8	350 - 3900	31000	NA	UG/KG		
Diethylphthalate		2	27	790 - 5900	3345.0	340 - 1100	6300000	NA	UG/KG		
Dimethyl phthalate		1	27	2400 - 2400	2400.0	340 - 3900	78000000	NA	UG/KG		

Table 10.10.10.1
Chemicals Present in Site Samples
SWMUs 83, 84; AOC 574 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Reference	Units	Number Exceeding Res. RBC	Ref.
Di-n-butylphthalate	1	27	74 - 74	74.0	20 - 3900	780000	NA	UG/KG		
Di-n-octyl phthalate	2	27	52 - 170	111.0	20 - 3900	160000	NA	UG/KG		
Fluoranthene	20	27	100 - 73000	8334.0	720 - 3900	310000	NA	UG/KG		
Fluorene	10	27	100 - 8200	2209.0	350 - 870	310000	NA	UG/KG		
Naphthalene	9	27	64 - 6900	1555.0	710 - 3900	310000	NA	UG/KG		
Pentachlorophenol	1	27	320 - 320	320.0	100 - 19000	5300	NA	UG/KG		
Phenanthrene	21	27	96 - 83000	8203.1	720 - 800	310000	NA	UG/KG		
Pyrene	21	27	120 - 59000	6588.1	720 - 3900	230000	NA	UG/KG		
Volatile Organics										
1,1,1-Trichloroethane	2	23	1 - 1	1.0	5 - 710	270000	NA	UG/KG		
2-Butanone	1	23	6 - 6	6.0	11 - 1400	4700000	NA	UG/KG		
2-Hexanone	1	23	20 - 20	20.0	11 - 1400	630	NA	UG/KG		
Acetone	12	23	6 - 200	75.2	11 - 1400	780000	NA	UG/KG		
Methylene chloride	6	23	1 - 14	4.3	5 - 710	85000	NA	UG/KG		
Toluene	4	23	1 - 1	1.0	5 - 710	1600000	NA	UG/KG		
Trichloroethene	1	23	37 - 37	37.0	5 - 710	58000	NA	UG/KG		
Xylene (Total)	2	23	2 - 6	4.0	5 - 710	16000000	NA	UG/KG		

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.10.10.2
Chemicals Present in Site Samples
SWMUs 83, 84; AOC 574 - Groundwater
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Deep wells											
Inorganics											
Aluminum (Al)		1	1	32.7 - 32.7	32.7	NA - NA	3700	319	UG/L		
Arsenic (As)	*	1	1	67.5 - 67.5	67.5	NA - NA	0.045	16.4	UG/L	1	1
Barium (Ba)		1	1	198 - 198	198	NA - NA	260	218	UG/L		
Calcium (Ca)	N	1	1	227000 - 227000	227000	NA - NA	NA	NA	UG/L		
Cobalt (Co)		1	1	2.3 - 2.3	2.3	NA - NA	220	12.9	UG/L		
Iron (Fe)	N	1	1	37000 - 37000	37000	NA - NA	1100	NA	UG/L		
Magnesium (Mg)	N	1	1	125000 - 125000	125000	NA - NA	NA	NA	UG/L		
Manganese (Mn)	*	1	1	3380 - 3380	3380	NA - NA	84	869	UG/L	1	1
Nickel (Ni)		1	1	4.3 - 4.3	4.3	NA - NA	73	42.2	UG/L		
Potassium (K)	N	1	1	51500 - 51500	51500	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	1290000 - 1290000	1290000	NA - NA	NA	NA	UG/L		
Vanadium (V)		1	1	1.9 - 1.9	1.9	NA - NA	26	5.3	UG/L		
Shallow Wells											
TCDD Equivalents											
Dioxin Equiv.		1	1	0.0455 - 0.0455	0.0455	NA - NA	0.43	NA	PG/L		
Inorganics											
Aluminum (Al)		5	7	54.7 - 695	270.0	58.4 - 131	3700	2810	UG/L		
Arsenic (As)	*	3	7	7.7 - 36.9	21.2	5 - 5	0.045	18.7	UG/L	3	2
Barium (Ba)		4	7	9.7 - 32	16.7	2.2 - 26.1	260	211	UG/L		
Calcium (Ca)	N	5	7	10300 - 81200	37680	3210 - 10500	NA	NA	UG/L		
Chromium (Cr)		1	7	2.4 - 2.4	2.4	1 - 1	18	12.3	UG/L		
Cobalt (Co)		1	7	2.7 - 2.7	2.7	2 - 2	220	2.5	UG/L		1
Copper (Cu)		1	7	3 - 3	3	2 - 8.1	150	2.7	UG/L		1
Iron (Fe)	N	7	7	167 - 11400	3350	NA - NA	1100	NA	UG/L		

Table 10.10.10.2
Chemicals Present in Site Samples
SWMUs 83, 84; AOC 574 - Groundwater
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Magnesium (Mg)	N	5	7	6730 - 46300	18086	884 - 2510	NA	NA	UG/L		
Manganese (Mn)		7	7	34.2 - 383	191	NA - NA	84	2560	UG/L	5	
Nickel (Ni)		3	7	1.5 - 2.2	1.9	1 - 1	73	15.2	UG/L		
Potassium (K)	N	5	7	6510 - 24200	13854	1500 - 2050	NA	NA	UG/L		
Silver (Ag)		1	7	2.1 - 2.1	2.1	2 - 2	18	NA	UG/L		
Sodium (Na)	N	5	7	24600 - 1130000	314860	21600 - 24100	NA	NA	UG/L		
Vanadium (V)		5	7	1.4 - 3.2	2.12	1 - 1	26	11.4	UG/L		
Zinc (Zn)		2	7	4.1 - 8.7	6.4	4 - 11.1	1100	27.3	UG/L		
Semivolatile Organics											
2-Methylnaphthalene		1	7	75 - 75	75	10 - 10	150	NA	UG/L		
Acenaphthene		1	7	2 - 2	2	10 - 10	220	NA	UG/L		
Benzoic acid		1	7	3 - 3	3	50 - 53	15000	NA	UG/L		
Dibenzofuran		1	7	3 - 3	3	10 - 10	15	NA	UG/L		
Fluorene		1	7	5 - 5	5	10 - 10	150	NA	UG/L		
Naphthalene		1	7	7 - 7	7	10 - 10	150	NA	UG/L		
Phenanthrene		1	7	3 - 3	3	10 - 10	150	NA	UG/L		
Organotins											
Tributyltin		1	7	24 - 24	24	2 - 2	NA	NA	UG/L		

Notes:
* - Identified as a COPC
N - Essential nutrient
UG/L - micrograms per liter
PG/L - picograms per liter
SQL - Sample quantitation limit
NA - Not applicable

Table 10.10.10.3
Exposure Pathways Summary — SWMUs 83, 84; AOC 574
NAVBASE — Zone E
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant 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 83.
	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 83.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be protective of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered in a separate section relative to industrial hygiene sampling in Building 9.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at combined SWMU 83. A FRE was provided for this pathway for use in remedial decisions
	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.

Table 10.10.10.3
Exposure Pathways Summary — SWMUs 83, 84; AOC 574
NAVBASE — Zone E
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	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 10.10.10.4
Summary of Statistical Analysis
Surface Soil COPCs; SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
Charleston, South Carolina

COPC	n	Natural Log Transformed mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Inorganic								
Antimony (Sb)	27	0.07	1.41	3.04	7	11	7	UCL
Arsenic (As)	27	1.35	0.99	2.46	10	25	10	UCL
Copper (Cu)	27	4.66	1.97	3.89	3293.64	1260	1260.00	MAX
Lead (Pb)	27	4.44	1.61	3.34	892	1400	892	UCL
Manganese (Mn)	27	4.54	0.81	2.26	187	441	187	UCL
Mercury (Hg)	27	-2.61	1.76	3.57	1	19.4	1	UCL
Thallium (Tl)	27	-1.08	0.57	2.01	1	2.8	1	UCL
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	27	6.72	1.89	3.77	19.86	28.991	19.86	UCL

Notes:
n - Number of samples analyzed
mean - Arithmetic mean of the logtransformed data
SD - Standard deviation for a sample of data
H-stat -"H" statistic from Gilbert 1987;
cuboidal interpolation was used to
NA - Not applicable
EPC - Exposure point concentration
UCL - 95 percentile upper confidence level mean
MAX - Maximum reported concentration

Table 10.10.10.5
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
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)	Current Worker adult H-CDI (mg/kg-day)	Current Worker adult C-CDI (mg/kg-day)
Inorganic							
Antimony (Sb)	1	6.62	9.07E-06	8.46E-05	1.04E-05	3.24E-06	1.16E-06
Arsenic (As)	1	10.08	1.38E-05	1.29E-04	1.58E-05	4.93E-06	1.76E-06
Copper (Cu)	1	1260.00	1.73E-03	1.61E-02	1.97E-03	6.16E-04	2.20E-04
Lead (Pb)	1	892.39	1.22E-03	1.14E-02	1.40E-03	4.37E-04	1.56E-04
Manganese (Mn)	1	186.73	2.56E-04	2.39E-03	2.92E-04	9.14E-05	3.26E-05
Mercury (Hg)	1	1.19	1.63E-06	1.52E-05	1.87E-06	5.83E-07	2.08E-07
Thallium (Tl)	1	0.50	6.85E-07	6.40E-06	7.83E-07	2.45E-07	8.74E-08
Semivolatile Organic Compounds							
Benzo(a)pyrene equivalents	1	19.86	2.72E-05	2.54E-04	3.11E-05	9.71531E-06	3.46975E-06

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 10.10.10.6
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentratio (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)	Current Worker adult H-CDI (mg/kg-day)	Current Worker adult C-CDI (mg/kg-day)
Inorganic								
Antimony (Sb)	1	7	0.001	3.72E-07	1.23E-06	2.33E-07	2.66E-07	9.48E-08
Arsenic (As)	1	10	0.001	5.66E-07	1.87E-06	3.54E-07	4.05E-07	1.44E-07
Copper (Cu)	1	1260	0.001	7.08E-05	2.34E-04	4.43E-05	5.05E-05	1.81E-05
Lead (Pb)	1	892	0.001	5.01E-05	1.65E-04	3.14E-05	3.58E-05	1.28E-05
Manganese (Mn)	1	187	0.001	1.05E-05	3.46E-05	6.56E-06	7.49E-06	2.68E-06
Mercury (Hg)	1	1	0.001	6.70E-08	2.21E-07	4.19E-08	4.78E-08	1.71E-08
Thallium (Tl)	1	1	0.001	2.81E-08	9.27E-08	1.76E-08	2.01E-08	7.17E-09
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	1	19.858095	0.01	1.12E-05	3.68E-05	6.98E-06	7.97E-06	2.85E-06

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 10.10.10.7
Toxicological Database Information for Chemical of Potential Concern
SWMUs 83, 84; AOC 574
NAVBASE - Charleston, Zone E
Charleston, South Carolina

	Noncarcinogenic Effects						Carcinogenic Effects					
	Oral RfD		Inhalation RfD	Confidence Level	Critical Effect; Target Organ	Uncertainty Factor Oral	Oral Slope Factor		Inhalation Slope Factor		Weight of Evidence	Tumor Type
Semivolatile Organics												
Benzo(a)pyrene equivalent	ND		ND				7.3	a	0.61	c	B2	forestomach, squamous cell papillomas and carcinomas
Inorganic compounds												
Antimony	0.0004	a	ND	Low	Decreased lifespan; whole body	1000	ND		ND			
Arsenic	0.0003	a	ND	Medium	Hyperpigmentation, keratosis; skin	3	1.5	a	50	b	A	Various
Copper	0.04	b	ND	NA	NA	NA	ND	a	ND		D	
Lead	ND		ND				ND		ND		B2	Various
Manganese (food)	0.047	a	0.0000143	Medium	Neurological effects; CNS	1	ND	a	ND		D	
Mercury	0.0003	b	0.000086	NA	Autoimune effects	30	ND		ND	a	D	
Thallium	0.00008	a	ND	Low	Increased SGOP; liver	3000	ND	a	ND		D	

Notes:

a - Integrated Risk Information System (IRIS)
b - Health Effects Assessment Summary Tables (HEAST)
c - EPA Environmental Criteria and Assessment Office - Cincinnati (provisional)
NA - Not applicable or not available
ND - Not determined due to lack of information
RfD and Slope Factors are presented in milligrams/kilogram/day (mg/kg/day)

Table 10.10.10.8
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
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	Current Worker Adult Hazard Quotient	Current Worker Adult ILCR
Inorganic							
Antimony (Sb)	0.0004	NA	2.27E-02	2.12E-01	ND	8.10E-03	ND
Arsenic (As)	0.0003	1.5000	4.60E-02	4.30E-01	2.37E-05	1.64E-02	2.64E-06
Copper (Cu)	0.0400	NA	4.32E-02	4.03E-01	ND	1.54E-02	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Manganese (Mn)	0.0470	NA	5.44E-03	5.08E-02	ND	1.94E-03	ND
Mercury (Hg)	0.0003	NA	5.44E-03	5.08E-02	ND	1.94E-03	ND
Thallium (Tl)	0.0001	NA	8.56E-03	7.99E-02	ND	3.06E-03	ND
Semivolatile Organic Compounds							
Benzo(a)pyrene equivalents	NA	7.3000	ND	ND	2.27E-04	ND	2.53E-05
SUM Hazard Index/ILCR			1.31E-01	1.23E+00	2.51E-04	4.69E-02	2.80E-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 10.10.10.9
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
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
Inorganic								
Antimony (Sb)	0.2	0.00008	NA	4.65E-03	1.53E-02	ND	3.32E-03	ND
Arsenic (As)	0.2	0.00006	7.5	9.44E-03	3.12E-02	2.66E-06	6.74E-03	1.08E-06
Copper (Cu)	0.2	0.008	NA	8.85E-03	2.92E-02	ND	6.32E-03	ND
Lead (Pb)	0.2	NA	NA	ND	ND	ND	ND	ND
Manganese (Mn)	0.2	0.0094	NA	1.12E-03	3.68E-03	ND	7.97E-04	ND
Mercury (Hg)	0.2	0.00006	NA	1.12E-03	3.68E-03	ND	7.97E-04	ND
Thallium (Tl)	0.2	0.000016	NA	1.76E-03	5.80E-03	ND	1.25E-03	ND
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	1.02E-04	ND	4.15E-05
SUM Hazard Index/ILCR				2.69E-02	8.89E-02	1.05E-04	1.92E-02	4.26E-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
1 - 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 10.10.10.10
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
574	G01D	Arsenic (As)	67.50	UG/L	1505.8708	100.00	14.3836	60.49
574	G01D	Manganese (Mn)	3380.00	UG/L	NA		9.3945	39.51
		Total			1505.8708		23.7780	
083	G001	Arsenic (As)	18.90	UG/L	421.6438	100.00	4.0274	100.00
		Total			421.6438		4.0274	
083	G002	Arsenic (As)	7.70	UG/L	171.7808	100.00	1.6408	100.00
		Total			171.7808		1.6408	
084	G001	Arsenic (As)	ND	UG/L	NA		NA	
		Total			NA		NA	
084	G002	Arsenic (As)	36.90	UG/L	823.2094	100.00	7.8630	100.00
		Total			823.2094		7.8630	
574	G001	Arsenic (As)	ND	UG/L	NA		NA	
		Total			NA		NA	
574	G002	Arsenic (As)	ND	UG/L	NA		NA	
		Total			NA		NA	
574	G003	Arsenic (As)	ND	UG/L	NA		NA	
		Total			NA		NA	

Table 10.10.10.11
Summary of Lead Model Results - Future Residential Scenario
SWMUs 83, 84; AOC 574
NAVBASE - Charleston, Zone E
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: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT
SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	892.0	892.0
1-2	892.0	892.0
2-3	892.0	892.0
3-4	892.0	892.0
4-5	892.0	892.0
5-6	892.0	892.0
6-7	892.0	892.0

Additional Dust Sources: None DEFAULT
Alternative Source 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 (ug/day)	Soil+Dust (ug/day)	Diet (ug/day)	Water (ug/day)	Alt. Source (ug/day)	Air (ug/day)
0.5-1:	10.7	20.41	17.90	2.18	0.31	0.00	0.02
1-2:	12.33	0.40	27.41	2.19	0.76	0.00	0.03
2-3:	11.63	1.73	28.31	2.54	0.82	0.00	0.06
3-4:	11.23	2.63	29.19	2.52	0.86	0.00	0.07
4-5:	9.42	6.66	23.06	2.59	0.95	0.00	0.07
5-6:	7.92	5.19	21.27	2.80	1.02	0.00	0.09
6-7:	7.12	4.64	20.36	3.13	1.06	0.00	0.09

Table 10.10.10.12
Summary of Lead Model Results - Future Industrial Scenario
SWMUs 83, 84; AOC 574
NAVBASE - Charleston, Zone E
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: 4.00 ug Pb/L DEFAULT
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: 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: 0.24 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 (ug/day)	Soil+Dust (ug/day)	Diet (ug/day)	Water (ug/day)	Alt. Source (ug/day)	Air (ug/day)
0.5-1:	4.1	7.60	4.68	2.54	0.37	0.00	0.02
1-2:	4.5	10.93	7.36	2.63	0.91	0.00	0.03
2-3:	4.2	11.44	7.44	2.98	0.96	0.00	0.06
3-4:	4.0	11.48	7.53	2.90	0.99	0.00	0.07
4-5:	3.4	9.65	5.69	2.85	1.04	0.00	0.07
5-6:	3.0	9.46	5.16	3.03	1.11	0.07	0.09
6-7:	2.7	9.47	4.89	3.36	1.13	0.00	0.09

Table 10.10.10.13
Summary of Risk and Hazard-based COCs
SWMUs 83, 84; AOC 574
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Current Site Worker Hazard Quotient	ILCR	Identification of COCs		
Surface Soil	Incidental	**Inorganic**								
	Ingestion	Antimony (Sb)	2.27E-02	2.12E-01	ND	8.10E-03	ND	1		
		Arsenic (As)	4.60E-02	4.30E-01	2.37E-05	1.64E-02	2.64E-06	1	2	4
		Copper (Cu)	4.32E-02	4.03E-01	ND	1.54E-02	ND	1		
		Lead (Pb)	ND	ND	ND	ND	ND			
		Manganese (Mn)	5.44E-03	5.08E-02	ND	1.94E-03	ND			
		Mercury (Hg)	5.44E-03	5.08E-02	ND	1.94E-03	ND			
		Thallium (Tl)	8.56E-03	7.99E-02	ND	3.06E-03	ND			
		Semivolatile Organics								
		Benzo(a)pyrene equivalent	ND	ND	2.27E-04	ND	2.53E-05		2	4
	Dermal	**Inorganic**								
		Antimony (Sb)	4.65E-03	1.53E-02	ND	3.32E-03	ND			
		Arsenic (As)	9.44E-03	3.12E-02	2.66E-06	6.74E-03	1.08E-06		2	4
		Copper (Cu)	8.85E-03	2.92E-02	ND	6.32E-03	ND			
		Lead (Pb)	ND	ND	ND	ND	ND			
		Manganese (Mn)	1.12E-03	3.68E-03	ND	7.97E-04	ND			
		Mercury (Hg)	1.12E-03	3.68E-03	ND	7.97E-04	ND			
		Thallium (Tl)	1.76E-03	5.80E-03	ND	1.25E-03	ND			
		Semivolatile Organics								
		Benzo(a)pyrene equivalent	ND	ND	1.02E-04	ND	4.15E-05		2	4
Surface Soil Pathway Sum			1.58E-01	1.31E+00	3.55E-04	6.61E-02	7.06E-05			

Notes:
ND - Not Determined due to the lack of available risk information.
ILCR - Incremental excess Lifetime Cancer Risk
HI - 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.

Table 10.10.10.14
Summary of Risk and Hazard
SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.13	1.23	2.51E-04	0.05	2.80E-05
	Dermal Contact	0.03	0.09	1.05E-04	0.02	4.26E-05
Sum of Soil Pathways		0.16	1.31	3.55E-04	0.07	7.06E-05
Groundwater	Mean*	NA	5.00	4.00E-04	NA	NA
	Maximum	NA	24.00	2.00E-03	NA	NA

Notes:
ILCR - Indicates incremental lifetime cancer risk
HI - Indicates hazard index
* Arithmetic mean calculated assuming a deminimus risk of 1E-07 and a deminimus hazard index of 0.01 for sample locations with no contributing COPCs

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
083	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B001	Arsenic (As)	2.5	MG/KG	6.5300	23.42	0.1143	64.23
083	B001	B(a)P Equiv.	1289.38	UG/KG	21.3525	76.58	NA	
083	B001	Copper (Cu)	107	MG/KG	NA		0.0367	20.62
083	B001	Lead (Pb)	30.2	MG/KG	NA		NA	
083	B001	Manganese (Mn)	75.2	MG/KG	NA		0.0219	12.33
083	B001	Mercury (Hg)	0.11	MG/KG	NA		0.0050	2.83
083	B001	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			27.8825		0.1779	
083	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B002	Arsenic (As)	1.9	MG/KG	4.9628	100.00	0.0868	52.29
083	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B002	Copper (Cu)	136	MG/KG	NA		0.0466	28.07
083	B002	Lead (Pb)	49.6	MG/KG	NA		NA	
083	B002	Manganese (Mn)	104	MG/KG	NA		0.0303	18.27
083	B002	Mercury (Hg)	0.05	MG/KG	NA		0.0023	1.38
083	B002	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			4.9628		0.1661	
083	B003	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B003	Arsenic (As)	2.8	MG/KG	7.3136	100.00	0.1280	88.06
083	B003	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B003	Copper (Cu)	5	MG/KG	NA		0.0017	1.18
083	B003	Lead (Pb)	25.3	MG/KG	NA		NA	
083	B003	Manganese (Mn)	53.6	MG/KG	NA		0.0156	10.76
083	B003	Mercury (Hg)	ND	MG/KG	NA		NA	
083	B003	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			7.3136		0.1453	
083	B004	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B004	Arsenic (As)	2.7	MG/KG	7.0524	71.47	0.1234	90.54
083	B004	B(a)P Equiv.	170	UG/KG	2.8153	28.53	NA	
083	B004	Copper (Cu)	18.3	MG/KG	NA		0.0063	4.60
083	B004	Lead (Pb)	22.7	MG/KG	NA		NA	
083	B004	Manganese (Mn)	22.7	MG/KG	NA		0.0066	4.86
083	B004	Mercury (Hg)	ND	MG/KG	NA		NA	
083	B004	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			9.8677		0.1363	
083	B005	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B005	Arsenic (As)	1.3	MG/KG	3.3956	38.49	0.0594	39.23
083	B005	B(a)P Equiv.	327.64	UG/KG	5.4258	61.51	NA	

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
083	B005	Copper (Cu)	142	MG/KG	NA		0.0487	32.14
083	B005	Lead (Pb)	40.1	MG/KG	NA		NA	
083	B005	Manganese (Mn)	144	MG/KG	NA		0.0420	27.73
083	B005	Mercury (Hg)	0.03	MG/KG	NA		0.0014	0.91
083	B005	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			8.8214		0.1515	
083	B006	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B006	Arsenic (As)	9.3	MG/KG	24.2916	25.52	0.4251	93.54
083	B006	B(a)P Equiv.	4281	UG/KG	70.8947	74.48	NA	
083	B006	Copper (Cu)	8	MG/KG	NA		0.0027	0.60
083	B006	Lead (Pb)	9.6	MG/KG	NA		NA	
083	B006	Manganese (Mn)	86.6	MG/KG	NA		0.0253	5.56
083	B006	Mercury (Hg)	0.03	MG/KG	NA		0.0014	0.30
083	B006	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			95.1863		0.4545	
083	B007	Antimony (Sb)	3.7	MG/KG	NA		0.1268	36.09
083	B007	Arsenic (As)	2.8	MG/KG	7.3136	100.00	0.1280	36.41
083	B007	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B007	Copper (Cu)	243	MG/KG	NA		0.0833	23.70
083	B007	Lead (Pb)	94.2	MG/KG	NA		NA	
083	B007	Manganese (Mn)	45.7	MG/KG	NA		0.0133	3.79
083	B007	Mercury (Hg)	ND	MG/KG	NA		NA	
083	B007	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			7.3136		0.3515	
083	B008	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B008	Arsenic (As)	1.3	MG/KG	3.3956	100.00	0.0594	74.76
083	B008	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B008	Copper (Cu)	22.7	MG/KG	NA		0.0078	9.79
083	B008	Lead (Pb)	11.8	MG/KG	NA		NA	
083	B008	Manganese (Mn)	42.1	MG/KG	NA		0.0123	15.45
083	B008	Mercury (Hg)	ND	MG/KG	NA		NA	
083	B008	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			3.3956		0.0795	
083	B010	Antimony (Sb)	ND	MG/KG	NA		NA	
083	B010	Arsenic (As)	5.4	MG/KG	14.1048	35.86	0.2468	27.37
083	B010	B(a)P Equiv.	1523.3	UG/KG	25.2263	64.14	NA	
083	B010	Copper (Cu)	439	MG/KG	NA		0.1505	16.69
083	B010	Lead (Pb)	1400	MG/KG	NA		NA	
083	B010	Manganese (Mn)	117	MG/KG	NA		0.0341	3.78

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
083	B010	Mercury (Hg)	0.09	MG/KG	NA		0.0041	0.46
083	B010	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			39.3311		0.4356	
084	B001	Antimony (Sb)	0.59	MG/KG	NA		0.0202	6.40
084	B001	Arsenic (As)	2.2	MG/KG	5.7464	5.55	0.1006	31.81
084	B001	B(a)P Equiv.	5904.3	UG/KG	97.7771	94.45	NA	
084	B001	Copper (Cu)	16.3	MG/KG	NA		0.0056	1.77
084	B001	Lead (Pb)	89.9	MG/KG	NA		NA	
084	B001	Manganese (Mn)	138	MG/KG	NA		0.0403	12.74
084	B001	Mercury (Hg)	0.04	MG/KG	NA		0.0018	0.58
084	B001	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			103.5235		0.1685	
084	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
084	B002	Arsenic (As)	0.87	MG/KG	2.2724	100.00	0.0398	29.84
084	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
084	B002	Copper (Cu)	4.2	MG/KG	NA		0.0014	1.08
084	B002	Lead (Pb)	8.7	MG/KG	NA		NA	
084	B002	Manganese (Mn)	22.5	MG/KG	NA		0.0066	4.93
084	B002	Mercury (Hg)	ND	MG/KG	NA		NA	
084	B002	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			2.2724		0.0478	
084	B003	Antimony (Sb)	2.1	MG/KG	NA		0.0720	10.88
084	B003	Arsenic (As)	6.8	MG/KG	17.7616	27.53	0.3108	46.98
084	B003	B(a)P Equiv.	2823.8	UG/KG	46.7630	72.47	NA	
084	B003	Copper (Cu)	332	MG/KG	NA		0.1138	17.20
084	B003	Lead (Pb)	408	MG/KG	NA		NA	
084	B003	Manganese (Mn)	192	MG/KG	NA		0.0560	8.47
084	B003	Mercury (Hg)	0.17	MG/KG	NA		0.0078	1.17
084	B003	Thallium (Tl)	0.59	MG/KG	NA		0.1011	15.29
		Total			64.5246		0.6615	
084	B004	Antimony (Sb)	1.6	MG/KG	NA		0.0548	9.94
084	B004	Arsenic (As)	6.2	MG/KG	16.1944	5.89	0.2834	51.35
084	B004	B(a)P Equiv.	15629	UG/KG	258.8211	94.11	NA	
084	B004	Copper (Cu)	476	MG/KG	NA		0.1632	29.57
084	B004	Lead (Pb)	317	MG/KG	NA		NA	
084	B004	Manganese (Mn)	126	MG/KG	NA		0.0368	6.66
084	B004	Mercury (Hg)	0.3	MG/KG	NA		0.0137	2.48
084	B004	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			275.0155		0.5519	

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
084	B005	Antimony (Sb)	0.6	MG/KG	NA		0.0206	5.27
084	B005	Arsenic (As)	5.9	MG/KG	15.4108	14.49	0.2697	69.11
084	B005	B(a)P Equiv.	5491.3	UG/KG	90.9376	85.51	NA	
084	B005	Copper (Cu)	90.4	MG/KG	NA		0.0310	7.94
084	B005	Lead (Pb)	281	MG/KG	NA		NA	
084	B005	Manganese (Mn)	216	MG/KG	NA		0.0630	16.15
084	B005	Mercury (Hg)	0.13	MG/KG	NA		0.0059	1.52
084	B005	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			106.3485		0.3902	
084	B006	Antimony (Sb)	ND	MG/KG	NA		NA	
084	B006	Arsenic (As)	ND	MG/KG	NA		NA	
084	B006	B(a)P Equiv.	541.22	UG/KG	8.9628	100.00	NA	
084	B006	Copper (Cu)	6.9	MG/KG	NA		0.0024	20.84
084	B006	Lead (Pb)	2.9	MG/KG	NA		NA	
084	B006	Manganese (Mn)	30.8	MG/KG	NA		0.0090	79.16
084	B006	Mercury (Hg)	ND	MG/KG	NA		NA	
084	B006	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			8.9628		0.0114	
084	B007	Antimony (Sb)	10.7	MG/KG	NA		0.3668	19.11
084	B007	Arsenic (As)	25	MG/KG	65.3000	65.57	1.1427	59.54
084	B007	B(a)P Equiv.	2070.2	UG/KG	34.2832	34.43	NA	
084	B007	Copper (Cu)	942	MG/KG	NA		0.3229	16.83
084	B007	Lead (Pb)	644	MG/KG	NA		NA	
084	B007	Manganese (Mn)	109	MG/KG	NA		0.0318	1.66
084	B007	Mercury (Hg)	1.2	MG/KG	NA		0.0548	2.86
084	B007	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			99.5832		1.9191	
084	B008	Antimony (Sb)	0.86	MG/KG	NA		0.0295	11.25
084	B008	Arsenic (As)	4.8	MG/KG	12.5376	49.01	0.2194	83.69
084	B008	B(a)P Equiv.	787.74	UG/KG	13.0452	50.99	NA	
084	B008	Copper (Cu)	9.1	MG/KG	NA		0.0031	1.19
084	B008	Lead (Pb)	12.7	MG/KG	NA		NA	
084	B008	Manganese (Mn)	27	MG/KG	NA		0.0079	3.00
084	B008	Mercury (Hg)	0.05	MG/KG	NA		0.0023	0.87
084	B008	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			25.5828		0.2622	
084	B009	Antimony (Sb)	ND	MG/KG	NA		NA	
084	B009	Arsenic (As)	2.9	MG/KG	7.5748	100.00	0.1326	70.53

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
084	B009	B(a)P Equiv.	ND	UG/KG	NA		NA	
084	B009	Copper (Cu)	10.1	MG/KG	NA		0.0035	1.84
084	B009	Lead (Pb)	53.6	MG/KG	NA		NA	
084	B009	Manganese (Mn)	178	MG/KG	NA		0.0519	27.63
084	B009	Mercury (Hg)	ND	MG/KG	NA		NA	
084	B009	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			7.5748		0.1879	
574	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
574	B001	Arsenic (As)	3.2	MG/KG	8.3584	10.05	0.1463	25.15
574	B001	B(a)P Equiv.	4517	UG/KG	74.8029	89.95	NA	
574	B001	Copper (Cu)	1180	MG/KG	NA		0.4045	69.56
574	B001	Lead (Pb)	110	MG/KG	NA		NA	
574	B001	Manganese (Mn)	85	MG/KG	NA		0.0248	4.26
574	B001	Mercury (Hg)	0.13	MG/KG	NA		0.0059	1.02
574	B001	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			83.1613		0.5815	
574	B002	Antimony (Sb)	5	MG/KG	NA		0.1714	11.19
574	B002	Arsenic (As)	9.9	MG/KG	25.8588	64.12	0.4525	29.53
574	B002	B(a)P Equiv.	873.66	UG/KG	14.4681	35.88	NA	
574	B002	Copper (Cu)	868	MG/KG	NA		0.2976	19.42
574	B002	Lead (Pb)	476	MG/KG	NA		NA	
574	B002	Manganese (Mn)	441	MG/KG	NA		0.1286	8.40
574	B002	Mercury (Hg)	0.05	MG/KG	NA		0.0023	0.15
574	B002	Thallium (Tl)	2.8	MG/KG	NA		0.4799	31.32
		Total			40.3269		1.5323	
574	B003	Antimony (Sb)	9.1	MG/KG	NA		0.3120	27.83
574	B003	Arsenic (As)	6.7	MG/KG	17.5004	23.41	0.3062	27.32
574	B003	B(a)P Equiv.	3458.2	UG/KG	57.2689	76.59	NA	
574	B003	Copper (Cu)	1260	MG/KG	NA		0.4319	38.54
574	B003	Lead (Pb)	438	MG/KG	NA		NA	
574	B003	Manganese (Mn)	183	MG/KG	NA		0.0534	4.76
574	B003	Mercury (Hg)	0.38	MG/KG	NA		0.0174	1.55
574	B003	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			74.7693		1.1209	
574	B004	Antimony (Sb)	0.93	MG/KG	NA		0.0319	12.73
574	B004	Arsenic (As)	2.3	MG/KG	6.0076	100.00	0.1051	41.97
574	B004	B(a)P Equiv.	ND	UG/KG	NA		NA	
574	B004	Copper (Cu)	292	MG/KG	NA		0.1001	39.96
574	B004	Lead (Pb)	46.8	MG/KG	NA		NA	

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
574	B004	Manganese (Mn)	33.4	MG/KG	NA		0.0097	3.89
574	B004	Mercury (Hg)	0.08	MG/KG	NA		0.0037	1.46
574	B004	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			6.0076		0.2505	
574	B005	Antimony (Sb)	10.7	MG/KG	NA		0.3668	16.04
574	B005	Arsenic (As)	9.2	MG/KG	24.0304	4.77	0.4205	18.39
574	B005	B(a)P Equiv.	28991	UG/KG	480.1000	95.23	NA	
574	B005	Copper (Cu)	729	MG/KG	NA		0.2499	10.93
574	B005	Lead (Pb)	700	MG/KG	NA		NA	
574	B005	Manganese (Mn)	187	MG/KG	NA		0.0546	2.39
574	B005	Mercury (Hg)	19.4	MG/KG	NA		0.8867	38.77
574	B005	Thallium (Tl)	1.8	MG/KG	NA		0.3085	13.49
		Total			504.1304		2.2870	
574	B006	Antimony (Sb)	2.9	MG/KG	NA		0.0994	11.28
574	B006	Arsenic (As)	11.9	MG/KG	31.0828	95.60	0.5439	61.73
574	B006	B(a)P Equiv.	86.3	UG/KG	1.4292	4.40	NA	
574	B006	Copper (Cu)	602	MG/KG	NA		0.2064	23.42
574	B006	Lead (Pb)	128	MG/KG	NA		NA	
574	B006	Manganese (Mn)	87.4	MG/KG	NA		0.0255	2.89
574	B006	Mercury (Hg)	0.13	MG/KG	NA		0.0059	0.67
574	B006	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			32.5120		0.8811	
574	B007	Antimony (Sb)	7.1	MG/KG	NA		0.2434	15.19
574	B007	Arsenic (As)	22.1	MG/KG	57.7252	61.40	1.0101	63.03
574	B007	B(a)P Equiv.	2191.4	UG/KG	36.2903	38.60	NA	
574	B007	Copper (Cu)	631	MG/KG	NA		0.2163	13.50
574	B007	Lead (Pb)	280	MG/KG	NA		NA	
574	B007	Manganese (Mn)	400	MG/KG	NA		0.1167	7.28
574	B007	Mercury (Hg)	0.35	MG/KG	NA		0.0160	1.00
574	B007	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			94.0155		1.6025	
574	B008	Antimony (Sb)	7.5	MG/KG	NA		0.2571	27.30
574	B008	Arsenic (As)	6.2	MG/KG	16.1944	7.29	0.2834	30.09
574	B008	B(a)P Equiv.	12438.4	UG/KG	205.9838	92.71	NA	
574	B008	Copper (Cu)	1000	MG/KG	NA		0.3428	36.40
574	B008	Lead (Pb)	506	MG/KG	NA		NA	
574	B008	Manganese (Mn)	130	MG/KG	NA		0.0379	4.03
574	B008	Mercury (Hg)	0.45	MG/KG	NA		0.0206	2.18
574	B008	Thallium (Tl)	ND	MG/KG	NA		NA	

Table 10.10.10.15
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
		Total			222.1782		0.9418	
574	B009	Antimony (Sb)	0.6	MG/KG	NA		0.0206	11.86
574	B009	Arsenic (As)	2.4	MG/KG	6.2688	79.99	0.1097	63.25
574	B009	B(a)P Equiv.	94.699	UG/KG	1.5682	20.01	NA	
574	B009	Copper (Cu)	20.4	MG/KG	NA		0.0070	4.03
574	B009	Lead (Pb)	41	MG/KG	NA		NA	
574	B009	Manganese (Mn)	124	MG/KG	NA		0.0362	20.86
574	B009	Mercury (Hg)	ND	MG/KG	NA		NA	
574	B009	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			7.8370		0.1734	

Table 10.10.10.16
Point Estimates of Risk and Hazard - Surface Soil
Industrial Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
083	B001	Arsenic (As)	2.50	MG/KG	0.9238	17.54	0.0057	100.00
083	B001	B(a)P Equiv.	1289.38	UG/KG	4.3415	82.46	NA	
083	B001	Lead (Pb)	30.20	MG/KG	NA		NA	
		Total			5.2653		0.0057	
083	B002	Arsenic (As)	1.90	MG/KG	0.7021	100.00	0.0044	100.00
083	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B002	Lead (Pb)	49.60	MG/KG	NA		NA	
		Total			0.7021		0.0044	
083	B003	Arsenic (As)	2.80	MG/KG	1.0346	100.00	0.0064	100.00
083	B003	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B003	Lead (Pb)	25.30	MG/KG	NA		NA	
		Total			1.0346		0.0064	
083	B004	Arsenic (As)	2.70	MG/KG	0.9977	63.54	0.0062	100.00
083	B004	B(a)P Equiv.	170.00	UG/KG	0.5724	36.46	NA	
083	B004	Lead (Pb)	22.70	MG/KG	NA		NA	
		Total			1.5701		0.0062	
083	B005	Arsenic (As)	1.30	MG/KG	0.4804	30.33	0.0030	100.00
083	B005	B(a)P Equiv.	327.64	UG/KG	1.1032	69.67	NA	
083	B005	Lead (Pb)	40.10	MG/KG	NA		NA	
		Total			1.5836		0.0030	
083	B006	Arsenic (As)	9.30	MG/KG	3.4364	19.25	0.0214	100.00
083	B006	B(a)P Equiv.	4281.00	UG/KG	14.4147	80.75	NA	
083	B006	Lead (Pb)	9.60	MG/KG	NA		NA	
		Total			17.8511		0.0214	
083	B007	Arsenic (As)	2.80	MG/KG	1.0346	100.00	0.0064	100.00
083	B007	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B007	Lead (Pb)	94.20	MG/KG	NA		NA	
		Total			1.0346		0.0064	
083	B008	Arsenic (As)	1.30	MG/KG	0.4804	100.00	0.0030	100.00
083	B008	B(a)P Equiv.	ND	UG/KG	NA		NA	
083	B008	Lead (Pb)	11.80	MG/KG	NA		NA	
		Total			0.4804		0.0030	

Table 10.10.10.16
Point Estimates of Risk and Hazard - Surface Soil
Industrial Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
083	B010	Arsenic (As)	5.40	MG/KG	1.9953	28.01	0.0124	100.00
083	B010	B(a)P Equiv.	1523.30	UG/KG	5.1292	71.99	NA	
083	B010	Lead (Pb)	1400.00	MG/KG	NA		NA	
		Total			7.1245		0.0124	
084	B001	Arsenic (As)	2.20	MG/KG	0.8129	3.93	0.0051	100.00
084	B001	B(a)P Equiv.	5904.30	UG/KG	19.8806	96.07	NA	
084	B001	Lead (Pb)	89.90	MG/KG	NA		NA	
		Total			20.6935		0.0051	
084	B002	Arsenic (As)	0.87	MG/KG	0.3215	100.00	0.0020	100.00
084	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
084	B002	Lead (Pb)	8.70	MG/KG	NA		NA	
		Total			0.3215		0.0020	
084	B003	Arsenic (As)	6.80	MG/KG	2.5126	20.90	0.0156	100.00
084	B003	B(a)P Equiv.	2823.80	UG/KG	9.5081	79.10	NA	
084	B003	Lead (Pb)	408.00	MG/KG	NA		NA	
		Total			12.0208		0.0156	
084	B004	Arsenic (As)	6.20	MG/KG	2.2909	4.17	0.0143	100.00
084	B004	B(a)P Equiv.	15629.00	UG/KG	52.6250	95.83	NA	
084	B004	Lead (Pb)	317.00	MG/KG	NA		NA	
		Total			54.9160		0.0143	
084	B005	Arsenic (As)	5.90	MG/KG	2.1801	10.55	0.0136	100.00
084	B005	B(a)P Equiv.	5491.30	UG/KG	18.4900	89.45	NA	
084	B005	Lead (Pb)	281.00	MG/KG	NA		NA	
		Total			20.6701		0.0136	
084	B006	Arsenic (As)	ND	MG/KG	NA		NA	
084	B006	B(a)P Equiv.	541.22	UG/KG	1.8224	100.00	NA	
084	B006	Lead (Pb)	2.90	MG/KG	NA		NA	
		Total			1.8224		NA	
084	B007	Arsenic (As)	25.00	MG/KG	9.2377	56.99	0.0575	100.00
084	B007	B(a)P Equiv.	2070.20	UG/KG	6.9707	43.01	NA	
084	B007	Lead (Pb)	644.00	MG/KG	NA		NA	
		Total			16.2083		0.0575	

Table 10.10.10.16
Point Estimates of Risk and Hazard - Surface Soil
Industrial Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
084	B008	Arsenic (As)	4.80	MG/KG	1.7736	40.07	0.0110	100.00
084	B008	B(a)P Equiv.	787.74	UG/KG	2.6524	59.93	NA	
084	B008	Lead (Pb)	12.70	MG/KG	NA		NA	
		Total			4.4261		0.0110	
084	B009	Arsenic (As)	2.90	MG/KG	1.0716	100.00	0.0067	100.00
084	B009	B(a)P Equiv.	ND	UG/KG	NA		NA	
084	B009	Lead (Pb)	53.60	MG/KG	NA		NA	
		Total			1.0716		0.0067	
574	B001	Arsenic (As)	3.20	MG/KG	1.1824	7.21	0.0074	100.00
574	B001	B(a)P Equiv.	4517.00	UG/KG	15.2094	92.79	NA	
574	B001	Lead (Pb)	110.00	MG/KG	NA		NA	
		Total			16.3918		0.0074	
574	B002	Arsenic (As)	9.90	MG/KG	3.6581	55.43	0.0228	100.00
574	B002	B(a)P Equiv.	873.66	UG/KG	2.9417	44.57	NA	
574	B002	Lead (Pb)	476.00	MG/KG	NA		NA	
		Total			6.5999		0.0228	
574	B003	Arsenic (As)	6.70	MG/KG	2.4757	17.53	0.0154	100.00
574	B003	B(a)P Equiv.	3458.20	UG/KG	11.6442	82.47	NA	
574	B003	Lead (Pb)	438.00	MG/KG	NA		NA	
		Total			14.1199		0.0154	
574	B004	Arsenic (As)	2.30	MG/KG	0.8499	100.00	0.0053	100.00
574	B004	B(a)P Equiv.	ND	UG/KG	NA		NA	
574	B004	Lead (Pb)	46.80	MG/KG	NA		NA	
		Total			0.8499		0.0053	
574	B005	Arsenic (As)	9.20	MG/KG	3.3995	3.37	0.0212	100.00
574	B005	B(a)P Equiv.	28991.00	UG/KG	97.6167	96.63	NA	
574	B005	Lead (Pb)	700.00	MG/KG	NA		NA	
		Total			101.0162		0.0212	
574	B006	Arsenic (As)	11.90	MG/KG	4.3971	93.80	0.0274	100.00
574	B006	B(a)P Equiv.	86.30	UG/KG	0.2906	6.20	NA	
574	B006	Lead (Pb)	128.00	MG/KG	NA		NA	
		Total			4.6877		0.0274	

Table 10.10.10.16
Point Estimates of Risk and Hazard - Surface Soil
Industrial Scenario
SWMUs 83 and 84/AOC 574
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
574	B007	Arsenic (As)	22.10	MG/KG	8.1661	52.53	0.0508	100.00
574	B007	B(a)P Equiv.	2191.40	UG/KG	7.3787	47.47	NA	
574	B007	Lead (Pb)	280.00	MG/KG	NA		NA	
		Total			15.5449		0.0508	
574	B008	Arsenic (As)	6.20	MG/KG	2.2909	5.19	0.0143	100.00
574	B008	B(a)P Equiv.	12438.40	UG/KG	41.8818	94.81	NA	
574	B008	Lead (Pb)	506.00	MG/KG	NA		NA	
		Total			44.1728		0.0143	
574	B009	Arsenic (As)	2.40	MG/KG	0.8868	73.55	0.0055	100.00
574	B009	B(a)P Equiv.	94.70	UG/KG	0.3189	26.45	NA	
574	B009	Lead (Pb)	41.00	MG/KG	NA		NA	
		Total			1.2057		0.0055	

Table 10.10.10.17
Remedial Goal Options for Soil
SWMUs 83, 84; AOC 574
Naval Base Charleston, Zone E
Charleston, South Carolina

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Remedial Goal Options 0.000001 mg/kg	0.00001 mg/kg	0.0001 mg/kg	Background Concentration mg/kg
Residential-Based Remedial Goal Options										
Inorganic										
Antimony (Sb)	NA	0.0004	6.62	88	29	2.92	ND	ND	ND	NA
Arsenic (As)	1.5	0.0003	10.08	66	22	2	0.38	3.83	38	9.44
Copper (Cu)	NA	0.04	892	6198	2066	207	ND	ND	ND	165
Semivolatile Organic Compounds										
Benzo(a)pyrene equivalents	7.3	NA	19.86	ND	ND	ND	0.06	0.60	6.04	NA
Worker-Based Remedial Goal Options										
Inorganic										
Arsenic (As)	1.5	0.0003	10.08	1304.68	434.89	43.49	2.71	27.06	270.60	9.44
Semivolatile Organic Compounds										
Benzo(a)pyrene equivalents	7.3	NA	19.86	ND	ND	ND	0.30	2.97	29.70	NA

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

10.10.11 Corrective Measures Considerations

For SWMUs 83 and 84 and AOC 574, the upper and lower soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and the shallow and deep 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. However, the industrial exposure risk for the upper soil interval exceeds 1E-06 for arsenic and BEQs. Risk associated with the upper interval is diminished because most of the site is capped with concrete and asphalt. Soil sample locations 084SB004, 084SB007, 574SB005, and 574SB008 are not covered with either concrete or asphalt.

Antimony, arsenic, copper, and BEQs were identified as COCs in the upper soil interval. Arsenic and BEQs soil pathway residential exposure risk ranges from 2E-06 to 5E-04 with the arithmetic mean risk of 7E-05. The HI estimates range from 0.001 to 2.2 with a mean HI of 0.6. The equated mean is between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI.

However, the arithmetic mean risk and HI associated with the four soil samples not covered by concrete or asphalt are 2.7E-04 and 1.4, respectively. Arsenic and BEQs contribute to risk at these points.

Lead was identified at seven of 27 locations above USEPA's acceptable residential level of 400 mg/kg. The highest concentration of lead is at soil boring 083SB010, 1,400 mg/kg. The soil samples from this boring and soil borings 084SB003, 574SB002, and 574SB003 were collected beneath concrete or asphalt; direct exposure at these covered locations is unlikely. Lead was detected above USEPA's acceptable residential level in three of the four soil samples collected

from uncovered areas: borings 084SB007, 574SB005, and 574SB008 at 644 mg/kg, 700 mg/kg, and 506 mg/kg, respectively.

Since all but four soil sample locations are covered with either concrete or asphalt and their equated mean residential risk and HI are within USEPA's acceptable ranges, no further action is recommended for those soil locations. Further action is recommended for soil with no concrete or asphalt cover. Corrective measures are provided in Table 10.10.11.1.

Arsenic, iron, and manganese was identified in deep groundwater at concentrations equaling a risk above 1E-06 and/or HI above 1 (3.1E-05 and 1,505, respectively). Arsenic drives the HI. Arsenic and iron were identified in the shallow groundwater as COPCs. The equated risk ranges from < 1E-07 to 8E-06 with a arithmetic mean of 3E-06 and an HI range between 0.0 to 823 with an HI mean of 202. Arsenic drives the HI at monitoring wells NBCE083001, NBCE083002, and NBCE084002. No plume is apparent in the shallow groundwater. Human health risk is not a significant factor since groundwater is not a potable drinking water source. However, further assessment is needed to evaluate the natural attenuation process and potential discharge to surface water.

Potential corrective measures for the impacted media and respective COCs are in Table 10.10.11.1.

Table 10.10.11.1
Potential Corrective Measures for SWMUs 83 and 84 and AOC 574

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, lead, and benzo(a)pyrene	a) No Action b) Containment - Capping c) Ex-situ, Excavate and Offsite Disposal
Deep Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment
Shallow Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment

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10.11 SWMU 87, Less-than-90-Day Accumulation Area, Building 80; SWMU 172, Steam Cleaning Operations, Building 80; and AOC 564, Oil/Water Separator, Building 80

SWMU 87 consists of a former less-than-90-day accumulation area that was once a part of the Charleston Naval Shipyard hazardous waste management system. Located north of Building 80, the unit is a metal building with an asphalt foundation. Wastes were accumulated in closed, palletized 55-gallon drums and palletized plastic bags. The accumulation area was taken out of service in March 1994.

SWMU 172 consists of a steam cleaning area north of Building 80. Steam cleaning has been performed on various types of equipment including small engines, generators, and construction equipment. The unit consists of a concrete-paved area designed with curbing and sloping surfaces so all liquids drain into two storm drains. This unit is not enclosed or roofed.

AOC 564 consists of a 300-gallon oil-water separator (OWS) north of Building 80. Wastewater from machining and parts cleaning in Building 80 drains onto a sloped asphalt ramp which feeds into an exterior drain connected to the OWS. The OWS has been in operation for more than 25 years.

Materials of concern indicated in the *Final Zone E RFI Work Plan* at SWMU 87 include paint, mercury, anti-freeze, and petroleum hydrocarbons. Materials of concern for SWMU 172 and AOC 564 are petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill CSI objectives for SWMUs 87 and 172 and AOC 564, soil, groundwater, air, and sediment were sampled in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether contamination resulted from onsite activities.

10.11.1 Soil Sampling and Analysis

Soil was sampled in one round at SWMUs 87 and 172 and AOC 564 from the locations shown on Figure 10.11.1. The *Final Zone E RFI Work Plan* proposed collection of eight soil samples from the upper interval and eight from the lower interval. Soil samples were also collected at both intervals for the two shallow monitoring well locations proposed at this site.

All proposed samples were collected and submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and organotins. Two upper-interval samples selected as duplicates were analyzed at DQO Level IV for Appendix IX parameters which includes the suite of parameters proposed for the site, a more comprehensive list of VOCs and SVOCs, and herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.11.1.1 summarizes soil sampling at SWMU 87 and associated sites.

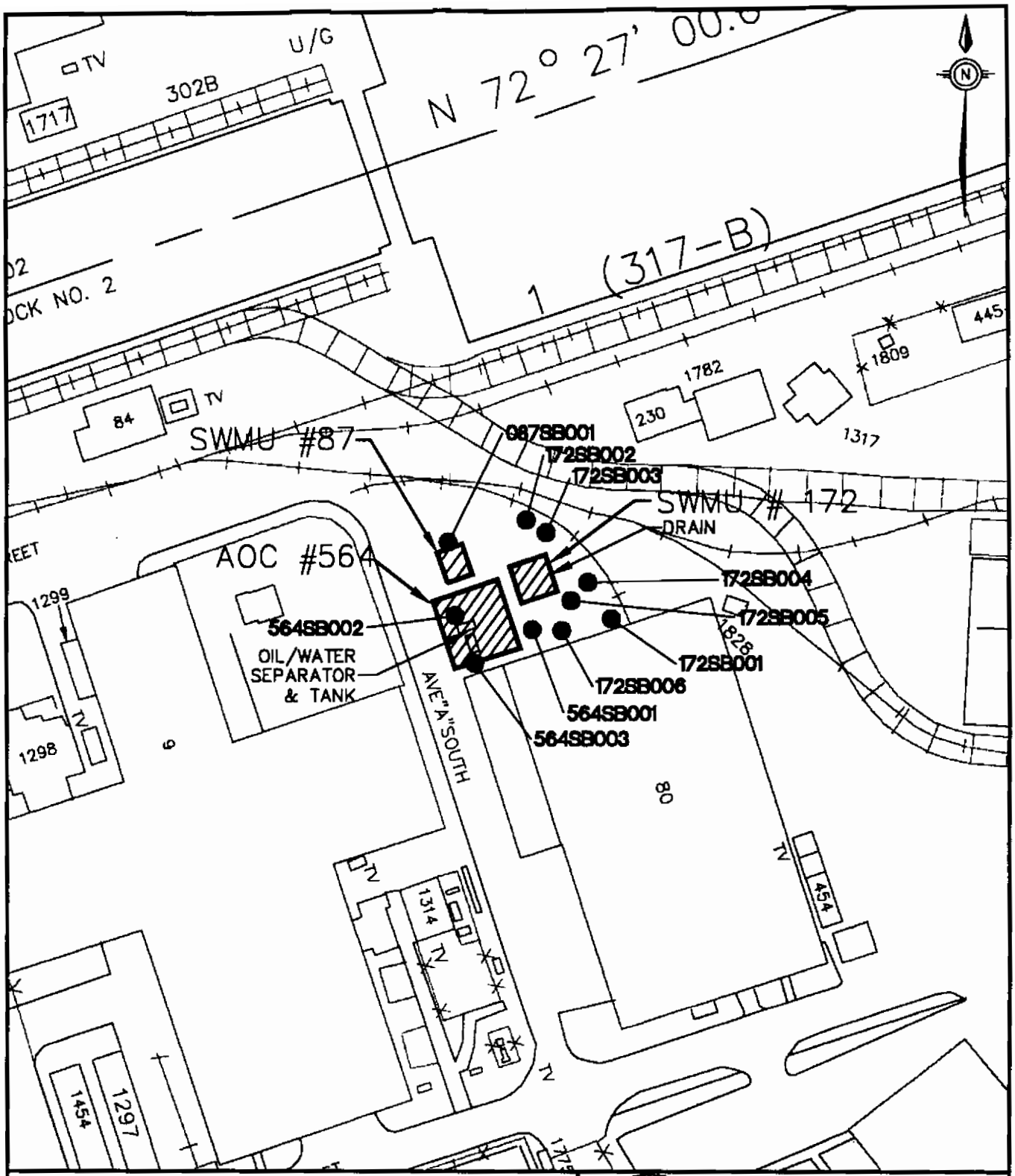
Table 10.11.1.1
SWMUs 87 and 172 and AOC 564
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	10	10	Standard Suite[a], organotins	Standard Suite[a], organotins	None
Lower	10	10	Standard Suite[a], organotins	Standard Suite[a], organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCB.

10.11.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.11.2.1. Inorganic analytical results for soil are summarized in Table 10.11.2.2. Appendix H contains the complete data report for all samples collected in Zone E.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.11.1
SOIL BORING LOCATIONS
SWMU#87,<90 DAY STORAGE AREA#11
SWMU #172, STEAM CLEANING OPER.
AOC #564, DISPOSAL PIT

DWG DATE: 09/02/97 | DWG NAME: 10-11-1

Table 10.11.2.1
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	8/10	10.0 - 300	123	20,000,000	0
	Lower	6/10	32.0 - 100	59.0	NA	NA
Bromodichloromethane	Upper	1/10	3.00	3.00	92,000	0
2-Butanone (MEK)	Lower	1/10	2.00	2.00	NA	NA
Chlorobenzene	Upper	1/10	130	130	4,100,000	0
	Lower	1/10	200	200	NA	NA
Chloroform	Upper	1/10	12.0	12.0	940,000	0
Chloromethane	Lower	2/10	3.00 - 7.00	5.00	NA	NA
1,1-Dichloroethane	Lower	1/10	43.0	43.0	NA	NA
1,2-Dichloroethene (total)	Upper	2/10	31.0 - 58.0	44.5	1,800,000	0
	Lower	1/10	100	100	NA	NA
Ethylbenzene	Upper	1/10	17.0	17.0	20,000,000	0
	Lower	1/10	4.00	4.00	NA	NA
Methylene chloride	Upper	6/10	2.00 - 18.0	9.50	760,000	0
Tetrachloroethene	Upper	1/10	520	520	110,000	0
Toluene	Upper	1/10	16.0	16.0	41,000,000	0
	Lower	1/10	6.00	6.00	NA	NA
Xylene (Total)	Upper	1/10	180	180	100,000,000	0
	Lower	1/10	26.0	26.0	NA	NA
SVOCs (μg/kg)						
Acenaphthene	Upper	1/10	120	120	12,000,000	0
Anthracene	Upper	1/10	60.0	60.0	61,000,000	0

Table 10.11.2.1
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Benzo(g,h,i)perylene	Upper	7/10	57.0 - 220	135	8,200,000	0
	Lower	1/10	59.0	59.0	NA	NA
4-Chloro-3-methylphenol	Upper	1/10	160	160	NA	NA
2-Chlorophenol	Upper	1/10	190	190	1,000,000	0
Dibenzofuran	Upper	1/10	120	120	820,000	0
1,2-Dichlorobenzene	Upper	2/10	120 - 3,500	1,810	18,000,000	0
	Lower	2/10	220 - 850	535	NA	NA
1,3-Dichlorobenzene	Lower	1/10	62.0	62.0	NA	NA
1,4-Dichlorobenzene	Lower	1/10	170	170	NA	NA
Di-n-octyl phthalate	Upper	1/10	54.0	54.0	4,100,000	0
Fluoranthene	Upper	8/10	56.0 - 680	265	8,200,000	0
	Lower	2/10	53.0 - 170	112	NA	NA
2-Methylnaphthalene	Upper	1/10	1,900	1,900	8,200,000	0
	Lower	1/10	47.0	47.0	NA	NA
Naphthalene	Upper	1/10	1,800	1,800	8,200,000	0
	Lower	1/10	220	220	NA	NA
Pentachlorophenol	Upper	1/10	69.0	69.0	48,000	0
Pyrene	Upper	8/10	50.0 - 610	259	6,100,000	0
	Lower	2/10	54.0 - 180	117	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	8/10	63.1 - 534	235	780	0
	Lower	3/10	4.30 - 240	120	NA	NA

Table 10.11.2.1
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
Benzo(a)anthracene	Upper	6/10	53.0 - 300	155	7,800	0
	Lower	1/10	92.0	92.0	NA	NA
Benzo(b)fluoranthene	Upper	5/10	58.0 - 330	182	7,800	0
	Lower	2/10	43.0 - 94.0	68.5	NA	NA
Benzo(k)fluoranthene	Upper	7/10	41.0 - 340	155	78,000	0
	Lower	1/10	69.0	69.0	NA	NA
Benzo(a)pyrene	Upper	8/10	62.0 - 370	163	780	0
	Lower	2/10	90.0 - 240	165	NA	NA
Chrysene	Upper	8/10	61.0 - 340	160	780,000	0
	Lower	1/10	97.0	97.0	NA	NA
Dibenz(a,h)anthracene	Upper	4/10	41.0 - 92.0	75.5	780	0
Indeno(1,2,3-cd)pyrene	Upper	6/10	48.0 - 200	124	7,800	0
	Lower	1/10	58.0	58.0	NA	NA
Pesticides (μg/kg)						
delta-BHC	Upper	1/10	4.83	4.83	910	0
alpha-Chlordane	Upper	2/10	3.22 - 48.8	26.0	4,400	0
gamma-Chlordane	Upper	2/10	3.25 - 55.5	29.4	4,400	0
4,4'-DDD	Upper	3/10	13.0 - 156	61.3	24,000	0
4,4'-DDE	Upper	3/10	8.70 - 664	238	17,000	0
4,4'-DDT	Upper	1/10	70.3	70.3	17,000	0
Dieldrin	Upper	1/10	290	290	360	0
Endrin	Upper	1/10	14.3	14.3	61,000	0
Endrin aldehyde	Upper	1/10	4.19	4.19	61,000	0

Table 10.11.2.1
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	2/2	0.101 - 1.45	0.774	1,000	0
1234678-HpCDD	Upper	2/2	2.12 - 41.9	22.0	NA	NA
1234678-HpCDF	Upper	1/2	12.2	12.2	NA	NA
123678-HxCDF	Upper	1/2	1.66	1.66	NA	NA
123789-HxCDF	Upper	1/2	0.612	0.612	NA	NA
OCDD	Upper	2/2	16.9 - 715	366	NA	NA
OCDF	Upper	2/2	1.45 - 24.8	13.1	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.11.2.2
SWMUs 87 and 172 and AOC 564
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	10/10	4,080 - 25,700	9,660	100,000	26,600	0
	Lower	10/10	2,090 - 11,900	6,970	NA	41,100	NA
Antimony (Sb)	Upper	2/10	0.750 - 5.10	2.93	82.0	1.77	0
Arsenic (As)	Upper	10/10	3.30 - 66.5	14.8	3.80	23.9	1
	Lower	10/10	1.60 - 7.50	4.15	NA	19.9	NA
Barium (Ba)	Upper	10/10	11.5 - 49.7	31.8	14,000	130	0
	Lower	10/10	11.0 - 29.5	18.1	NA	94.1	NA

Table 10.11.2.2
SWMUs 87 and 172 and AOC 564
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Beryllium (Be)	Upper	10/10	0.310 - 1.60	0.708	1.30	1.70	0
	Lower	10/10	0.290 - 0.780	0.430	NA	2.71	NA
Cadmium (Cd)	Upper	1/10	0.640	0.640	100	1.50	0
Calcium (Ca)	Upper	10/10	5,650 - 28,100	13,600	NA	NA	NA
	Lower	10/10	1,220 - 35,200	10,200	NA	NA	NA
Chromium (Cr)	Upper	10/10	10.2 - 143	47.8	1,000	94.6	0
	Lower	10/10	5.00 - 21.8	11.8	NA	75.2	NA
Cobalt (Co)	Upper	10/10	2.00 - 24.3	9.23	12,000	19.0	0
	Lower	10/10	1.40 - 3.60	2.16	NA	14.9	NA
Copper (Cu)	Upper	10/10	3.30 - 142	34.6	8,200	66.0	0
	Lower	10/10	1.20 - 9.20	3.89	NA	152	NA
Cyanide (CN)	Upper	8/10	0.340 - 1.000	0.594	4,100	0.500	0
	Lower	7/10	0.280 - 0.590	0.379	NA	NA	NA
Iron (Fe)	Upper	10/10	4,280 - 34,700	12,900	61,000	NA	0
	Lower	10/10	3,220 - 17,500	8,410	NA	NA	NA
Lead (Pb)	Upper	10/10	6.90 - 132	54.7	1,300	265	0
	Lower	10/10	2.20 - 54.8	15.3	NA	173	NA
Magnesium (Mg)	Upper	10/10	888 - 4,460	2,130	NA	NA	NA
	Lower	10/10	254 - 2,100	758	NA	NA	NA
Manganese (Mn)	Upper	10/10	46.2 - 495	190	4,700	302	0
	Lower	10/10	28.1 - 97.8	45.7	NA	881	NA
Mercury (Hg)	Upper	8/10	0.0300 - 0.620	0.296	61.0	2.60	0
	Lower	7/10	0.0300 - 0.150	0.0614	NA	1.59	NA
Nickel (Ni)	Upper	9/10	4.00 - 14.1	8.83	4,100	77.1	0
	Lower	9/10	2.20 - 7.30	4.52	NA	57.0	NA

Table 10.11.2.2
SWMUs 87 and 172 and AOC 564
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Potassium (K)	Upper	10/10	254 - 1,930	1,010	NA	NA	NA
	Lower	9/10	183 - 1,400	536	NA	NA	NA
Selenium (Se)	Upper	1/10	0.620	0.620	1,000	1.70	0
Silver (Ag)	Upper	2/10	2.00 - 2.20	2.10	1,000	NA	0
Sodium (Na)	Upper	10/10	236 - 1,750	536	NA	NA	NA
	Lower	10/10	245 - 456	302	NA	NA	NA
Thallium (Tl)	Upper	1/10	0.850	0.850	16.0	2.80	0
Tin (Sn)	Upper	10/10	2.80 - 10.1	4.99	100,000	59.4	0
	Lower	9/10	2.60 - 4.70	3.61	NA	9.23	NA
Vanadium (V)	Upper	10/10	7.60 - 78.5	27.7	1,400	94.3	0
	Lower	10/10	8.00 - 33.3	16.6	NA	155	NA
Zinc (Zn)	Upper	10/10	13.7 - 295	105	61,000	827	0
	Lower	10/10	7.20 - 31.8	15.6	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Thirteen VOCs were detected in soil samples collected at SWMUs 87 and 172 and AOC 564. Twenty-three detections occurred in the upper interval and 15 in the lower interval. No VOC exceeded its respective industrial RBC in the upper interval. However, one VOC — chloromethane — exceeded its respective SSL in the lower interval.

Chloromethane was detected in two of 10 lower-interval samples with a range of 3.0 to 7.0 μg/kg and a mean of 5.0 μg/kg. One lower-interval sample (564SB001, 7.0 μg/kg) exceeded the chloromethane SSL of 6.60 μg/kg.

Semivolatile Organic Compounds in Soil

Twenty-two SVOCs were detected in soil samples collected at SWMUs 87 and 172 and AOC 564. Seventy-seven detections occurred in the upper interval and 21 in the lower interval. No SVOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at SWMUs 87 and 172 and AOC 564. The upper-interval BEQ was calculated for eight samples with a range of 63.1 to 534 μg/kg and a mean of 235 μg/kg. The calculated BEQ did not exceed the benzo(a)pyrene industrial RBC of 780 μg/kg.

Pesticides and PCBs in Soil

Nine pesticides were detected in upper-interval soil samples collected at SWMUs 87 and 172 and AOC 564. No pesticide exceeded its respective industrial RBC in the upper interval and no pesticides were analyzed for in lower-interval samples.

No PCBs were detected in soil samples collected at SWMUs 87 and 172 and AOC 564.

Other Organic Compounds in Soil

Seven dioxins were detected in upper-interval soil samples collected at SWMUs 87 and 172 and AOC 564. No industrial RBCs have been established for the detected dioxins. Lower-interval samples were not analyzed for dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for the upper-interval samples. The TEQ was calculated for two samples with a range of 0.101 to 1.45 ng/kg and a mean of 0.774 ng/kg. The calculated TEQ did not exceed the industrial RBC of 1,000 ng/kg.

Inorganic Elements in Soil

Twenty-five metals were detected in soil samples collected at SWMUs 87 and 172 and AOC 564. Two hundred and two detections occurred in the upper interval and 191 in the lower interval. One metal — arsenic — exceeded both its respective industrial RBC and background RC in the upper interval. No metal exceeded both its respective SSL and background RC in the lower interval.

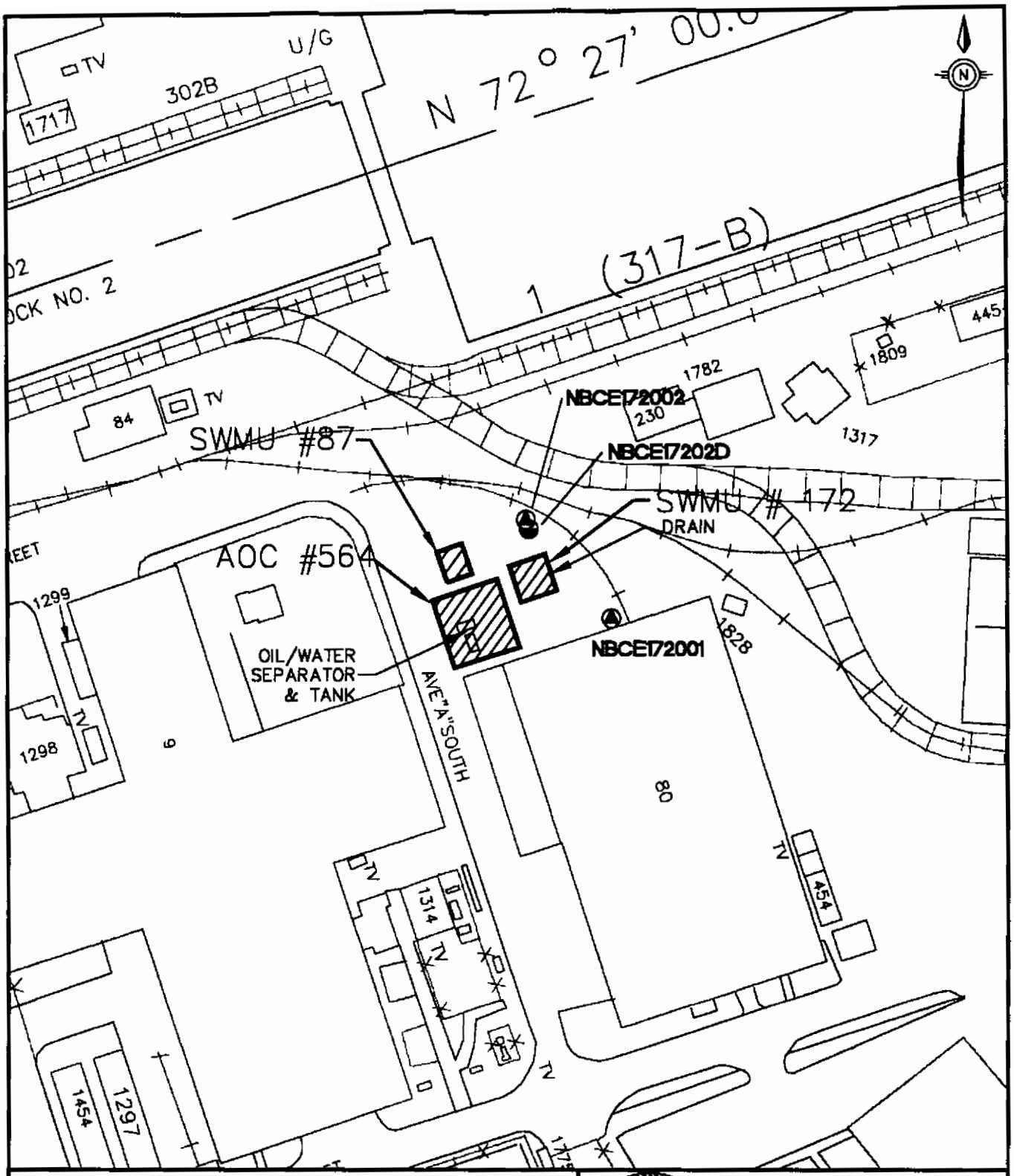
Arsenic was detected in 10 of 10 upper-interval samples with a range of 3.30 to 66.5 mg/kg and a mean of 14.8 mg/kg. One upper-interval sample (087SB001, 66.5 mg/kg) exceeded both the arsenic industrial RBC of 3.80 mg/kg and the arsenic background RC of 23.9 mg/kg.

10.11.3 Groundwater Sampling and Analysis

One deep monitoring well and two shallow monitoring wells were installed and sampled to assess groundwater quality at SWMUs 87 and 172 and AOC 564 as shown in Figure 10.11.2. The wells were installed as follows:

- Shallow Wells installed at SWMU 172 — NBCE172001 and NBCE172002
- Deep Well installed at SWMU 172 — NBCE17202D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. No samples were selected as duplicates at this site. Table 10.11.3.1 summarizes groundwater sampling and analysis at SWMUs 87 and 172 and AOC 564.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.11.2
MONITORING WELL LOCATIONS
SWMU#87,<90 DAY STORAGE AREA#11
SWMU #172, STEAM CLEANING OPER.
AOC #564, DISPOSAL PIT

DWG DATE: 09/02/97 | DWG NAME: 10-11-2

Table 10.11.3.1
SWMUs 87 and 172 and AOC 564
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2	2	Standard Suite[a], chlorides, TDS, sulfates, and organotins	Standard Suite[a], chlorides, sulfates, TDS, and organotins	None
Deep	1	1	Standard Suite[a], chlorides, TDS, sulfates, and organotins	Standard Suite[a], chlorides, sulfates, TDS, and organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs.

The shallow monitoring wells were installed at 13 feet bgs in the surficial aquifer. The deep well was installed at 28.4 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.3 of this report.

10.11.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow and deep groundwater are summarized in Tables 10.11.4.1 and 10.11.4.2, respectively. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.11.4.3 and 10.11.4.4, respectively. Appendix H contains the complete data report for all samples collected in Zone E.

Volatile Organic Compounds in Groundwater

Shallow Groundwater

Three VOCs were detected in shallow groundwater samples collected at SWMU 172 (no shallow wells were installed at SWMU 87 or AOC 564). Two VOCs — chlorobenzene and 1,2-dichloroethene (total) — exceeded their respective tap-water RBCs.

Table 10.11.4.1
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in First-Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
Chlorobenzene	1/2	110	110	3.90	NA	1
1,1-Dichloroethane	1/2	3.00	3.00	81.0	NA	0
1,2-Dichloroethene (total)	1/2	37.0	37.0	5.50	70.0	1
SVOCs						
bis(2-Ethylhexyl)phthalate	1/2	2.00	2.00	4.80	NA	0
1,2-Dichlorobenzene	1/2	10.0	10.0	27.0	600	0
1,3-Dichlorobenzene	1/2	2.00	2.00	54.0	600	0
1,4-Dichlorobenzene	1/2	6.00	6.00	0.440	75.0	1

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.11.4.2
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in First-Quarter Groundwater (μg/L)
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
1,2-Dichloroethene (total)	1/1	2.00	2.00	5.50	70.0	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level

Table 10.11.4.3
SWMUs 87 and 172 and AOC 564
Inorganic Detections for First-Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/2	1,010	1,010	3,700	2,810	NA	0
Arsenic (As)	1/2	5.10	5.10	0.0450	18.7	50.0	0
Barium (Ba)	1/2	18.9	18.9	260	211	2,000	0
Calcium (Ca)	1/2	49,500	49,500	NA	NA	NA	NA
Cobalt (Co)	1/2	16.8	16.8	220	2.5	NA	0
Copper (Cu)	1/2	2.00	2.00	150	2.7	1,300	0
Iron (Fe)	2/2	2,200 - 6,100	4,150	1,100	NA	NA	2
Magnesium (Mg)	2/2	6,680 - 11,700	9,190	NA	NA	NA	NA
Manganese (Mn)	2/2	88.0 - 261	175	84.0	2,560	NA	0
Nickel (Ni)	1/2	9.30	9.30	73.0	15.2	100	0
Potassium (K)	1/2	5,970	5,970	NA	NA	NA	NA
Sodium (Na)	2/2	128,000 - 452,000	290,000	NA	NA	NA	NA
Vanadium (V)	1/2	2.70	2.70	26.0	11.4	NA	0
Zinc (Zn)	1/2	44.4	44.4	1,100	27.3	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Table 10.11.4.4
SWMUs 87 and 172 and AOC 564
Inorganic Detections for First-Quarter Groundwater (μg/L)
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Arsenic (As)	1/1	18.5	18.5	0.0450	16.4	50.0	1
Calcium (Ca)	1/1	216,000	216,000	NA	NA	NA	NA
Cobalt (Co)	1/1	18.1	18.1	220	12.9	NA	0
Iron (Fe)	1/1	7,040	7,040	1,100	NA	NA	1
Magnesium (Mg)	1/1	30,500	30,500	NA	NA	NA	NA
Manganese (Mn)	1/1	1,240	1,240	84.0	869	NA	1
Nickel (Ni)	1/1	18.7	18.7	73.0	42.2	100	0
Sodium (Na)	1/1	408,000	408,000	NA	NA	NA	NA

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Chlorobenzene was detected in one of two samples in well NBCE172001 (110 μg/L), exceeding the chlorobenzene tap-water RBC of 3.90 μg/L. No MCL has been established for chlorobenzene.

1,2-Dichloroethene (total) was detected in one of two samples in well NBCE172001 (37.0 μg/L), exceeding the 1,2-dichloroethene (total) tap-water RBC of 5.50 μg/L. The detection was below the 1,2-dichloroethene MCL of 70 μg/L.

Deep Groundwater

One VOC — 1,2-dichloroethene (total) — was detected in the deep groundwater sample collected at SWMU 172 (no deep wells were installed at SWMU 87 or AOC 564). The SVOC did not exceed its respective tap-water RBC.

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

Four SVOCs were detected in shallow groundwater samples collected at SWMU 172. One SVOC — 1,4-dichlorobenzene — exceeded its tap water RBC.

1,4-dichlorobenzene was detected in one of two samples in well NBCE172001 (6.00 μg/L), exceeding its tap-water RBC of 4.80 μg/L. The detection did not exceed the 1,4-dichlorobenzene MCL of 75 μg/L.

Inorganic Elements in Groundwater

Shallow Groundwater

Fourteen metals were detected in shallow groundwater samples collected at SWMU 172. One metal — iron — exceeded its respective tap-water RBC.

Iron was detected in two of two samples with a range of 2,200 to 6,100 μg/L and a mean of 4,150 μg/L. Two samples from wells NBCE172001 (6,100 μg/L) and NBCE172002 (2,200 μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

Deep Groundwater

Eight metals were detected in the one deep groundwater sample collected at SWMU 172. Three metals — arsenic, iron, and manganese — exceeded both their respective tap-water RBC and background deep groundwater RC.

Arsenic was detected in well NBCE17202D (18.5 μg/L), exceeding both the arsenic tap-water RBC of 0.0450 μg/L and the arsenic deep groundwater RC of 16.4 μg/L. The sample did not exceed the arsenic MCL of 50 μg/L.

Iron was detected in well NBCE17202D (7,040 μg/L), exceeding the iron tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

Manganese was detected in well NBCE17292D (1,240 μg/L), exceeding both the manganese tap-water RBC of 84.0 μg/L and the manganese deep groundwater RC of 869 μg/L. No MCL has been established for manganese.

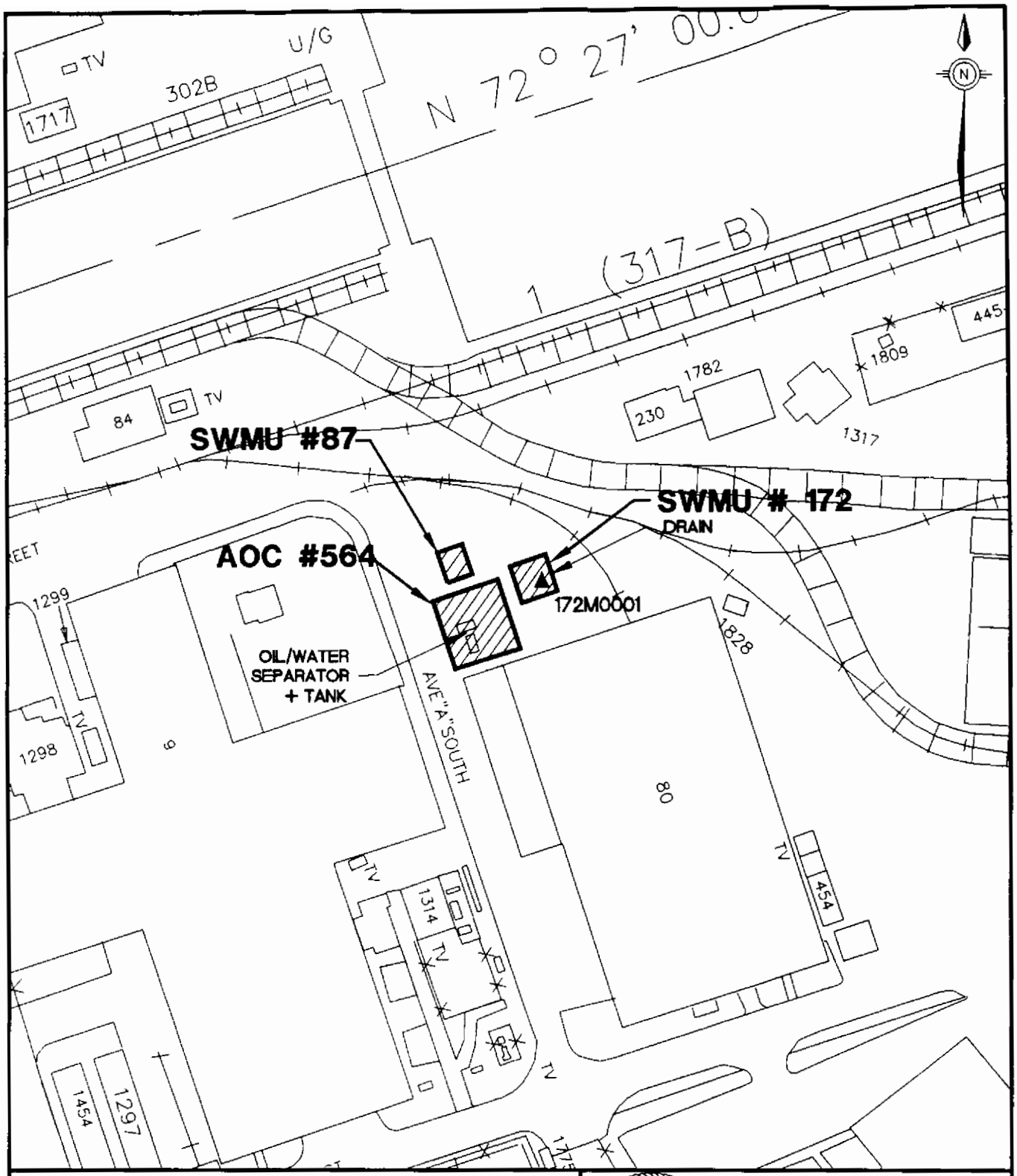
10.11.5 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed one sediment sample at SWMUs 87 and 172 and AOC 564 from the location shown in Figure 10.11.3. One sediment sample was collected and submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals and cyanide. No samples were selected as duplicates at this site. Table 10.11.5.1 summarizes sediment sampling and analysis at SWMUs 87 and 172 and AOC 564.

Table 10.11.5.1
SWMUs 87 and 172 and AOC 564
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
1	1	Standard Suite[a] and organotins	Standard Suite[a] and organotins	Metals analysis inadvertently left out of requested sample analysis

Note:
a = Standard suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.11.3
SEDIMENT SAMPLE LOCATIONS
SWMU#87,<90 DAY STORAGE AREA#11
SWMU #172, STEAM CLEANING OPER.
AOC #564, DISPOSAL PIT

DWG DATE: 09/02/97 | DWG NAME: 10-11-3

10.11.6 Nature of Contamination in Sediment

Table 10.11.6.1 summarizes the organic analytical results for sediment. Table 10.11.6.2 summarizes the inorganic analytical results for sediment. Appendix H contains the complete analytical report for all samples collected in Zone E.

Table 10.11.6.1
SWMUs 87 and 172 and AOC 564
Organic Compounds Detected in Sediment (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Ethylbenzene	Upper	1/1	2.00	2.00	20,000	0
Xylene (Total)	Upper	1/1	19.0	19.0	100,000	0
SVOCs						
bis(2-Ethylhexyl)phthalate	Upper	1/1	12,000	12,000	410,000	0
Butylbenzylphthalate	Upper	1/1	5,200	5,200	410,000	0
Di-n-butylphthalate	Upper	1/1	8,200	8,200	NA	NA
2-Methylnaphthalene	Upper	1/1	6,800	6,800	8,200,000	0
Pesticides						
4,4'-DDE	Upper	1/1	26.1	26.1	17,000	0
Endrin aldehyde	Upper	1/1	35.3	35.3	61,000	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial soil RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS sediment screening values.

Table 10.11.6.2
SWMUs 87 and 172 and AOC 574
Inorganic Detections in Sediment (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Cyanide (CN)	Upper	1/1	0.450	0.450	41,000	0

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS sediment screening values.

Volatile Organic Compounds in Sediment

Two VOCs were detected in the one sediment sample collected at SWMUs 87 and 172 and AOC 564. Neither VOC exceeded its respective industrial soil RBC.

Semivolatile Organic Compounds in Sediment

Four SVOCs were detected in the one sediment sample collected at SWMUs 87 and 172 and AOC 564. No SVOCs exceeded their respective industrial soil RBCs.

Pesticides and PCBs in Sediment

Two pesticides were detected in the one sediment sample collected at SWMUs 87 and 172 and AOC 564. Neither pesticide exceeded its respective industrial soil RBC.

No PCBs were detected in the one sediment sample collected at SWMUs 87 and 172 and AOC 564.

Other Organic Compounds in Sediment

No other organic compounds were detected in the one sediment sample collected at SWMUs 87 and 172 and AOC 564.

Inorganic Elements in Sediment

One metal — cyanide — was detected in the one sediment sample collected at SWMUs 87 and 172 and AOC 564. The detected concentration did not exceed the industrial soil RBC for cyanide.

10.11.7 Air Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting random air samples at SWMU 87 with a mercury vapor analyzer. Both the number and location of screening samples were to be determined in the field. It was determined that the area associated with SWMU 87 is currently an asphalt lot, therefore mercury vapor analysis was deemed unnecessary. Table 10.11.7.1 summarizes air sampling activity for SWMU 87.

Table 10.11.7.1
SWMU 87
Air Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
TBD	0	Mercury Vapor	Mercury Vapor	No samples collected.

10.11.8 Nature of Contamination in Air

No air samples were collected.

10.11.9 Fate and Transport Assessment for SWMUs 87 and 172 and AOC 564

Combined SWMU 87 is located north of Building 80 and comprises SWMU 87, SWMU 172, and AOC 564. SWMU 87 is a former less-than-90-day accumulation area consisting of a metal building with an asphalt foundation. SWMU 172 is a steam cleaning area consisting of a concrete-paved area designed with curbing and sloping surfaces so all liquids drain into two storm drains. AOC 564 is a 300-gallon oil-water separator (OWS). Wastewater from machining and parts cleaning in Building 80 drains onto a sloped asphalt ramp which feeds into an exterior drain

connected to the OWS. Environmental media sampled as part of the combined SWMU 87 RFI include surface soil, subsurface soil, sediment, and shallow and deep groundwater. Potential constituent migration pathways investigated for combined SWMU 87 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of volatiles from surface soil-to-air.

10.11.9.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.11.9.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) background RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Six organic constituents (delta-BHC, chloromethane, dieldrin, methylene chloride, pentachlorophenol, and tetrachloroethene) were detected in combined SWMU 87 soil above groundwater protection SSLs. None of these organic constituents was detected in first-quarter groundwater samples. Dieldrin, delta-BHC, pentachlorophenol, and tetrachloroethene were each detected in only one surface soil sample at concentrations above their respective generic SSLs. Methylene chloride was detected in only two surface soil samples at concentrations above its generic SSL. Chloromethane was detected in only one subsurface soil sample at a concentration above its generic SSL. Four inorganic constituents (antimony, arsenic, chromium, and cobalt) were detected in surface soil above their respective groundwater protection SSLs or background reference values; there were no exceedances in subsurface samples. Antimony and arsenic were each detected in only one surface soil sample at concentrations exceeding their respective screening levels. Chromium and cobalt were each detected in only two surface soil samples at concentrations exceeding their respective screening levels. Of the four inorganic constituents exceeding SSLs, only arsenic and cobalt were also detected in first-quarter groundwater samples.

Arsenic was not detected at a concentration above its background reference value and cobalt was not detected at a concentration above its tap water RBC.

10.11.9.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.11.9.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to RBCs 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 RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Two organic constituents (chlorobenzene and 1,4-dichlorobenzene) were detected in combined SWMU 87 shallow groundwater above tap water RBCs. Each of these organic constituents was detected at a concentration above its respective tap water RBC in all four quarters of groundwater samples collected from shallow monitoring well NBCE172001. No inorganic constituents were detected in groundwater (shallow or deep) above their respective tap water RBCs or background reference values.

10.11.9.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.11.9.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of

leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined SWMU 87 is 95,800:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.11.9.4 Surface Soil-to-Sediment Cross-Media Transport

Tables 10.11.6.1 and 10.11.6.2 summarize the constituent concentrations detected in sediment samples at combined SWMU 87. Ethylbenzene, 4,4'-DDE, endrin aldehyde, 2-methylnaphthalene, and xylene were detected in both surface soil and sediment samples. This relationship implies either that surface soil is a potential source of these constituents in catch basin sediment, or that both surface soil and catch basin sediment received these constituents from the same site source. Fate and transport for constituents detected in sediments from catch basins will be examined in the Zone L RFI report; fate and transport for constituents in sediments collected from surface water bodies will be discussed in the RFI report for Zone J.

10.11.9.5 Soil-to-Air Cross-Media Transport

Table 10.11.9.3 lists the VOCs detected in surface soil samples collected at combined SWMU 87 along with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at combined SWMU 87. 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 expected to be significant at combined SWMU 87.

10.11.9.6 Fate and Transport Summary

In the first-tier screen, two metals (arsenic and cobalt) detected above their background RCs in surface soil (but not subsurface soil) were also detected in groundwater samples. Arsenic and cobalt exceeded their respective background reference values in only one surface soil sample each, indicating that overall site concentrations were similar to background. Except for arsenic in deep groundwater, subsequent quarterly groundwater sampling results were generally consistent with first-quarter results. Although below background in the first-quarter sample, arsenic was detected at concentrations above its background reference value in second, third, and fourth-quarter samples collected from monitoring well NBCE17202D.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.11.9.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMUs 87 and 172 and AOC 564
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	300	100	ND	ND	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Bromodichloromethane	3	ND	ND	ND	300	0.17	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	2	ND	ND	ND	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	130	200	110	ND	350	39	105	UG/KG	UG/L	NO	YES	YES
Chloroform	12	ND	ND	ND	300	0.15	815	UG/KG	UG/L	NO	NO	NO
Chloromethane	ND	7	ND	ND	3.3	1.4	NA	UG/KG	UG/L	YES	NO	NO
1,1-Dichloroethane	ND	43	3	ND	11500	810	NA	UG/KG	UG/L	NO	NO	NO
1,2-Dichloroethene (total)	58	100	37	2	200	55	NA	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	17	4	ND	ND	6500	1300	4.3	UG/KG	UG/L	NO	NO	NO
Methylene chloride	18	ND	ND	ND	10	4.1	2560	UG/KG	UG/L	YES	NO	NO
Tetrachloroethene	520	ND	ND	ND	30	1.1	45	UG/KG	UG/L	YES	NO	NO
Toluene	16	6	ND	ND	6000	750	37	UG/KG	UG/L	NO	NO	NO
Xylene (total)	180	26	ND	ND	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	300	100	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	60	ND	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	220	59	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	300	92	ND	ND	800	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	370	240	ND	ND	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	330	94	ND	ND	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	340	69	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	340	97	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	92	ND	ND	ND	800	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	200	58	ND	ND	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
4-Chloro-3-methylphenol	160	ND	ND	ND	180	180	NA	UG/KG	UG/L	NO	NO	NO
2-Chlorophenol	190	ND	ND	ND	2000	180	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	120	ND	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
1,2-Dichlorobenzene	3500	850	10	ND	8500	270	19.7	UG/KG	UG/L	NO	NO	NO
1,3-Dichlorobenzene	62	ND	2	ND	3000	540	28.5	UG/KG	UG/L	NO	NO	NO
1,4-Dichlorobenzene	170	ND	6	ND	1000	0.44	19.9	UG/KG	UG/L	NO	YES	NO
Di-n-octylphthalate	54	ND	ND	ND	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	ND	ND	2	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	680	170	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	1900	47	ND	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	1800	220	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	69	ND	ND	ND	15	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Pyrene	610	180	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
delta-BHC	4.83	ND	ND	ND	1.5	0.037	NA	UG/KG	UG/L	YES	NO	NO
alpha-Chlordane	48.8	ND	ND	ND	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	55.5	ND	ND	ND	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	156	ND	ND	ND	8000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	664	ND	ND	ND	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	70.3	ND	ND	ND	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Dieldrin	290	ND	ND	ND	2	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO
Endrin	14.3	ND	ND	ND	500	11	0.0023	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	4.19	ND	ND	ND	500	11	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	1.45	ND	ND	ND	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	25700	11900	1010	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO

Table 10.11.9.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMUs 87 and 172 and AOC 564
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Antimony	5.1	ND	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	66.5	7.5	5.1	18.5	23.9	18.7	36	MG/KG	UG/L	YES	NO	NO
Barium	49.7	29.5	18.9	ND	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1.6	0.78	ND	ND	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.64	ND	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	143	21.8	ND	ND	94.6	37000	103	MG/KG	UG/L	YES	NO	NO
Cobalt	24.3	3.6	16.8	18.1	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	142	9.2	2	ND	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	1	0.59	ND	ND	20	730	37.3	MG/KG	UG/L	NO	NO	NO
Lead	132	54.8	ND	ND	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	495	97.8	261	1240	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.62	0.15	ND	ND	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	14.1	7.3	9.3	18.7	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.62	ND	ND	ND	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	2.2	ND	ND	ND	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	0.85	ND	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	10.1	4.7	ND	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	78.5	33.3	2.7	ND	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	295	31.8	44.4	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.11.9.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMUs 87 and 172 and AOC 564
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Volatile Organic Compounds																
Chlorobenzene	130	200	110	ND	350	39	105	39	3.74E+06	100	3.74E+04	1.31E+06	UG/KG	UG/L	NO	NO
Chloromethane	ND	7	ND	ND	3.3	1.4	NA	1.4	1.34E+05	1.4	9.58E+04	3.16E+04	UG/KG	UG/L	NO	NO
Methylene chloride	18	ND	ND	ND	10	4.1	2560	4.1	3.93E+05	5	7.86E+04	7.86E+04	UG/KG	UG/L	NO	NO
Tetrachloroethene	520	ND	ND	ND	30	1.1	45	1.1	1.05E+05	5	2.11E+04	6.32E+04	UG/KG	UG/L	NO	NO
Semivolatile Organic Compounds																
1,4-Dichlorobenzene	170	ND	6	ND	1000	0.44	19.9	0.44	4.22E+04	75	5.62E+02	5.62E+04	UG/KG	UG/L	NO	NO
Pentachlorophenol	69	ND	ND	ND	15	0.56	7.9	0.56	5.36E+04	1	5.36E+04	8.05E+04	UG/KG	UG/L	NO	NO
Pesticides/PCB Compounds																
delta-BHC	4.83	ND	ND	ND	1.5	0.037	NA	0.037	3.54E+03	0.05	7.09E+04	1.06E+04	UG/KG	UG/L	NO	NO
Dieldrin	290	ND	ND	ND	2	0.0042	0.0019	0.0019	1.82E+02	0.005	3.64E+04	7.28E+03	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	5.1	ND	ND	ND	2.5	15	NA	15	1.44E+06	6	2.40E+05	5.99E+04	MG/KG	UG/L	NO	NO
Arsenic	66.5	7.5	5.1	18.5	14.6	0.045	36	0.045	4.31E+03	50	8.62E+01	1.26E+02	MG/KG	UG/L	NO	NO
Chromium (total)	143	21.8	ND	ND	19	180	50	50	4.79E+06	100	4.79E+04	9.10E+04	MG/KG	UG/L	NO	NO
Cobalt	24.3	3.6	16.8	18.1	1040	2200	NA	2200	2.11E+08	2200	9.58E+04	1.00E+06	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 95,800: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.11.9.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMUs 87 and 172 and AOC 564
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	300	62000000	UG/KG	NO
Bromodichloromethane	3	1800000	UG/KG	NO
2-Butanone (MEK)	2	10000	UG/KG	NO
Chlorobenzene	130	94000	UG/KG	NO
Chloroform	12	200	UG/KG	NO
1,2-Dichloroethene (total)	58	1500000	UG/KG	NO
Ethylbenzene	17	260000	UG/KG	NO
Methylene chloride	18	7000	UG/KG	NO
Tetrachloroethene	520	11000	UG/KG	NO
Toluene	16	520000	UG/KG	NO
Xylene (total)	180	320000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996. The value for 2-Butanone (MEK) was estimated.

10.11.10 Fixed-Point Risk Evaluation for SWMUs 87 and 172 and AOC 564

10.11.10.1 Site Background and Investigative Approach

SWMU 87 is a former less-than-90-day accumulation area (Building 80), which was used to store hazardous waste until 1994. SWMU 172 is the old steam cleaning operations area (Building 80). AOC 564 consists of a 300-gallon oil/water separator (Building 80). The following refers to these sites as combined SWMU 87. All are located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3. Due to their proximity, the investigational effort for these sites was combined. As a result, the risk evaluation will combine the environmental data from all three sites.

A total of ten surface soil samples were considered in the combined SWMU 87 FRE. One was collected from SWMU 87, six were collected from SWMU 172, and three were collected from AOC 564. Two shallow monitoring wells and one deep monitoring well were installed as part of the 1995 RFI. Surface soil and groundwater data generated from the first-quarter RFI sampling event are used to represent point risk/hazard for the combined SWMU 87 FRE. Sections 10.11.1 and 10.11.3 contain summaries of the sampling effort for combined SWMU 87 soil and groundwater.

10.11.10.2 Fixed-Point Risk Evaluation for Soil

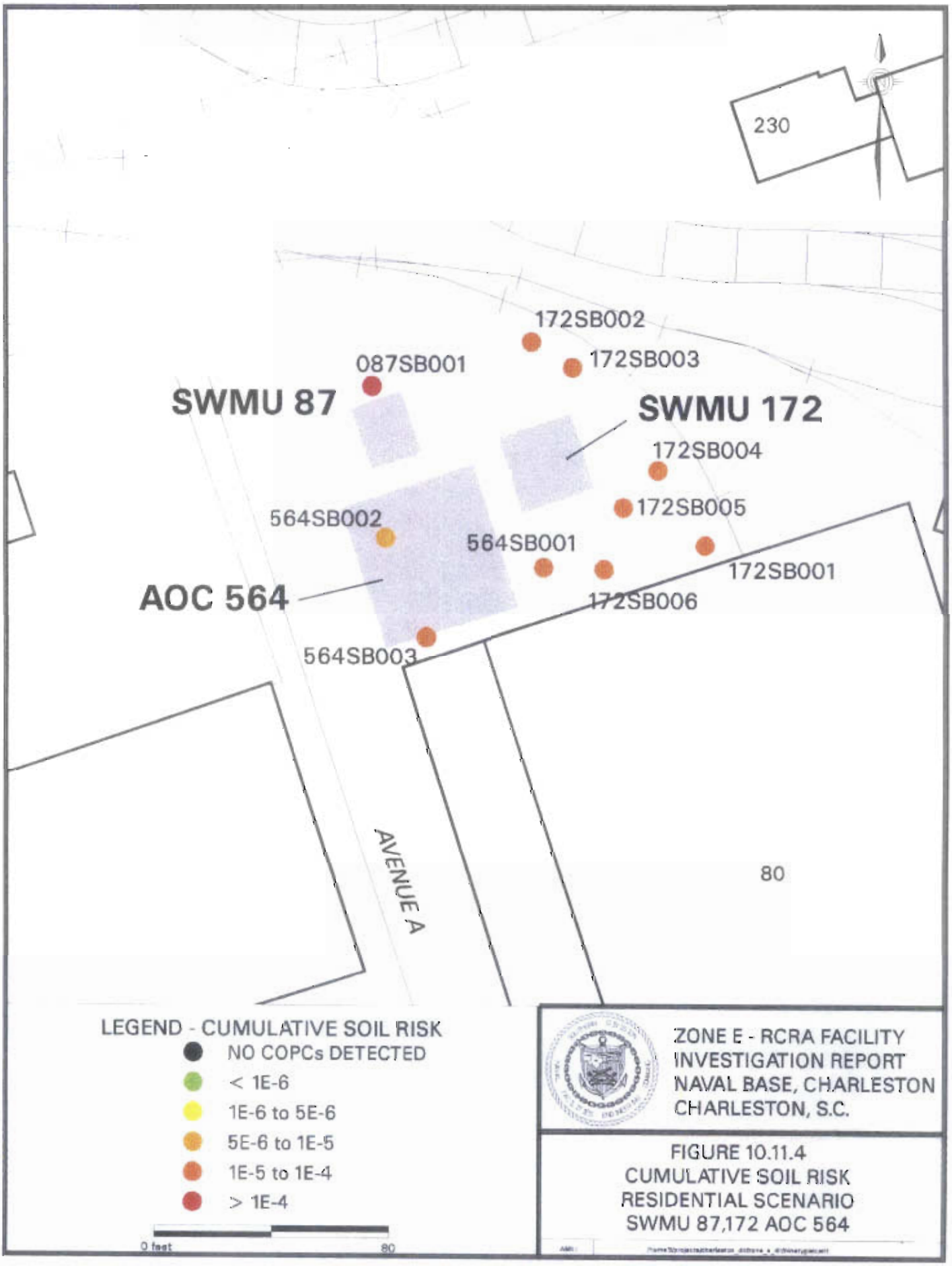
Residential Scenario

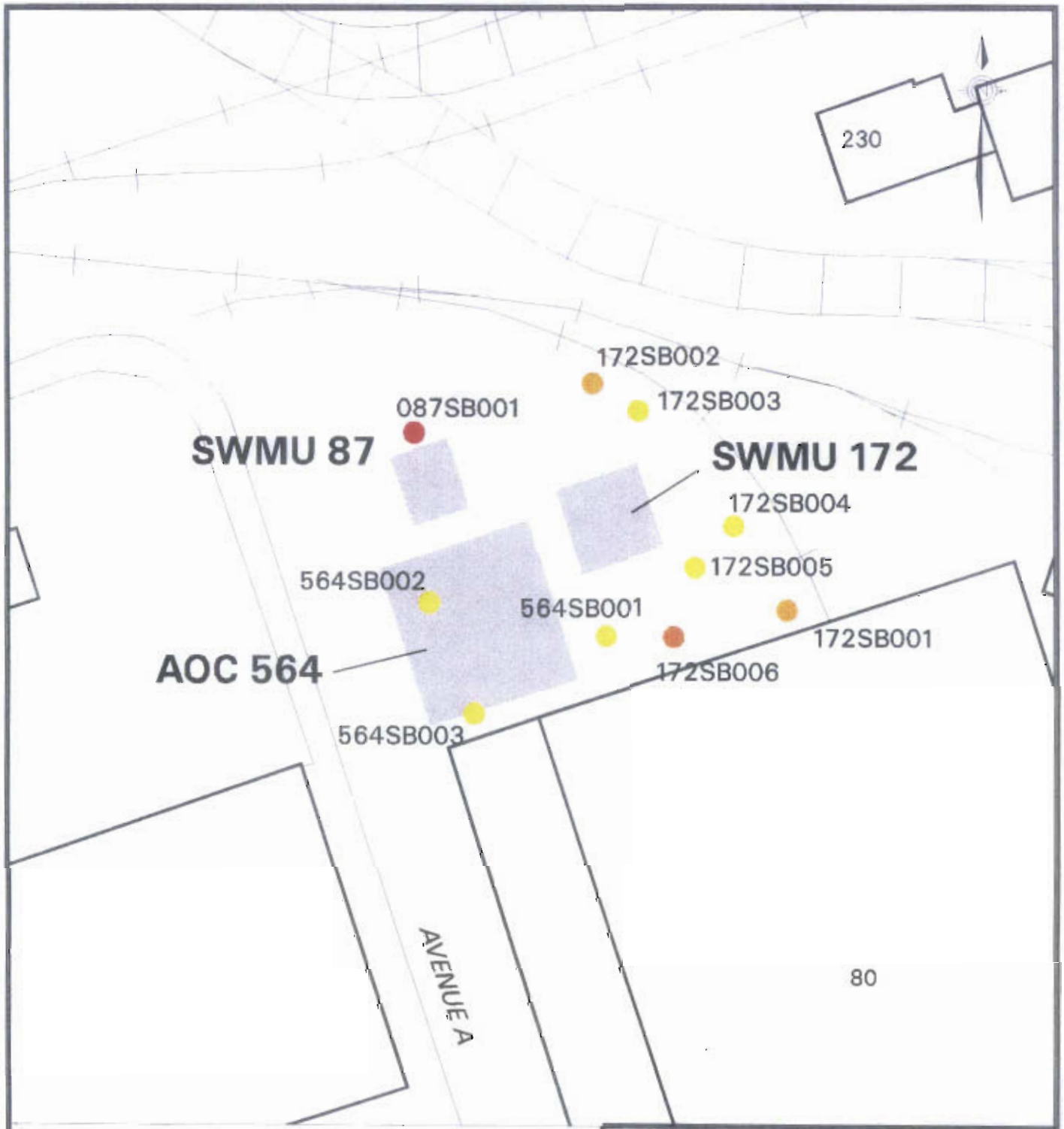
Table 10.11.10.1 provides CPSS summaries for combined SWMU 87 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Based on residential RBCs, six COPCs (antimony, arsenic, BEQs, chromium, manganese, and dieldrin) were identified for combined SWMU 87 soil. Chromium, which predominantly exists in either the trivalent or hexavalent state, was identified as a COPC based on a conservative comparison of the maximum concentration (regardless of valence) to the RBC for its hexavalent species (39 mg/kg). Analyses for hexavalent chromium in soil indicate that the trivalent valence state predominates for

combined SWMU 87 surface soil. The RBC for trivalent chromium is 7,800 mg/kg. Since it is evident that combined SWMU 87 soil chromium exists predominantly in the less toxic trivalent state, chromium was eliminated as a COPC. Aluminum, beryllium, thallium, and vanadium were detected in combined SWMU 87 soil at concentrations above their residential RBCs, but were eliminated from consideration in the residential FRE 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 based on background concentration.

Table 10.11.10.2 summarizes the residential COPCs detected at each combined SWMU 87 sample location, with contribution to risk and hazard. As shown, arsenic is the primary contributor to risk for combined SWMU 87, exceeding 1E-06 at all ten locations, and contributing to approximately 85-90% of the cumulative risk at each of these locations. However, arsenic was reported at a concentration greater than its corresponding RC at only one sampling location (NBCE87SB001). BEQs and dieldrin were secondary contributors to risk at combined SWMU 87. BEQ concentrations exceeded 1E-06 at eight of ten locations, while dieldrin exceeded 1E-06 at one location (NBCE087SB001). Figure 10.11.4 is a spatial presentation of residential risk estimates for combined SWMU 87 soil. For samples with concentrations of carcinogenic COPCs, risk estimates range from 1E-05 to 2E-04 with an arithmetic mean risk of 4E-05.

HI projections exceeded the threshold of unity at 087B001 and 172B006. HI estimates range from 0.2 to 3. Arsenic was the primary contributor to hazard, contributing more than 80% to the cumulative HI at each sampling location. Other contributors to the HI at combined SWMU 87 include antimony, dieldrin, and manganese. However, none individually exceeded the target HI of 1.0 at any sample location. Figure 10.11.5 is a spatial presentation of residential HI estimates for combined SWMU 87.


230
172SB002
172SB003
087SB001
SWMU 87
SWMU 172
172SB004
172SB005
564SB002
564SB001
172SB001
AOC 564
172SB006
564SB003
AVENUE A
80
LEGEND - CUMULATIVE SOIL RISK
NO COPCs DETECTED
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
80
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.11.4
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
SWMU 87,172 AOC 564



LEGEND - CUMULATIVE SOIL HAZARD

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

0 feet 80

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

FIGURE 10.11.5
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
SWMU 87,172 AOC 564

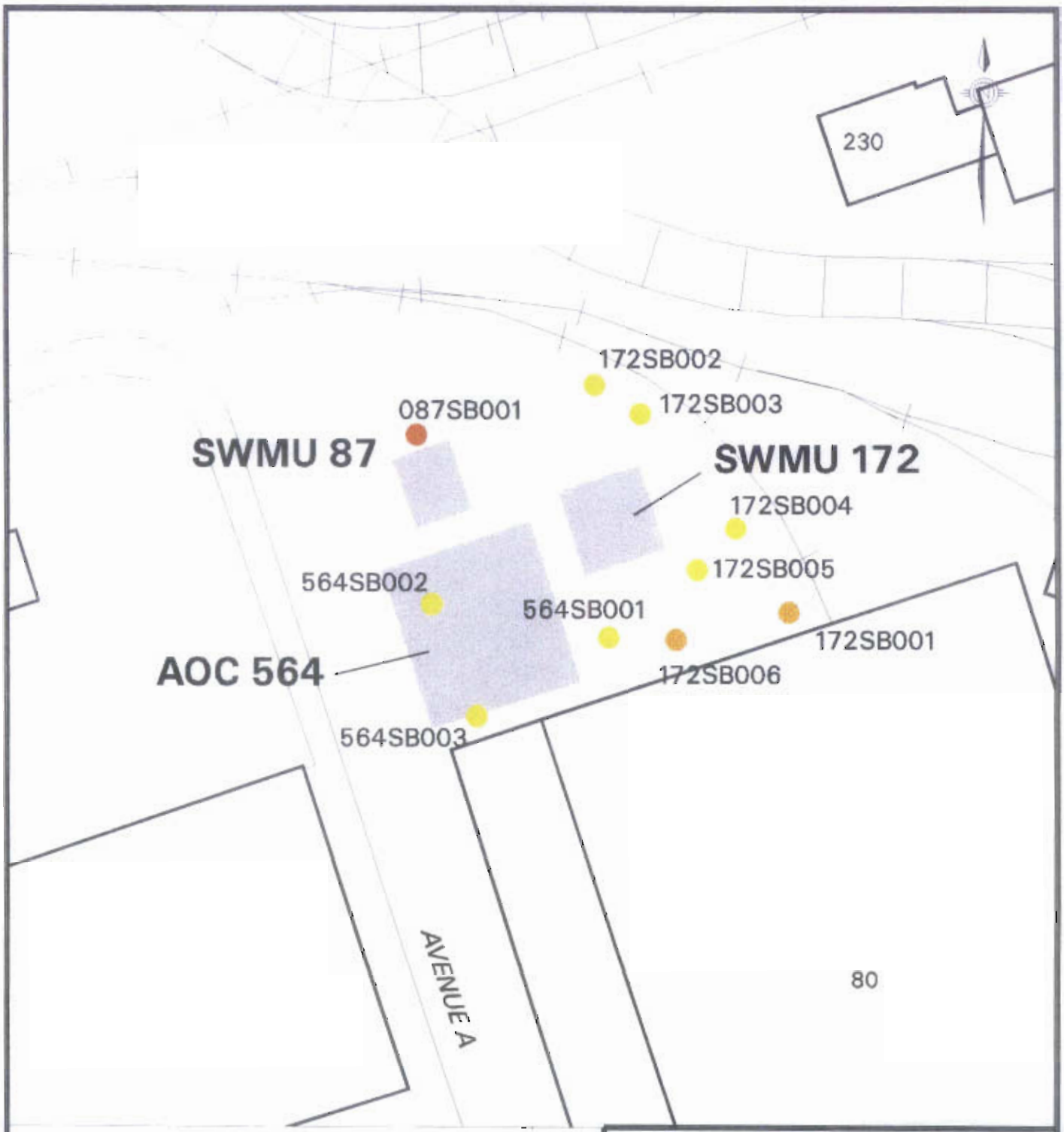
Industrial Scenario

Based on industrial RBCs, arsenic was identified as a COPC for combined SWMU 87 soil. Table 10.11.10.3 summarizes the industrial COPCs detected at each combined SWMU 87 sample location with contribution to risk and hazard, which for arsenic was 100%. Carcinogenic risk estimations exceeded 1E-06 at all ten sample locations, and ranged from 1E-06 to 2E-05. The HI for arsenic did not exceed the threshold of unity at any of the sample locations. Figure 10.11.6 is a spatial presentation of risk estimates for the site worker scenario for combined SWMU 87.

10.11.10.3 Fixed-Point Risk Evaluation for Groundwater

Residential Scenario

Table 10.11.10.4 provides CPSS summaries for combined SWMU 87 groundwater and identifies COPCs. Arsenic and manganese were identified as groundwater COPCs in the sample collected from the deep well (NBCE17202D); and 1,4-dichlorobenzene, 1,2-dichloroethene (total), and chlorobenzene were identified as groundwater COPCs in the shallow aquifer. COPC identification was based on comparison of first-quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. Arsenic and manganese were detected in combined SWMU 87 shallow groundwater at concentrations above their RBCs, but were eliminated from consideration in the FRE for shallow groundwater, based on comparison to their background concentrations. The maximum concentration of neither arsenic nor manganese reported in the deep well samples exceeded corresponding shallow aquifer RCs. Because there is no physical distinction between the two units, it is possible that deep well results are representative of natural conditions. Combined SWMU 87 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses, and as a result, arsenic and manganese were eliminated from the shallow groundwater FRE based on direct comparison of their maximum concentrations to their background RCs.



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 80

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

FIGURE 10.11.6
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
SWMU 87,172 AOC 564

Table 10.11.10.5 summarizes the COPCs identified in combined SWMU 87 monitoring wells sampled during the first-quarter. Risk projections above 1E-06 were associated with the arsenic concentration in the groundwater sample collected from monitoring well NBCE17202D; and with the concentration of 1,4-dichlorobenzene in the groundwater sample collected from well NBCE172001. Risk estimations were approximately 4E-4 for arsenic, and 4E-6 for 1,4-dichlorobenzene, respectively. Monitoring well 172G002 had no carcinogenic COPCs detected in the first-quarter groundwater sample. The arithmetic mean was calculated assuming a deminimus risk level of 1E-07 for locations were no carcinogenic COPCs were detected, and yielded a result of 1E-04. Figure 10.11.7 illustrates the groundwater data as a function of point-specific risk projections.

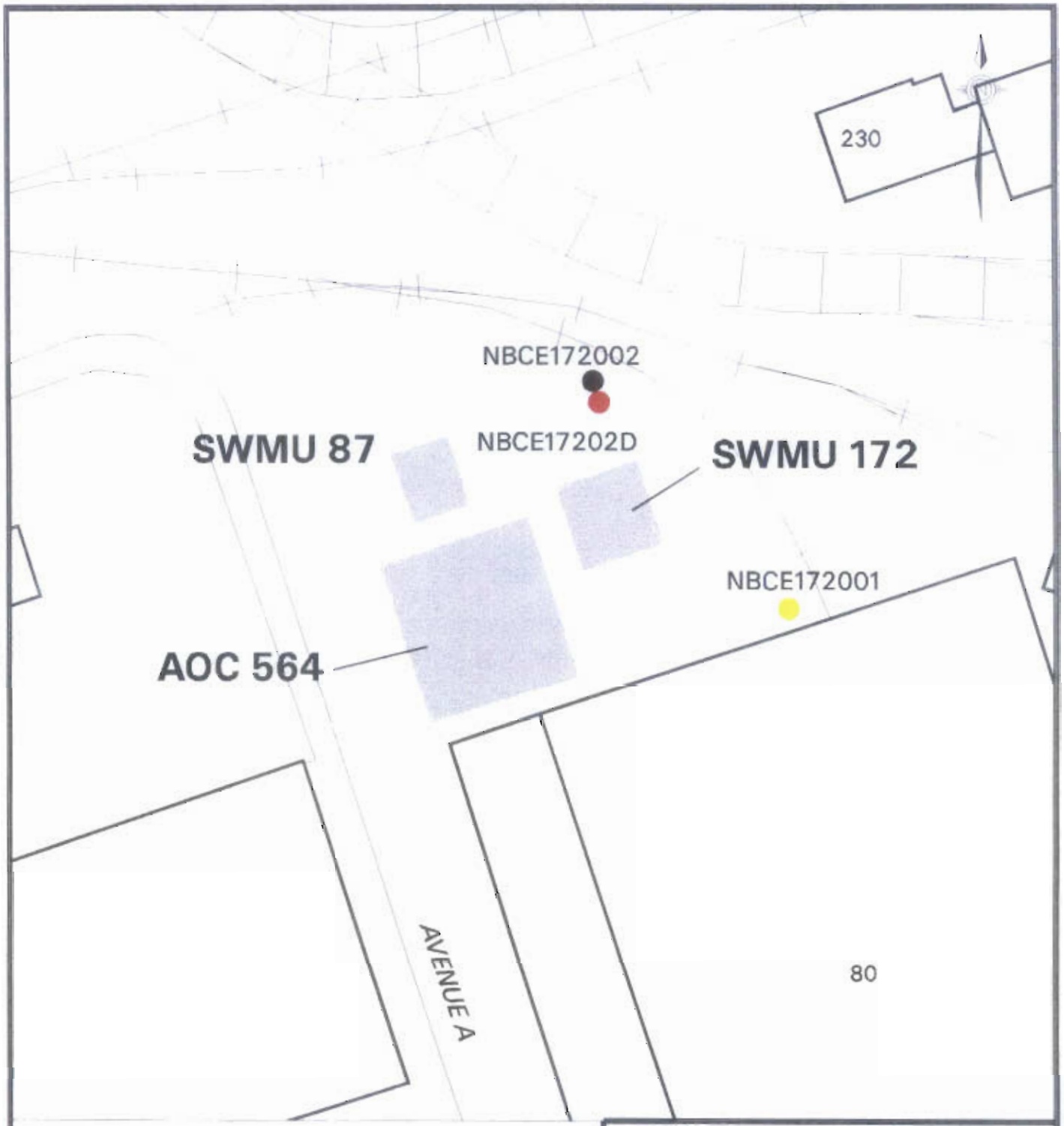
Monitoring wells NBCE17202D and NBCE172001 produced results corresponding with HIs above unity, as well. Arsenic and manganese were the sole contributors to HI projections for the sample collected from the deep well, while 1,2-dichloroethene (total) and chlorobenzene contributed to the hazard in the shallow aquifer. HIs ranged from 2 (NBCE172001) to 7 (NBCE17202D). The arithmetic mean HI for combined SWMU 87 is 3. The arithmetic mean was calculated assuming a deminimus hazard level of 0.01 for locations were no noncarcinogenic COPCs were detected. Figure 10.11.8 illustrates the groundwater data as a function of point-specific hazard projections.

10.11.10.4 Uncertainty

SWMU 87 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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



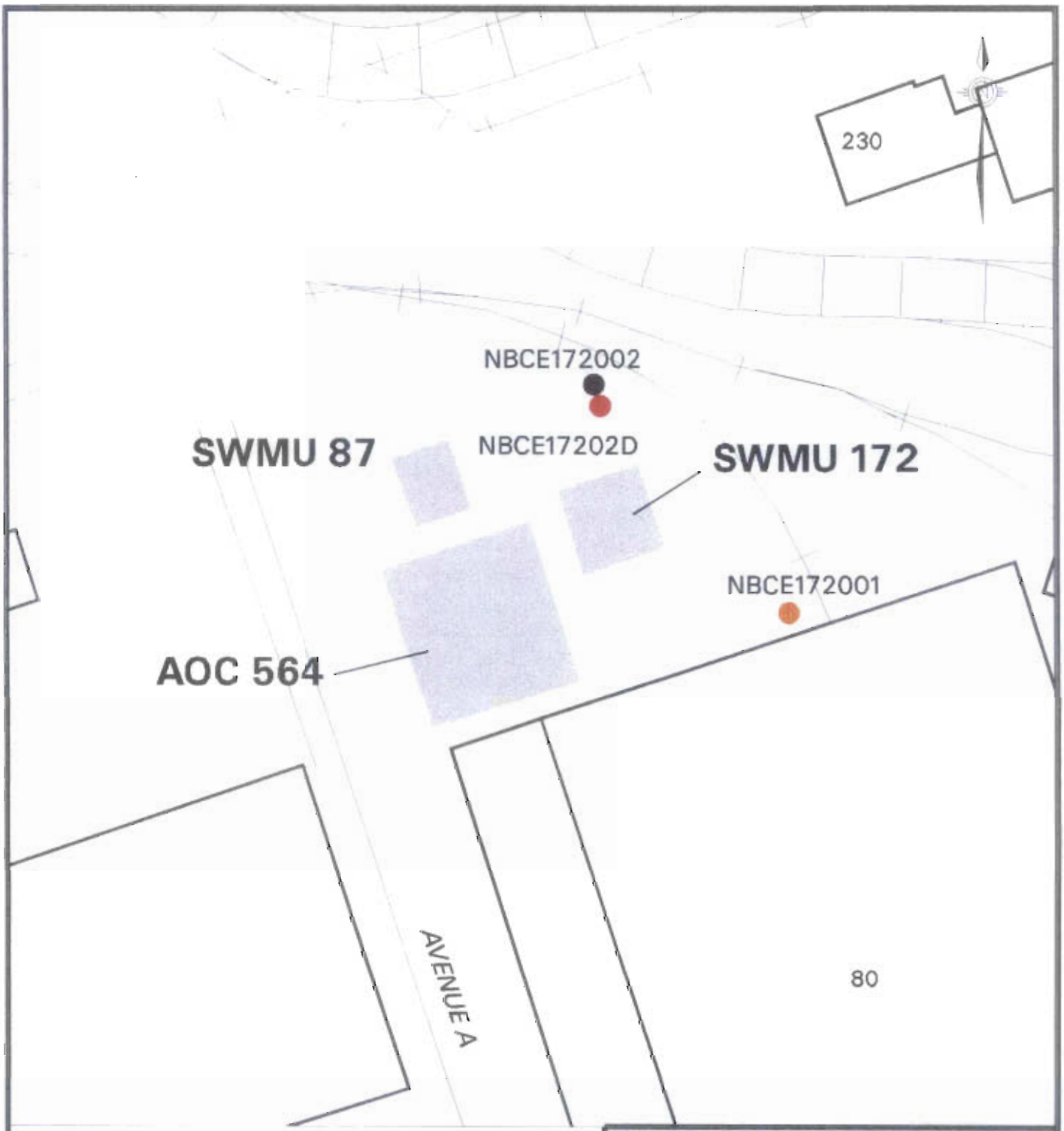
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 80

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

FIGURE 10.11.7
CUMULATIVE GROUNDWATER RISK IN WELLS
SWMU 87,172 AOC 564



LEGEND - CUMULATIVE GROUNDWATER HAZARD

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

0 feet 80

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

FIGURE 10.11.8
CUMULATIVE GROUNDWATER HAZARD IN WELLS
SWMU 87,172 AOC 564

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 E, specifically as a marine cargo terminal and drydocking facility. The ground surface around SWMUs 87 and 172, and AOC 564 is currently covered with either asphalt or concrete. As a result, chronic exposure to current soil condition is highly unlikely and the associated direct contact exposure pathways evaluations overestimate risk and hazard. If this area were to be redeveloped, 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, chronic exposure to current surface soil conditions would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined SWMU 87, 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.

COPC Selection

Chromium was identified as a COPC in soil based on a conservative comparison to the RBC for the hexavalent species. Hexavalent chromium analysis was conducted on surface soil samples NBCE087CB001 and NBCE172CB003; the second of which was collected at the same soil boring

which contained the maximum detected concentration of total chromium, 143 mg/kg (NBCE087SB001). Hexavalent chromium was not reported above a detectable concentration at either location. Chromium was therefore eliminated as a soil COPC based on comparison to the RBC for trivalent chromium. Since hexavalent chromium was not detected at either location, uncertainty associated with the elimination of chromium as a COPC is expected to be minimal. Chromium was not detected in groundwater samples collected at combined SWMU 87.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for combined SWMU 87 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration within 10% of its RBC.

Aluminum, beryllium, thallium, and vanadium were present in combined SWMU 87 soil at concentrations above RBC benchmarks and were eliminated from consideration in the FRE based on comparison to background concentrations. As a result, their contribution to risk and hazard has not been considered in this FRE.

Arsenic exceeded its background concentration in only one of ten sample locations (NBCE087SB001). Hence, while arsenic contributed to elevated risk and hazard projections, its maximum concentration was only marginally above its corresponding background concentration, and its average was below the background RC for arsenic across the combined sites.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 within 10% of its RBC).

Arsenic and manganese were present in combined SWMU 87 shallow groundwater at concentrations above RBC benchmarks and were eliminated from consideration in the FRE based on comparison to background concentrations. As a result, their contribution to risk and hazard has not been considered in this FRE. They were, however, considered with respect to deep groundwater, although concentrations in this portion of the water-bearing zone were less than shallow background concentrations.

10.11.10.5 FRE Summary

The risk and hazard posed by contaminants at combined SWMU 87 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first-quarter data and considers the ingestion and inhalation (VOCs only) pathways. Risk and HI estimates are presented on Tables 10.11.10.2, 10.11.10.3, and 10.11.10.5, such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO. Section 7, Tables 7.11.1, 7.11.2, and 7.11.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all COPCs identified in Zone E.

Soil — Residential Scenario

Arsenic, BEQs, and dieldrin were detected in combined SWMU 87 surface soil at concentrations above their residential RGOs

Soil — Site Worker Scenario

Arsenic was detected in combined SWMU 87 surface soil at a concentration above its industrial RGO.

Groundwater — Residential Scenario

Arsenic, manganese, 1,4-dichlorobenzene, and chlorobenzene were detected in combined SWMU 87 groundwater at concentrations above their residential RGOs.

Table 10.11.10.1
Chemicals Present in Site Samples
SWMUs 87, 172; AOC 564 - Surface Soil
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Screening Concentration: Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Carcinogenic PAHs													
B(a)P Equiv.	*	8	10	63.064 - 533.74	234.57	970.62 - 1016.84	88	780	NA	UG/KG	5		
Benzo(a)anthracene		6	10	53 - 300	154.83	370 - 590	880	7800	NA	UG/KG			
Benzo(a)pyrene	*	8	10	62 - 370	163.00	420 - 440	88	780	NA	UG/KG	4		
Benzo(b)fluoranthene		5	10	58 - 330	181.80	360 - 590	880	7800	NA	UG/KG			
Benzo(k)fluoranthene		7	10	41 - 340	155 14	420 - 590	8800	78000	NA	UG/KG			
Chrysene		8	10	61 - 340	160.13	420 - 440	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	4	10	41 - 92	75.50	370 - 590	88	780	NA	UG/KG	2		
Indeno(1,2,3-cd)pyrene		6	10	48 - 200	124.33	410 - 590	880	7800	NA	UG/KG			
TCDD Equivalents													
Dioxin Equiv.		2	2	0.1008 - 1.4468	0.77	NA - NA	1000	1000	NA	NG/KG			
Inorganics													
Aluminum (Al)		10	10	4080 - 25700	9655.00	NA - NA	7800	100000	26600	MG/KG	3		
Antimony (Sb)	*	2	10	0.75 - 5.1	2.93	0.57 - 4.8	3.1	82	1.77	MG/KG	1		1
Arsenic (As)	* *	10	10	3.3 - 66.5	14.84	NA - NA	0.43	3.8	23.9	MG/KG	10	8	1
Barium (Ba)		10	10	11.5 - 49.7	31.77	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		10	10	0.31 - 1.6	0.71	NA - NA	0.15	1.3	1.7	MG/KG	10	1	
Cadmium (Cd)		1	10	0.64 - 0.64	0.64	0.13 - 0.64	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	10	10	5650 - 28100	13622.00	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)	*	10	10	10.2 - 143	47.83	NA - NA	39	1000	94.6	MG/KG	4		2
Chromium (Hexavalent)		0	2	NA - NA	NA	0.059 - 0.067	39	1000	NA	MG/KG			
Cobalt (Co)		10	10	2 - 24.3	9.23	NA - NA	470	12000	19	MG/KG			2
Copper (Cu)		10	10	3.3 - 142	34.63	NA - NA	310	8200	66	MG/KG			1
Cyanide (CN)		8	10	0.34 - 1	0.59	0.25 - 0.26	160	4100	0.5	MG/KG			6
Iron (Fe)	N	10	10	4280 - 34700	12875.00	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)		10	10	6.9 - 132	54.73	NA - NA	400	1300	265	MG/KG			
Magnesium (Mg)	N	10	10	888 - 4460	2125.80	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)	*	10	10	46.2 - 495	190.11	NA - NA	180	4700	302	MG/KG	4		3
Mercury (Hg)		8	10	0.03 - 0.62	0.30	0.02 - 0.03	2.3	61	2.6	MG/KG			
Nickel (Ni)		9	10	4 - 14.1	8.83	6.9 - 6.9	160	4100	77.1	MG/KG			
Potassium (K)	N	10	10	254 - 1930	1013.10	NA - NA	NA	NA	NA	MG/KG			

Table 10.11.10.1
Chemicals Present in Site Samples
SWMUs 87, 172; AOC 564 - Surface Soil
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Screening Concentration: Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Selenium (Se)		1	10	0.62 - 0.62	0.62	0.58 - 0.79	39	1000	1.7	MG/KG			
Silver (Ag)		2	10	2 - 2.2	2.10	0.22 - 0.32	39	1000	NA	MG/KG			
Sodium (Na)	N	10	10	236 - 1750	536.10	NA - NA	NA	NA	NA	MG/KG			
Thallium (Tl)		1	10	0.85 - 0.85	0.85	0.55 - 0.79	0.63	16	2.8	MG/KG	1		
Tin (Sn)		10	10	2.8 - 10.1	4.99	NA - NA	4700	6100	59.4	MG/KG			
Vanadium (V)		10	10	7.6 - 78.5	27.71	NA - NA	55	1400	94.3	MG/KG	1		
Zinc (Zn)		10	10	13.7 - 295	105.46	NA - NA	2300	61000	827	MG/KG			
Pesticides													
4,4'-DDD		3	10	13 - 156	61.33	2.7 - 4.5	2700	24000	NA	UG/KG			
4,4'-DDE		3	10	8.7 - 664	238.43	2.7 - 4.5	1900	17000	NA	UG/KG			
4,4'-DDT		1	10	70.3 - 70.3	70.30	2.7 - 4.5	1900	17000	NA	UG/KG			
alpha-Chlordane		2	10	3.22 - 48.8	26.01	1.4 - 2.3	470	2200	NA	UG/KG			
delta-BHC		1	10	4.83 - 4.83	4.83	1.4 - 2.3	100	910	NA	UG/KG			
Dieldrin	*	1	10	290 - 290	290.00	2.7 - 4.5	40	360	NA	UG/KG	1		
Endrin		1	10	14.3 - 14.3	14.30	2.7 - 4.5	2300	61000	NA	UG/KG			
Endrin aldehyde		1	10	4.19 - 4.19	4.19	2.7 - 4.5	2300	61000	NA	UG/KG			
gamma-Chlordane		2	10	3.25 - 55.5	29.38	1.4 - 2.3	470	2200	NA	UG/KG			
Semivolatile Organics													
1,2-Dichlorobenzene		2	10	120 - 3500	1810.00	360 - 460	700000	18000000	NA	UG/KG			
2-Chlorophenol		1	10	190 - 190	190.00	360 - 590	39000	1000000	NA	UG/KG			
2-Methylnaphthalene		1	10	1900 - 1900	1900.00	360 - 590	310000	8200000	NA	UG/KG			
4-Chloro-3-methylphenol		1	10	160 - 160	160.00	360 - 590	NA	NA	NA	UG/KG			
Acenaphthene		1	10	120 - 120	120.00	360 - 590	470000	12000000	NA	UG/KG			
Anthracene		1	10	60 - 60	60.00	360 - 590	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene		7	10	57 - 220	134.57	420 - 590	310000	8200000	NA	UG/KG			
Dibenzofuran		1	10	120 - 120	120.00	360 - 590	31000	820000	NA	UG/KG			
Di-n-octyl phthalate		1	10	54 - 54	54.00	360 - 590	160000	4100000	NA	UG/KG			
Fluoranthene		8	10	56 - 680	264.75	420 - 440	310000	8200000	NA	UG/KG			
Naphthalene		1	10	1800 - 1800	1800.00	360 - 590	310000	8200000	NA	UG/KG			
Pentachlorophenol		1	10	69 - 69	69.00	1800 - 2800	5300	48000	NA	UG/KG			
Phenanthrene		6	10	70 - 310	187.00	370 - 590	310000	8200000	NA	UG/KG			
Pyrene		8	10	50 - 610	258.63	420 - 440	230000	6100000	NA	UG/KG			

Table 10.11.10.1
Chemicals Present in Site Samples
SWMUs 87, 172; AOC 564 - Surface Soil
NAVBASE - Charleston
Charleston, SC

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RBC	Ref.
Volatile Organics												
1,2-Dichloroethene (total)	2	10	31 - 58	44.50	5 - 7	70000	1800000	NA	UG/KG			
Acetone	8	10	10 - 300	123.13	12 - 13	780000	20000000	NA	UG/KG			
Bromodichloromethane	1	10	3 - 3	3.00	5 - 32	10000	92000	NA	UG/KG			
Chlorobenzene	1	10	130 - 130	130.00	5 - 32	160000	4100000	NA	UG/KG			
Chloroform	1	10	12 - 12	12.00	5 - 32	100000	940000	NA	UG/KG			
Ethylbenzene	1	10	17 - 17	17.00	5 - 9	780000	20000000	NA	UG/KG			
Methylene chloride	6	10	2 - 18	9.50	6 - 32	85000	760000	NA	UG/KG			
Tetrachloroethene	1	10	520 - 520	520.00	5 - 9	12000	110000	NA	UG/KG			
Toluene	1	10	16 - 16	16.00	5 - 9	1600000	41000000	NA	UG/KG			
Xylene (Total)	1	10	180 - 180	180.00	5 - 9	16000000	100000000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.11.10.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 87 and 172/AOC 564
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
087	B001	Antimony (Sb)	5.10	MG/KG	NA		0.1748	5.26
087	B001	Arsenic (As)	66.50	MG/KG	173.6981	89.97	3.0396	91.37
087	B001	B(a)P Equiv.	533.74	UG/KG	8.8389	4.58	NA	
087	B001	Dieldrin	290.00	UG/KG	10.5260	5.45	0.0957	2.88
087	B001	Manganese (Mn)	56.60	MG/KG	NA		0.0165	0.50
		Total			193.0630		3.3266	
172	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
172	B001	Arsenic (As)	16.50	MG/KG	43.0980	87.10	0.7542	88.71
172	B001	B(a)P Equiv.	385.34	UG/KG	6.3814	12.90	NA	
172	B001	Dieldrin	ND	UG/KG	NA		NA	
172	B001	Manganese (Mn)	329.00	MG/KG	NA		0.0960	11.29
		Total			49.4794		0.8502	
172	B002	Antimony (Sb)	0.75	MG/KG	NA		0.0257	3.59
172	B002	Arsenic (As)	12.50	MG/KG	32.6500	80.25	0.5713	79.89
172	B002	B(a)P Equiv.	485.23	UG/KG	8.0356	19.75	NA	
172	B002	Dieldrin	ND	UG/KG	NA		NA	
172	B002	Manganese (Mn)	405.00	MG/KG	NA		0.1181	16.52
		Total			40.6856		0.7152	
172	B003	Antimony (Sb)	ND	MG/KG	NA		NA	
172	B003	Arsenic (As)	8.20	MG/KG	21.4184	94.62	0.3748	86.88
172	B003	B(a)P Equiv.	73.57	UG/KG	1.2184	5.38	NA	
172	B003	Dieldrin	ND	UG/KG	NA		NA	
172	B003	Manganese (Mn)	194.00	MG/KG	NA		0.0566	13.12
		Total			22.6368		0.4314	
172	B004	Antimony (Sb)	ND	MG/KG	NA		NA	
172	B004	Arsenic (As)	6.10	MG/KG	15.9332	91.12	0.2788	86.67
172	B004	B(a)P Equiv.	93.77	UG/KG	1.5529	8.88	NA	
172	B004	Dieldrin	ND	UG/KG	NA		NA	
172	B004	Manganese (Mn)	147.00	MG/KG	NA		0.0429	13.33
		Total			17.4861		0.3217	
172	B005	Antimony (Sb)	ND	MG/KG	NA		NA	
172	B005	Arsenic (As)	4.80	MG/KG	12.5376	100.00	0.2194	94.21
172	B005	B(a)P Equiv.	ND	UG/KG	NA		NA	
172	B005	Dieldrin	ND	UG/KG	NA		NA	
172	B005	Manganese (Mn)	46.20	MG/KG	NA		0.0135	5.79
		Total			12.5376		0.2329	

Table 10.11.10.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMUs 87 and 172/AOC 564
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
172	B006	Antimony (Sb)	ND	MG/KG	NA		NA	
172	B006	Arsenic (As)	22.60	MG/KG	59.0312	98.26	1.0330	87.74
172	B006	B(a)P Equiv.	63.06	UG/KG	1.0444	1.74	NA	
172	B006	Dieldrin	ND	UG/KG	NA		NA	
172	B006	Manganese (Mn)	495.00	MG/KG	NA		0.1444	12.26
		Total			60.0756		1.1774	
564	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
564	B001	Arsenic (As)	4.30	MG/KG	11.2316	100.00	0.1965	89.80
564	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
564	B001	Dieldrin	ND	UG/KG	NA		NA	
564	B001	Manganese (Mn)	76.50	MG/KG	NA		0.0223	10.20
		Total			11.2316		0.2189	
564	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
564	B002	Arsenic (As)	3.30	MG/KG	8.6196	87.58	0.1508	83.96
564	B002	B(a)P Equiv.	73.82	UG/KG	1.2225	12.42	NA	
564	B002	Dieldrin	ND	UG/KG	NA		NA	
564	B002	Manganese (Mn)	98.80	MG/KG	NA		0.0288	16.04
		Total			9.8421		0.1797	
564	B003	Antimony (Sb)	ND	MG/KG	NA		NA	
564	B003	Arsenic (As)	3.60	MG/KG	9.4032	77.17	0.1645	91.41
564	B003	B(a)P Equiv.	168.00	UG/KG	2.7821	22.83	NA	
564	B003	Dieldrin	ND	UG/KG	NA		NA	
564	B003	Manganese (Mn)	53.00	MG/KG	NA		0.0155	8.59
		Total			12.1853		0.1800	

Table 10.11.10.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMUs 87 and 172/AOC 564
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
087	B001	Arsenic (As)	66.50	MG/KG	24.5722	100.00	0.1529	100.00
		Total			24.5722		0.1529	
172	B001	Arsenic (As)	16.50	MG/KG	6.0969	100.00	0.0379	100.00
		Total			6.0969		0.0379	
172	B002	Arsenic (As)	12.50	MG/KG	4.6188	100.00	0.0287	100.00
		Total			4.6188		0.0287	
172	B003	Arsenic (As)	8.20	MG/KG	3.0300	100.00	0.0189	100.00
		Total			3.0300		0.0189	
172	B004	Arsenic (As)	6.10	MG/KG	2.2540	100.00	0.0140	100.00
		Total			2.2540		0.0140	
172	B005	Arsenic (As)	4.80	MG/KG	1.7736	100.00	0.0110	100.00
		Total			1.7736		0.0110	
172	B006	Arsenic (As)	22.60	MG/KG	8.3509	100.00	0.0520	100.00
		Total			8.3509		0.0520	
564	B001	Arsenic (As)	4.30	MG/KG	1.5889	100.00	0.0099	100.00
		Total			1.5889		0.0099	
564	B002	Arsenic (As)	3.30	MG/KG	1.2194	100.00	0.0076	100.00
		Total			1.2194		0.0076	
564	B003	Arsenic (As)	3.60	MG/KG	1.3302	100.00	0.0083	100.00
		Total			1.3302		0.0083	

Table 10.11.10.4
Chemicals Present in Site Samples
SWMUs 87, 172; AOC 564 - Groundwater
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Screening Conc. Reference	Units	Number Exceeding Res.	Number Exceeding Ref.
Deep wells											
Inorganics											
Arsenic (As)	*	1	1	18.5 - 18.5	18.5	NA - NA	0.045	16.4	UG/L	1	1
Calcium (Ca)	N	1	1	216000 - 216000	216000	NA - NA	NA	NA	UG/L		
Cobalt (Co)		1	1	18.1 - 18.1	18.1	NA - NA	220	12.9	UG/L		1
Iron (Fe)	N	1	1	7040 - 7040	7040	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	30500 - 30500	30500	NA - NA	NA	NA	UG/L		
Manganese (Mn)	*	1	1	1240 - 1240	1240	NA - NA	84	869	UG/L	1	1
Nickel (Ni)		1	1	18.7 - 18.7	18.7	NA - NA	73	42.2	UG/L		
Sodium (Na)	N	1	1	408000 - 408000	408000	NA - NA	NA	NA	UG/L		
Volatile Organics											
1,2-Dichloroethene (total)		1	1	2 - 2	2	NA - NA	5.5	NA	UG/L		
Shallow Wells											
Inorganics											
Aluminum (Al)		1	2	1010 - 1010	1010	44.1 - 44.1	3700	2810	UG/L		
Arsenic (As)		1	2	5.1 - 5.1	5.1	5 - 5	0.045	18.7	UG/L	1	
Barium (Ba)		1	2	18.9 - 18.9	18.9	14.1 - 14.1	260	211	UG/L		
Calcium (Ca)	N	1	2	49500 - 49500	49500	14300 - 14300	NA	NA	UG/L		
Cobalt (Co)		1	2	16.8 - 16.8	16.8	2 - 2	220	2.5	UG/L		1
Copper (Cu)		1	2	2 - 2	2	2 - 2	150	2.7	UG/L		
Iron (Fe)	N	2	2	2200 - 6100	4150	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	2	2	6680 - 11700	9190	NA - NA	NA	NA	UG/L		
Manganese (Mn)		2	2	88 - 261	174.5	NA - NA	84	2560	UG/L	2	
Nickel (Ni)		1	2	9.3 - 9.3	9.3	1 - 1	73	15.2	UG/L		
Potassium (K)	N	1	2	5970 - 5970	5970	5910 - 5910	NA	NA	UG/L		
Sodium (Na)	N	2	2	128000 - 452000	290000	NA - NA	NA	NA	UG/L		

Table 10.11.10.4
Chemicals Present in Site Samples
SWMUs 87, 172; AOC 564 - Groundwater
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Screening Conc. Reference	Units	Number Exceeding Res.	Number Exceeding Ref.
Vanadium (V)		1	2	2.7 - 2.7	2.7	1 - 1	26	11.4	UG/L		
Zinc (Zn)		1	2	44.4 - 44.4	44.4	4 - 4	1100	27.3	UG/L		1
Semivolatile Organics											
1,2-Dichlorobenzene		1	2	10 - 10	10	10 - 10	27	NA	UG/L		
1,3-Dichlorobenzene		1	2	2 - 2	2	10 - 10	54	NA	UG/L		
1,4-Dichlorobenzene	*	1	2	6 - 6	6	10 - 10	0.44	NA	UG/L	1	
bis(2-Ethylhexyl)phthalate (BEHP)		1	2	2 - 2	2	10 - 10	4.8	NA	UG/L		
Volatile Organics											
1,1-Dichloroethane		1	2	3 - 3	3	5 - 5	81	NA	UG/L		
1,2-Dichloroethene (total)	*	1	2	37 - 37	37	5 - 5	5.5	NA	UG/L	1	
Chlorobenzene	*	1	2	110 - 110	110	5 - 5	3.9	NA	UG/L	1	

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

Table 10.11.10.5
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMUs 87 and 172/AOC 564
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
172	G02D	Arsenic (As)	18.50	UG/L	412.7202	100.00	3.9422	53.35
172	G02D	Manganese (Mn)	1240.00	UG/L	NA		3.4465	46.65
		Total			412.7202		7.3887	
172	G001	1,2-Dichloroethene (total)	37.00	UG/L	NA		0.5256	24.89
172	G001	1,4-Dichlorobenzene	6.00	UG/L	4.2834	100.00	0.0033	0.16
172	G001	Chlorobenzene	110.00	UG/L	NA		1.5831	74.96
		Total			4.2834		2.1121	
172	G002	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
172	G002	1,4-Dichlorobenzene	ND	UG/L	NA		NA	
172	G002	Chlorobenzene	ND	UG/L	NA		NA	
		Total			NA		NA	

10.11.11 Corrective Measures Considerations

For SWMUs 87 and 172 and AOC 564, the upper and lower soil intervals and shallow and deep groundwater were investigated. Based on the analytical results and the risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and the shallow and deep 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. However, the industrial exposure risk for the upper soil interval exceeds 1E-06 for arsenic. Risks associated with the upper interval are diminished because most of the site is capped with concrete and asphalt.

Arsenic, BEQs, and dieldrin were identified as COCs in the upper soil interval. The soil pathway residential exposure risk ranges from 1E-05 to 2E-04 with the arithmetic mean risk of 4E-05. The HI estimates range from 0.2 to 3.0 with a mean HI of 0.7. The equated mean is between USEPA's acceptable ranges of 1E-06 and 1E-04 for risk and 3 and 0.1 for HI. Since all soil sample locations are covered with either concrete or asphalt and their combined equated mean residential risk and HI are within USEPA's acceptable ranges, no further action is recommended for those locations.

Arsenic and manganese were identified in deep groundwater at concentrations equaling a risk above 1E-06 and/or HI above 1, 4E-04 and 7, respectively. Arsenic drives the risk and the HI. Chlorobenzene, 1,4-dichlorobenzene, and 1,2-dichloroethene were identified in the shallow groundwater at monitoring well NCBE172001 at concentrations that equal a risk above 1E-06 and/or HI above 1, 4E-06 and 2, respectively. No plume is apparent in the shallow groundwater. Human health risk is not a significant factor since the groundwater is not a potable drinking water source and the associated risk is between USEPA's acceptable range of 1E-06 and 1E-04. However, further assessment is needed to evaluate the natural attenuation process and potential

discharge to surface water associated with arsenic and manganese in the deep groundwater and the chloro-organics in the shallow aquifer.

Potential corrective measures for the impacted media and respective COCs are in Table 10.11.11.1.

Table 10.11.11.1
Potential Corrective Measures for SWMUs 87 and 172 and AOC 564

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic	a) No Action
Deep Groundwater	Arsenic and manganese	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment
Shallow Groundwater	Chlorobenzene, 1,4-dichlorobenzene, and 1,2-dichloroethene (total)	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment

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10.12 SWMU 97, Less-than-90-Day Accumulation Area, Building 236

SWMU 97 consists of a former less-than-90-day accumulation area located on the east corner of Building 236. Wastes were stored in 55-gallon drums on pallets inside the 20' x 20' metal structure on an asphalt foundation. The storage area is currently empty and the dates of operation are not known.

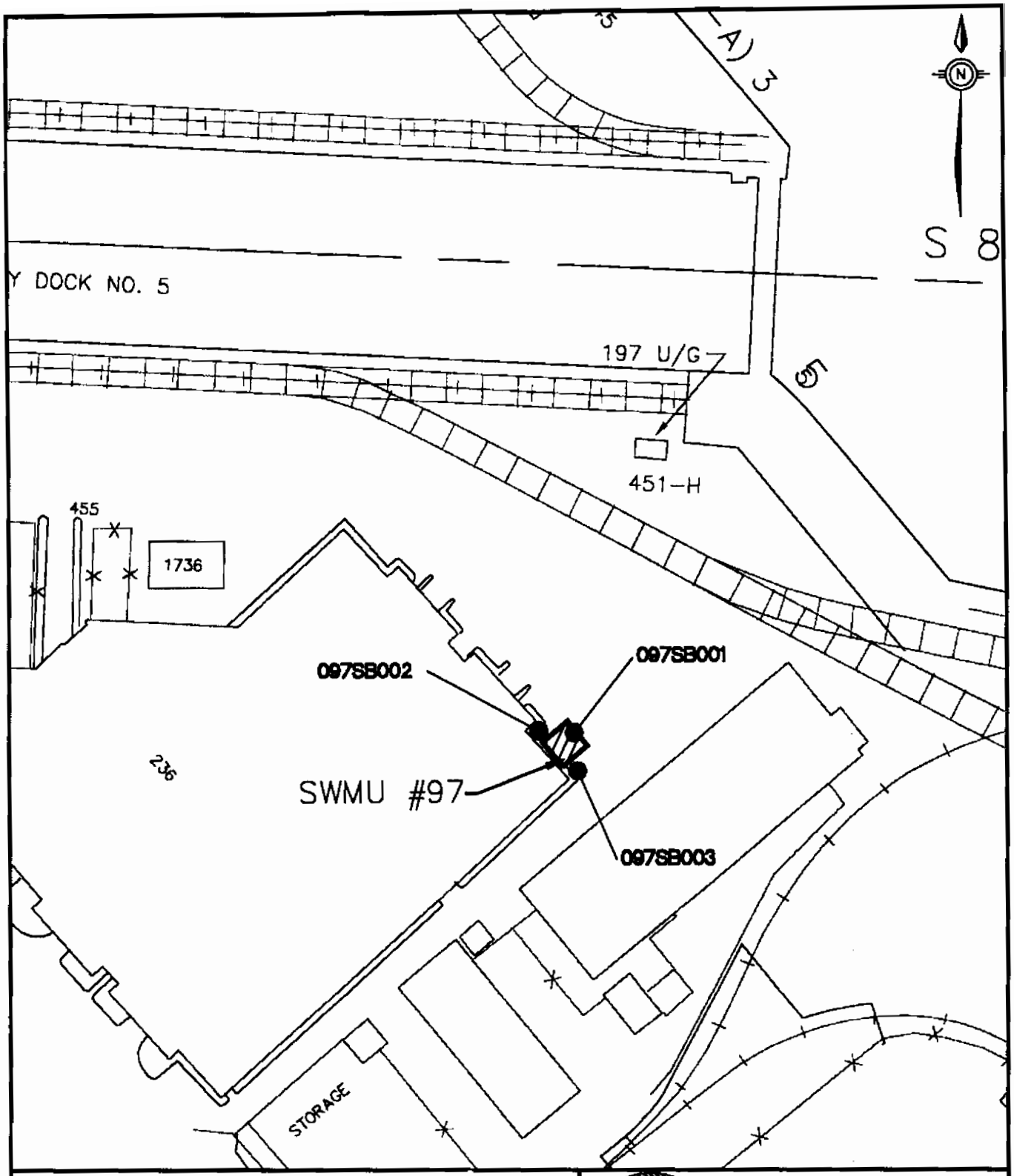
Materials of concern include freon, metals, solvents, and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for SWMU 97, soil and groundwater samples were collected in accordance with the *Final Zone E RFI Work Plan* and Section 3 of this report to determine whether contamination resulted from onsite activities.

10.12.1 Soil Sampling and Analysis

Soil was sampled in one round at SWMU 97 from the location shown in Figure 10.12.1. The *Final Zone E RFI Work Plan* proposed collecting two soil samples from the upper interval and two samples from the lower interval. Soil samples were also collected at both intervals for the shallow monitoring well location proposed at this site.

All proposed samples were collected and submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. One upper-interval soil sample selected as a duplicate was analyzed at DQO Level IV for Appendix IX parameters to include the suite of parameters proposed for the site, plus a more comprehensive list of VOCs and SVOCs as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.12.1.1 summarizes soil sampling at SWMU 97.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◓ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.12.1
SOIL BORING LOCATIONS
SWMU#97
BUILDING 236
<90 DAY STORAGE AREA

DWG DATE: 09/02/97 | DWG NAME: 10-12-1

Table 10.12.1.1
SWMU 97
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	3	3	Standard Suite[a], organotins	Standard Suite[a], organotins	None
Lower	3	3	Standard Suite[a], organotins	Standard Suite[a], organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCBs.

10.12.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.12.2.1. Inorganic analytical results for soil are summarized in Table 10.12.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.12.2.1
SWMU 97
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	1/3	37	37	20,000,000	0
	Lower	1/3	40	40	NA	NA
Methylene chloride	Upper	1/3	2	2	760,000	0
	Lower	1/3	1	1	NA	NA
SVOCs (μg/kg)						
Acenaphthene	Upper	1/3	54	54	12,000,000	0
Benzo(g,h,i)perylene	Upper	1/3	49.5	49.5	8,200,000	0

Table 10.12.2.1
SWMU 97
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Benzoic acid	Upper	2/3	130 - 200	165	100,000,000	0
	Lower	2/3	110 - 300	205	NA	NA
4-Chloro-3-methylphenol	Upper	1/3	67	67	NA	NA
Fluoranthene	Upper	2/3	66.0 - 95.5	80.8	8,200,000	0
	Lower	1/3	68	68	NA	NA
Pentachlorophenol	Upper	1/3	43	43	48,000	0
Phenanthrene	Upper	1/3	76	76	8,200,000	0
Pyrene	Upper	2/3	79.0 - 155	117	6,100,000	0
	Lower	1/3	100	100	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	2/3	54.8 - 83.8	69.3	780	0
	Lower	1/3	5.26	5.26	NA	NA
Benzo(a)anthracene	Upper	2/3	44.0 - 66.5	55.3	7,800	0
	Lower	1/3	46	46	NA	NA
Benzo(b)fluoranthene	Upper	2/3	40.0 - 63.0	51.5	7,800	0
Benzo(k)fluoranthene	Upper	2/3	38.0 - 59.0	48.5	78,000	0
	Lower	1/3	60	60	NA	NA
Benzo(a)pyrene	Upper	2/3	46.0 - 65.5	55.8	780	0
Chrysene	Upper	2/3	47.0 - 73.0	60	780,000	0
	Lower	1/3	60	60	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	1/3	47	47	7,800	0

Table 10.12.2.1
SWMU 97
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides/PCBs (μg/kg)						
alpha-Chlordane	Upper	2/3	2.68 - 56.7	29.7	4,400	0
gamma-Chlordane	Upper	2/3	6.41 - 153	79.8	4,400	0
4,4'-DDE	Upper	1/3	15.1	15.1	17,000	0
Dieldrin	Upper	1/3	5.5	5.5	360	0
Endrin	Upper	1/3	4.91	4.91	61,000	0
Heptachlor	Upper	1/3	4.77	4.77	1,300	0
Heptachlor epoxide	Upper	1/3	7.37	7.37	630	0
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	1/1	0.304	0.304	1,000	0
1234678-HpCDD	Upper	1/1	13.5	13.5	NA	NA
1234678-HpCDF	Upper	1/1	2.22	2.22	NA	NA
OCDD	Upper	1/1	142	142	NA	NA
OCDF	Upper	1/1	3.64	3.64	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.12.2.2
SWMU 97
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	3/3	2,010 - 3,540	2,810	100,000	26,600	0
	Lower	3/3	2,670 - 6,630	4,290	NA	41,100	NA

Table 10.12.2.2
SWMU 97
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Arsenic (As)	Upper	3/3	0.870 - 4.90	3.49	3.80	23.9	0
	Lower	3/3	1.40 - 4.40	3.13	NA	19.9	NA
Barium (Ba)	Upper	3/3	3.20 - 18.0	13.0	14,000	130	0
	Lower	3/3	11.7 - 31.1	18.6	NA	94.1	NA
Beryllium (Be)	Upper	2/3	0.330 - 0.340	0.335	1.30	1.70	0
	Lower	3/3	0.130 - 0.350	0.263	NA	2.71	NA
Cadmium (Cd)	Upper	1/3	0.260	0.260	100	1.50	0
	Lower	1/3	0.180	0.180	NA	0.960	NA
Calcium (Ca)	Upper	3/3	19,100 - 113,000	53,200	NA	NA	NA
	Lower	3/3	21,600 - 30,500	26,000	NA	NA	NA
Chromium (Cr)	Upper	3/3	3.80 - 54.9	24.5	1,000	94.6	0
	Lower	3/3	10.2 - 40.1	23.6	NA	75.2	NA
Cobalt (Co)	Upper	3/3	0.900 - 2.10	1.63	12,000	19.0	0
	Lower	3/3	1.30 - 1.50	1.40	NA	14.9	NA
Copper (Cu)	Upper	3/3	1.90 - 8.20	5.23	8,200	66.0	0
	Lower	3/3	4.70 - 51.9	20.6	NA	152	NA
Iron (Fe)	Upper	3/3	1,050 - 6,380	3,480	61,000	NA	0
	Lower	3/3	2,420 - 5,520	4,060	NA	NA	NA
Lead (Pb)	Upper	3/3	1.50 - 41.2	26.5	1,300	265	0
	Lower	3/3	12.5 - 20.6	16.6	NA	173	NA
Magnesium (Mg)	Upper	3/3	396 - 2,430	1,500	NA	NA	NA
	Lower	3/3	743 - 1,350	995	NA	NA	NA
Manganese (Mn)	Upper	3/3	24.8 - 179	94.4	4,700	302	0
	Lower	3/3	71.4 - 82.0	77.0	NA	881	NA
Nickel (Ni)	Upper	3/3	1.90 - 5.50	4.00	4,100	77.1	0
	Lower	3/3	3.60 - 9.10	5.87	NA	57.0	NA

Table 10.12.2.2
SWMU 97
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Potassium (K)	Upper	3/3	511 - 934	712	NA	NA	NA
	Lower	3/3	814 - 1,320	990	NA	NA	NA
Sodium (Na)	Upper	2/3	438 - 684	561	NA	NA	NA
	Lower	3/3	270 - 511	367	NA	NA	NA
Tin (Sn)	Lower	1/3	2.60	2.60	NA	9.23	NA
Vanadium (V)	Upper	3/3	2.20 - 9.60	5.53	1,400	94.3	0
	Lower	3/3	8.40 - 31.2	17.0	NA	155	NA
Zinc (Zn)	Upper	3/3	4.50 - 31.9	21.7	61,000	827	0
	Lower	3/3	18.9 - 46.2	29.6	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC or RC established

Volatile Organic Compounds in Soil

Two VOCs — acetone and methylene chloride — were detected in soil samples collected at SWMU 97. Two detections occurred in both the upper and lower intervals. Neither VOC was detected above its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Eight SVOCs were detected in soil samples collected at SWMU 97. Eleven detections occurred in the upper interval and four in the lower interval. No SVOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at SWMU 97. The BEQ was calculated for two upper-interval samples with a range of 54.8 to 83.8 μg/kg and a mean of 69.3 μg/kg. The BEQs did not exceed the benzo(a)pyrene industrial RBC of 780 μg/kg.

Pesticides and PCBs in Soil

Seven pesticides were detected in upper-interval soil samples collected at SWMU 97. No detected pesticide exceeded its respective industrial RBC in the upper interval. No pesticides were detected in the lower-interval samples. No PCBs were detected in soil samples collected at SWMU 97.

Other Organic Compounds in Soil

Five dioxins were detected in the duplicate upper-interval soil sample collected at SWMU 97. No industrial RBCs have been established for the detected dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated for the upper-interval duplicate sample. The calculated TEQ was 0.304 ng/kg, which did not exceed the industrial RBC of 1,000 ng/kg.

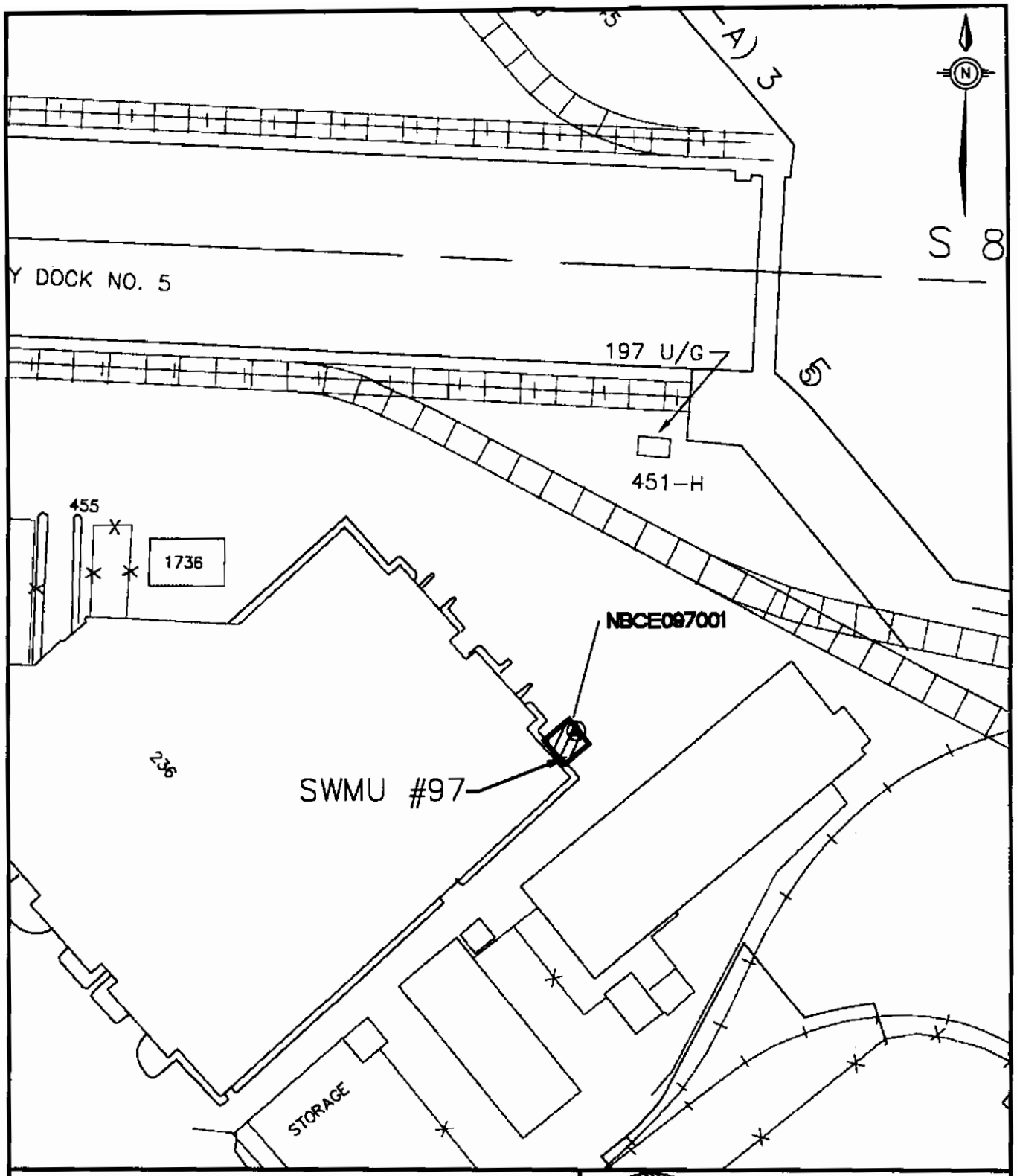
Inorganic Elements in Soil

Nineteen metals were detected in soil samples collected at SWMU 97. Fifty detections occurred in both the upper and lower interval. No metal exceeded both its respective industrial RBC and background RC in the upper interval or respective SSL and background RC in the lower interval.

10.12.3 Groundwater Sampling and Analysis

One shallow monitoring well was installed and sampled to assess groundwater quality at SWMU 97 as shown in Figure 10.12.2. The well was installed as follows:

- Shallow Well installed at SWMU 97 — NBCE097001



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ⊖ – DEEP MONITORING WELLS
- ⊕ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.12.2
MONITORING WELL LOCATIONS
SWMU#97
BUILDING 236
<90 DAY STORAGE AREA

DWG DATE: 09/02/97 | DWG NAME: 10-12-2

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. No samples were selected as duplicates at this site. Table 10.12.3.1 summarizes groundwater sampling and analysis at SWMU 97.

Table 10.12.3.1
SWMU 97
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	1	1	Standard Suite[b], chlorides, TDS, sulfates, and organotins	Standard Suite[b], chlorides, TDS, sulfates, and organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs.

The shallow monitoring well was installed at 13.1 feet bgs in the surficial aquifer in accordance with Section 3.3 of this report.

10.12.4 Nature of Contamination in Groundwater

Inorganic analytical results for groundwater are summarized in Table 10.12.4.1. No organic compounds were detected at this site. Appendix H contains the complete data report for all samples collected in Zone E.

Inorganic Elements in Groundwater

Shallow Groundwater

Five metals were detected in the shallow groundwater sample collected at SWMU 97. Two metals — antimony and arsenic — exceeded both their respective tap-water RBC and background shallow groundwater RC.

Table 10.12.4.1
SWMU 97
Inorganic Detections for First-Quarter Groundwater (μg/L)
Shallow Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/1	109	109	3,700	2,810	NA	0
Antimony (Sb)	1/1	5.10	5.10	1.50	NA	6.00	1
Arsenic (As)	1/1	31.5	31.5	0.0450	18.7	50.0	1
Chromium (Cr)	1/1	1.50	1.50	18.0	12.3	100	0
Vanadium (V)	1/1	12.6	12.6	26.0	11.4	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No MCL established

Antimony was detected in well NBCE097001 (5.10 μg/L), exceeding its tap-water RBC of 1.50 μg/L. No shallow groundwater RC or MCL has been established for antimony.

Arsenic was detected in well NBCE097001 (31.5 μg/L), exceeding both its tap-water RBC of 0.0450 μg/L and its shallow groundwater RC of 18.7 μg/L. The sample did not exceed the arsenic MCL of 50.0 μg/L.

10.12.5 Fate and Transport Assessment for SWMU 97

SWMU 97 consists of a former metal structure on asphalt, surrounded by pavement with engineered drainage. Environmental media sampled as part of the SWMU 97 CSI include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for SWMU 97 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of volatiles from surface soil-to-air.

10.12.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.12.5.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) background RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Two organic constituents (pentachlorophenol and dieldrin) were detected in SWMU 97 surface soil above groundwater protection SSLs. Neither of these organic constituents was detected in subsurface soil or first-quarter groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer. Both chemicals were detected at concentrations above their corresponding SSLs in only one sample, but the maximum reported concentrations were below RBCs for soil. No inorganic constituents were detected in soil above their respective groundwater protection SSLs or background reference values.

10.12.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.12.5.1 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs 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 RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic constituents were detected in SWMU 97 shallow groundwater. Arsenic was the only inorganic constituent detected in shallow groundwater at a concentration that exceeded its background reference value for groundwater. However, the maximum detected concentration of

31.5 μg/L is below arsenic's MCL of 50 μg/L. No constituents were detected at concentrations exceeding salt water surface water chronic screening levels.

10.12.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.12.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined SWMU 97 is 108,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.12.5.4 Soil-to-Air Cross-Media Transport

Table 10.12.5.3 lists the two VOCs detected in surface soil samples collected at SWMU 97 along with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at SWMU 97. In addition, neither 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 expected to be significant at SWMU 97.

10.12.5.5 Fate and Transport Summary

In the first-tier screen, two organic constituents (pentachlorophenol and dieldrin) were detected above their generic groundwater protection SSLs in the same surface soil sample, but were not detected in subsurface soil or groundwater samples. Arsenic exceeded its background reference value in the single first-quarter sample from the shallow aquifer, but its concentration in this sample was still below its respective MCL.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.12.5.1
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: Tier One
NAVBASE-Charleston, Zone E: SWMU 97
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	40	40	ND	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	2	1	ND	NA	10	4.1	2560	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	54	ND	ND	NA	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Benzoic acid	200	300	ND	NA	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	55	ND	ND	NA	2.3E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	78	46	ND	NA	800	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	66	ND	ND	NA	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	70	ND	ND	NA	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	61	60	ND	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	92	60	ND	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	47	ND	ND	NA	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
4-Chloro-3-methylphenol	67	ND	ND	NA	3150	180	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	110	68	ND	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Pentachlorophenol	43	ND	ND	NA	15	0.56	7.9	UG/KG	UG/L	YES	NO	NO
Phenanthrene	76	ND	ND	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	190	100	ND	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
alpha-Chlordane	97	ND	ND	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	260	ND	ND	NA	5000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	15.1	ND	ND	NA	27000	0,2	0.14	UG/KG	UG/L	NO	NO	NO
Dieldrin	5.5	ND	ND	NA	2	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO
Endrin	4.91	ND	ND	NA	500	11	0.0023	UG/KG	UG/L	NO	NO	NO
Heptachlor	7.7	ND	ND	NA	11500	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	7.37	ND	ND	NA	350	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.304	ND	ND	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	3540	6630	109	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	ND	ND	5.1	NA	2.5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	4.9	4.4	31.5	NA	23.9	18.7	36	MG/KG	UG/L	NO	YES	NO
Barium	18	31.1	ND	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.34	0.35	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.26	0.18	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	54.9	40.1	1.5	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	2.1	1.5	ND	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	8.2	51.9	ND	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	41.2	20.6	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	179	82	ND	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Nickel	5.5	9.1	ND	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Tin	2.6	2.6	ND	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	9.6	31.2	12.6	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	31.9	46.2	ND	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.12.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: SWMU 97
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #								
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Pentachlorophenol	43	ND	ND	NA	15	0.56	7.9	0.56	6.05E+04	1	6.05E+04	9.07E+04	UG/KG	UG/L	NO	NO
Pesticides/PCB Compounds																
Dieldrin	5.5	ND	ND	NA	2	0.0042	0.0019	0.0019	2.05E+02	0.005	4.10E+04	8.21E+03	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Arsenic	4.9	4.4	31.5	NA	14.6	0.045	36	0.045	4.86E+03	50	9.72E+01	1.42E+02	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 108,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.12.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: SWMU 097
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	40	62000000	UG/KG	NO
Methylene chloride	2	7000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.12.6 Fixed-Point Risk Evaluation for SWMU 97

10.12.6.1 Site Background and Investigative Approach

SWMU 97 is a former less-than-90-day accumulation area (Building 236), which was once used to store hazardous waste, and is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of three surface soil samples were considered in the SWMU 97 FRE. One shallow monitoring well was installed as part of the 1995 RFI. Surface soil and first-quarter groundwater data generated from RFI sampling activities are used to represent point risk/hazard for the SWMU 97 FRE. Sections 10.12.1 and 10.12.3 contain summaries of the sampling effort for SWMU 97 soil and groundwater.

10.12.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.12.6.1 provides CPSS summaries for SWMU 97 soil and identifies COPCs based on comparison to residential and industrial RBCs and background RCs. Concentrations of arsenic, beryllium, and chromium were reported at levels exceeding residential RBCs. However, none of the reported concentrations for these chemicals exceeded corresponding background RCs. Therefore, no COPCs were identified in surface soil for the residential scenario at SWMU 97. SWMU surface soil data were not sufficient to perform Wilcoxon rank sum test analyses, and as a result, arsenic, beryllium, and chromium were eliminated from the soil FRE based on direct comparison of their maximum concentrations to their background RCs.

Industrial Scenario

Arsenic concentrations were reported at levels exceeding industrial RBCs. However, none of the reported concentrations for arsenic exceeded its corresponding background RC. Therefore, no COPCs were identified in surface soil for the industrial scenario at SWMU 97.

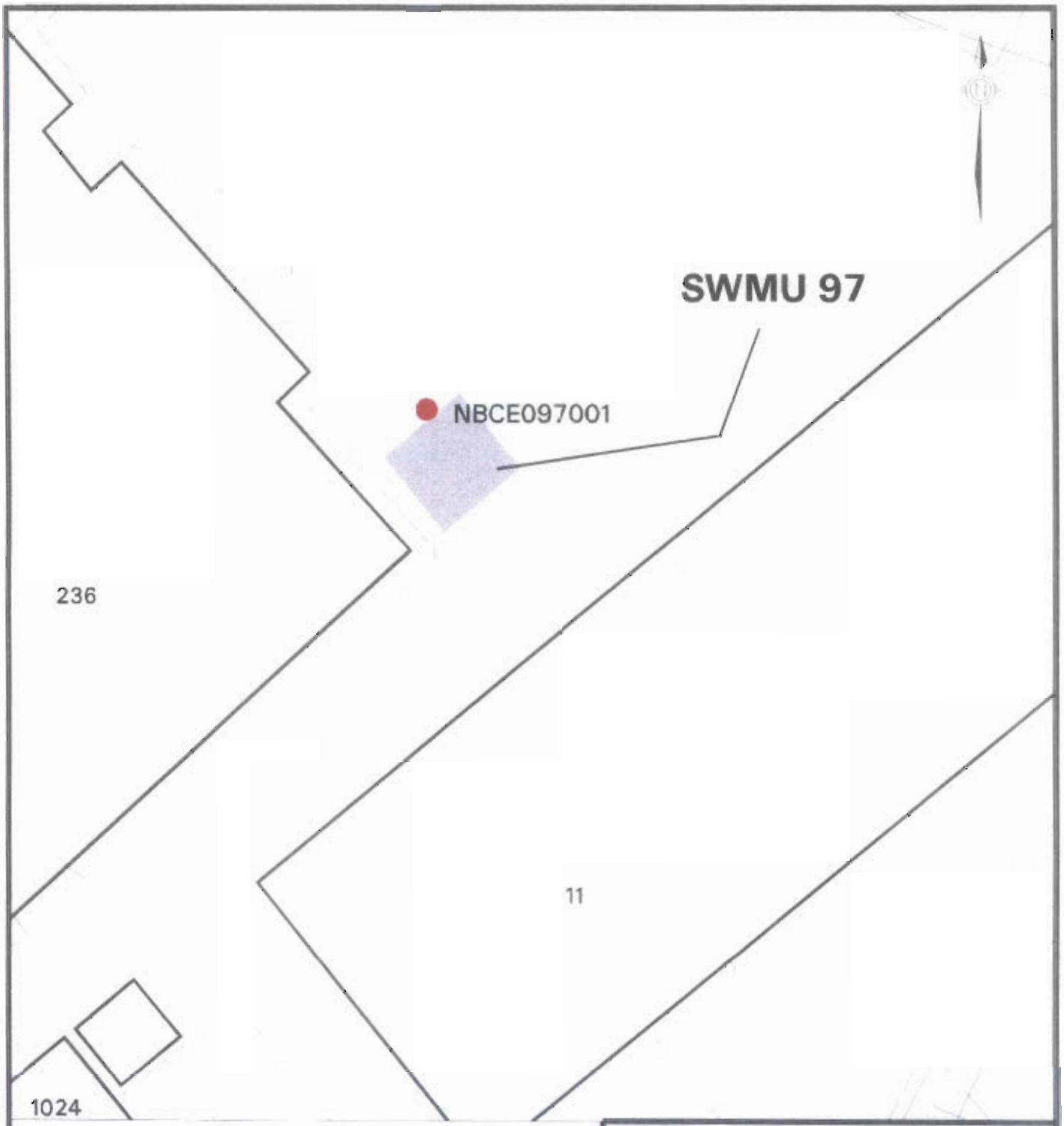
10.12.6.3 Fixed-Point Risk Evaluation for Groundwater

Residential Scenario

Table 10.12.6.2 provides CPSS summaries for SWMU 97 groundwater and identifies COPCs. Antimony and arsenic were identified as groundwater COPCs in the shallow aquifer. COPC identification was based on comparison of first-quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. Vanadium was detected at a concentration exceeding its background concentration, but was eliminated from further consideration because it did not exceed its corresponding tap water RBC.

Table 10.12.6.3 summarizes the COPCs identified in the SWMU 97 monitoring well sampled during the first quarter. Risk projections above 1E-06 were associated with the arsenic concentration in the groundwater sample collected from monitoring well NBCE097001. The risk estimate was approximately 7E-4 for arsenic. Figure 10.12.3 illustrates the groundwater data as a function of point-specific risk projections.

Monitoring well NBCE097001 produced results corresponding with an arsenic HI above unity, as well. Arsenic was the primary contributor to HI projections for the corresponding groundwater sample. The reported concentration of antimony yielded an individual hazard quotient of 0.8. The hazard quotient for arsenic was approximately 7, contributing to a cumulative HI of 8. Figure 10.12.4 illustrates the groundwater data as a function of point-specific hazard projections.



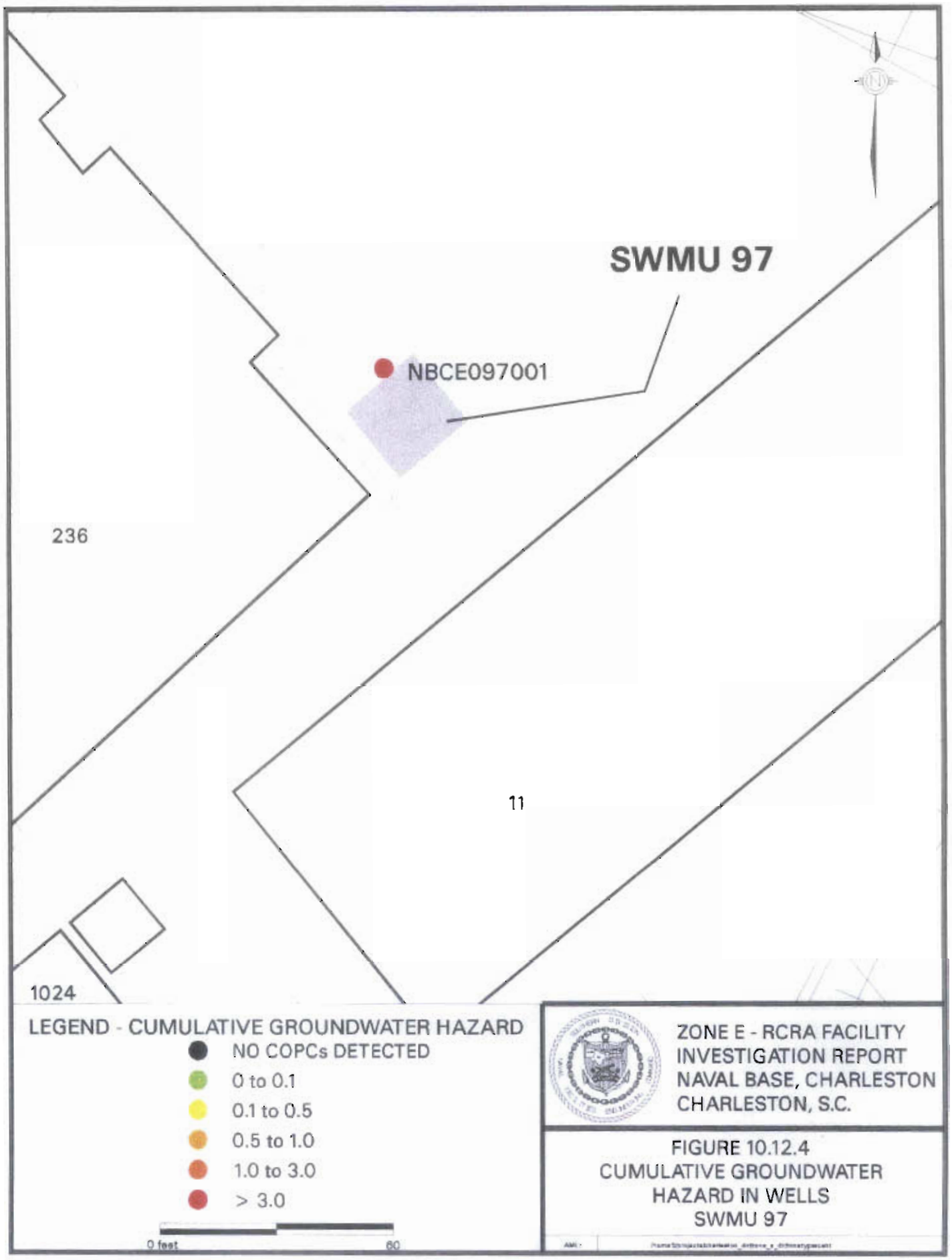
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 60

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

FIGURE 10.12.3
CUMULATIVE GROUNDWATER RISK IN WELLS
SWMU 97


SWMU 97
NBCE097001
236
11
1024
LEGEND - CUMULATIVE GROUNDWATER HAZARD
NO COPCs DETECTED
0 to 0.1
0.1 to 0.5
0.5 to 1.0
1.0 to 3.0
> 3.0
0 feet
60
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.12.4
CUMULATIVE GROUNDWATER
HAZARD IN WELLS
SWMU 97

10.12.6.4 Uncertainty

SWMU 97 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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 E, specifically as a marine cargo terminal and drydocking facility. The ground surface around SWMU 97 is currently covered with either asphalt or concrete. As a result, chronic exposure to current soil condition is highly unlikely and the associated direct contact exposure pathways evaluations overestimate risk and hazard. If this area were to be redeveloped, 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, chronic exposure to current surface soil conditions would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined SWMU 97, 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.

COPC Selection

4-Chloro-3-methylphenol was detected in 1 of 3 surface soil samples at a concentration of 67 μg/kg. There are no RBCs listed for this chemical in the Region III RBC tables, nor are there toxicological data with which to calculate a RBC. As a result, 4-chloro-3-methylphenol was not included in the FRE for SWMU 97. The maximum 4-chloro-3-methylphenol concentration did not exceed the RBC for 2-chlorophenol (39,000 μg/kg). This minimizes the uncertainty associated with the elimination of 4-chloro-3-methylphenol from consideration in the FRE.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for SWMU 97. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, only BEQs and manganese were reported at concentrations within 10% of their RBCs.

Arsenic, beryllium, and chromium were present in SWMU 97 surface soil at concentrations above RBC benchmarks and were eliminated from consideration in the FRE based on comparison to background concentrations. As a result, their contribution to risk and hazard has not been considered for the surface soil pathways in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 within 10% of its RBC.

Because data was collected from only one monitoring well at SWMU 97, inherent uncertainty is great. A comparison of the maximum reported concentrations of antimony and arsenic at SWMU 97 was made with antimony and arsenic concentrations reported at nearby wells (NBCE583W02D, NBCE586001, and GDEGW010) in an effort to reduce uncertainty and help to define the extent of contamination at SWMU 97. Antimony was not reported in groundwater samples collected from these nearby wells at a detectable concentration. Arsenic was reported at 15.6 mg/L (NBCE583W02D), 11.4 mg/L (NBCE586001), and 7.2 mg/L (GDEGW010). None of these concentrations exceeded arsenic's RC of 18.7 mg/L, and were all less than the maximum reported concentration of arsenic at SWMU 97, 31.5 mg/L.

In addition, monitoring well NBCE097001 was assumed to be a hypothetical future well supplying potable water to a single household. In this scenario, quarterly sample results from NBCE097001 were used to monitor SWMU 97 groundwater COPCs for a year. Concentrations previously addressed in this FRE were collected during the first sampling quarter. Antimony was not reported at a concentration above a detectable limit during the second, third, or fourth quarters of sampling. Arsenic concentrations, however, were detected at 38.7 mg/L in the second quarter of sampling and 4.0 mg/L in the third quarter of sampling. The fourth quarter sample was non-detected for arsenic. The arithmetic mean of arsenic concentrations collected quarterly from monitoring well NBCE097001 is 19 mg/L, which is only slightly greater than its background RC of 18.7 mg/L, and could be indicative of ambient concentrations.

Based upon proximate well and subsequent quarterly results at NBCE097001, it is considered that risk and hazard posed by antimony and arsenic have been overestimated in this FRE. Antimony, although considered a COPC, yielded an individual hazard quotient less than unity, and was only reported in the original first-quarter sample. Arsenic was detected at concentrations greater than its corresponding background RC, only in the first two quarters of sampling at NBCE097001. The two latest sampling rounds yielded arsenic concentrations less than the RC, and/or detection limit, indicating that arsenic risk and hazard is likely an overestimate. Arsenic quarterly results also indicate considerable variability spanning over an order of magnitude between sampling events.

10.12.6.5 FRE Summary

The risk and hazard posed by contaminants at SWMU 97 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first-quarter data and considers the ingestion and inhalation (VOCs only) pathways. Risk and HI estimates for the groundwater pathway are presented on Table 10.12.6.3, such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC (arsenic) exceeds its RGO. Section 7, Table 7.12.1 provides residential groundwater RGOs for COPCs identified in Zone E.

Soil — Residential Scenario

No COPCs were detected in SWMU 97 surface soil at concentrations above their residential RGOs.

Soil — Site Worker Scenario

No COPCs were detected in SWMU 97 surface soil at concentrations above their industrial RGOs.

Groundwater — Residential Scenario

Arsenic was detected in SWMU 97 groundwater at concentrations above its residential RGO.

Table 10.12.6.1
Chemicals Present in Site Samples
SWMU 97 - Surface Soil
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Carcinogenic PAHs													
B(a)P Equiv.		2	3	54.83 - 86.20	70.5145	831.96 - 831.96	88	780	NA	UG/KG			
Benzo(a)anthracene		2	3	44 - 78	61	360 - 360	880	7800	NA	UG/KG			
Benzo(a)pyrene		2	3	46 - 66	56	360 - 360	88	780	NA	UG/KG			
Benzo(b)fluoranthene		2	3	40 - 70	55	360 - 360	880	7800	NA	UG/KG			
Benzo(k)fluoranthene		2	3	38 - 61	49.5	360 - 360	8800	78000	NA	UG/KG			
Chrysene		2	3	47 - 92	69.5	360 - 360	88000	780000	NA	UG/KG			
Indeno(1,2,3-cd)pyrene		1	3	47 - 47	47	360 - 380	880	7800	NA	UG/KG			
TCDD Equivalents													
Dioxin Equiv.		1	1	0.30 - 0.30	0.30	NA - NA	1000	1000	NA	NG/KG			
Inorganics													
Aluminum (Al)		3	3	2010 - 3540	2813.33	NA - NA	7800	100000	26600	MG/KG			
Arsenic (As)		3	3	0.87 - 4.9	3.49	NA - NA	0.43	3.8	23.9	MG/KG	3	2	
Barium (Ba)		3	3	3.2 - 18	12.97	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		2	3	0.33 - 0.34	0.34	0.11 - 0.11	0.15	1.3	1.7	MG/KG	2		
Cadmium (Cd)		1	3	0.26 - 0.26	0.26	0.11 - 0.12	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	3	3	19100 - 113000	53166.67	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)		3	3	3.8 - 54.9	24.47	NA - NA	39	1000	94.6	MG/KG	1		
Cobalt (Co)		3	3	0.9 - 2.1	1.63	NA - NA	470	12000	19	MG/KG			
Copper (Cu)		3	3	1.9 - 8.2	5.23	NA - NA	310	8200	66	MG/KG			
Iron (Fe)	N	3	3	1050 - 6380	3476.67	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)		3	3	1.5 - 41.2	26.53	NA - NA	400	400	265	MG/KG			
Magnesium (Mg)	N	3	3	396 - 2430	1495.33	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)		3	3	24.8 - 179	94.43	NA - NA	180	4700	302	MG/KG			
Nickel (Ni)		3	3	1.9 - 5.5	4.00	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N	3	3	511 - 934	712.33	NA - NA	NA	NA	NA	MG/KG			
Sodium (Na)	N	2	3	438 - 684	561.00	199 - 199	NA	NA	NA	MG/KG			
Vanadium (V)		3	3	2.2 - 9.6	5.53	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		3	3	4.5 - 31.9	21.67	NA - NA	2300	61000	827	MG/KG			

Table 10.12.6.1
Chemicals Present in Site Samples
SWMU 97 - Surface Soil
NAVBASE - Charleston
Charleston, SC

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Screening Concentration Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Number Exceeding Ind. RB	Ref.
Pesticides												
4,4'-DDE	1	3	15.1 - 15.1	15.10	2.75 - 2.84	1900	17000	NA	UG/KG			
alpha-Chlordane	2	3	2.68 - 97	49.84	1.43 - 1.43	470	2200	NA	UG/KG			
Dieldrin	1	3	5.5 - 5.5	5.50	2.75 - 2.84	40	360	NA	UG/KG			
Endrin	1	3	4.91 - 4.91	4.91	2.75 - 2.84	2300	61000	NA	UG/KG			
gamma-Chlordane	2	3	6.41 - 260	133.21	1.43 - 1.43	470	2200	NA	UG/KG			
Heptachlor	1	3	7.7 - 7.7	7.70	1.43 - 1.48	140	1300	NA	UG/KG			
Heptachlor epoxide	1	3	7.37 - 7.37	7.37	1.43 - 1.48	70	630	NA	UG/KG			
Semivolatile Organics												
4-Chloro-3-methylphenol	1	3	67 - 67	67	360 - 380	NA	NA	NA	UG/KG			
Acenaphthene	1	3	54 - 54	54	360 - 380	470000	12000000	NA	UG/KG			
Benzo(g,h,i)perylene	1	3	55 - 55	55	360 - 380	310000	8200000	NA	UG/KG			
Benzoic acid	2	3	130 - 200	165	1800 - 1800	31000000	100000000	NA	UG/KG			
Fluoranthene	2	3	66 - 110	88	360 - 360	310000	8200000	NA	UG/KG			
Pentachlorophenol	1	3	43 - 43	43	1800 - 1800	5300	48000	NA	UG/KG			
Phenanthrene	1	3	76 - 76	76	360 - 380	310000	8200000	NA	UG/KG			
Pyrene	2	3	79 - 190	134.5	360 - 360	230000	6100000	NA	UG/KG			
Volatile Organics												
Acetone	1	3	40 - 40	40	11 - 11	780000	20000000	NA	UG/KG			
Methylene chloride	1	3	2 - 2	2	5 - 6	85000	760000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
** - Identified as an industrial COPC
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.12.6.2
Chemicals Present in Site Samples
SWMU 97 - Shallow Groundwater
NAVBASE - Charleston
Charleston, SC

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Screening Conc. Reference	Units	Number Exceeding Res.	Number Exceeding Ref.
Inorganics											
Aluminum (Al)		1	1	109 - 109	109	NA - NA	3700	2810	UG/L		
Antimony (Sb)	*	1	1	5.1 - 5.1	5.1	NA - NA	1.5	NA	UG/L	1	1
Arsenic (As)	*	1	1	31.5 - 31.5	31.5	NA - NA	0.045	18.7	UG/L	1	1
Chromium (Cr)		1	1	1.5 - 1.5	1.5	NA - NA	18	12.3	UG/L		
Vanadium (V)		1	1	12.6 - 12.6	12.6	NA - NA	26	11.4	UG/L		1

Notes:
* - Identified as a COPC
UG/L - micrograms per liter
SQL - Sample quantitation limit
NA - Not applicable

Table 10.12.6.3
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 97
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
097	G001	Antimony (Sb)	5.10	UG/L	NA		0.8151	10.83
097	G001	Arsenic (As)	31.50	UG/L	702.7397	100.00	6.7123	89.17
		Total			702.7397		7.5274	

10.12.7 Corrective Measures Considerations

For SWMU 97, the upper and lower soil intervals and the shallow groundwater were investigated. Based on the analytical results and the risk assessment, COCs requiring further evaluation through the CMS process were identified for the 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. Little risk is associated with the upper interval; additionally, the site soil is capped with asphalt.

Arsenic and antimony were identified in the shallow groundwater at concentrations equaling a risk of 7E-04 and an HI of 7.5. The single groundwater monitoring well installed is insufficient for determining whether a plume exists. No plume is apparent in the shallow groundwater. Human health risk may not be a significant factor since the groundwater is not a potable drinking water source even though the associated risk is above USEPA's acceptable range of 1E-06 and 1E-04. Further assessment is needed to evaluate the natural attenuation process and potential discharge to surface water associated with arsenic in the shallow groundwater.

Potential corrective measures for the impacted medium and the COC are in Table 10.12.7.1.

Table 10.12.7.1
Potential Corrective Measures for SWMU 97

Medium	Compounds	Potential Corrective Measures
Shallow Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-Situ, Chemical and Physical Treatment

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10.19 AOC 525, Paint Booth No. 35, Building 223

AOC 525 is a paint booth (No. 35) in Building 223. Booth 35 is the oldest of the paint booths and is used to paint miscellaneous parts. The booth is 20' x 20' x 15' with a 3' diameter, 15' high stack and operates under a South Carolina Bureau of Air Quality Control Permit. Before 1972, water used to capture paint dust from the booths was discharged directly into the storm sewer system.

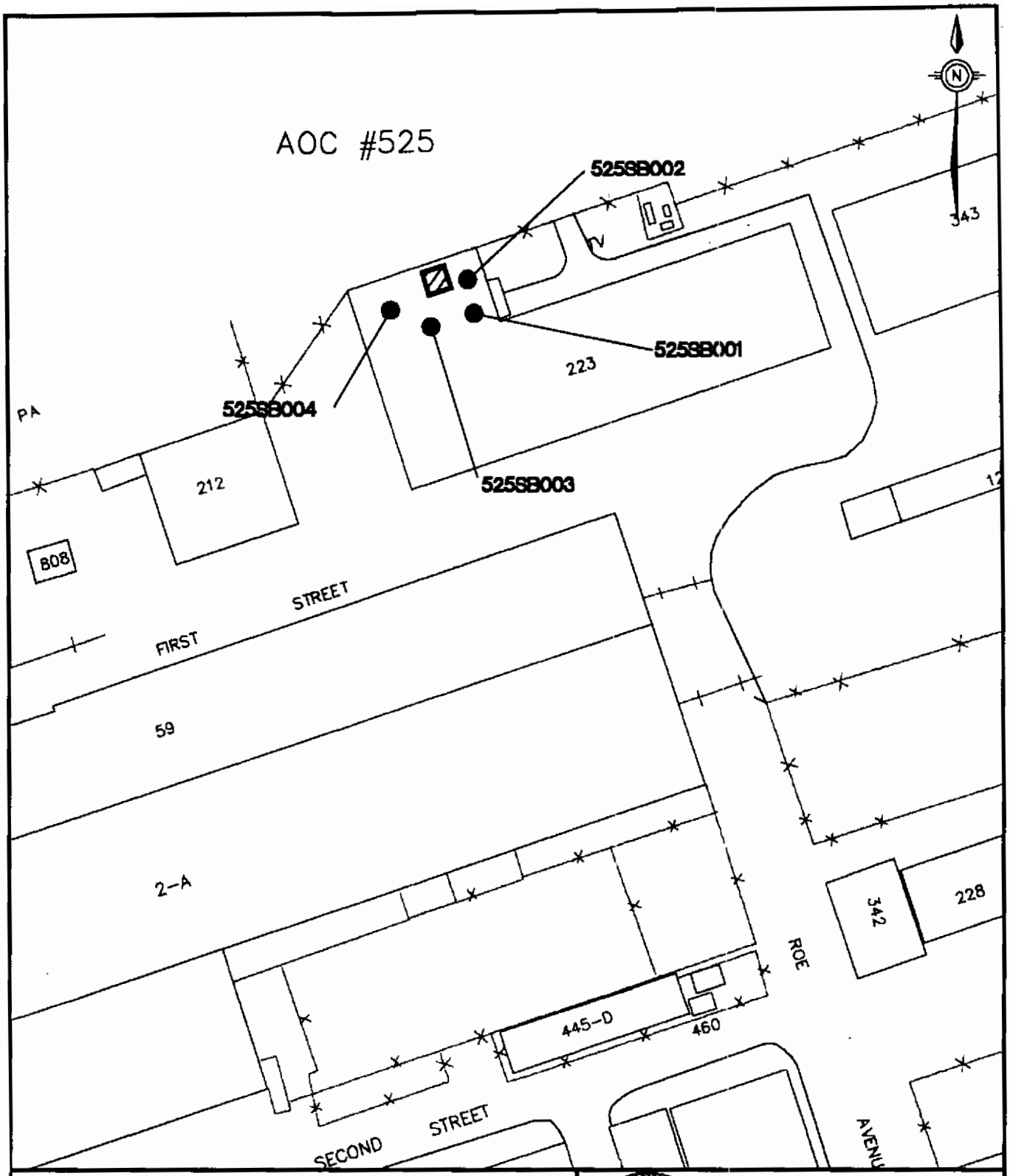
Materials of concern for AOC 525 identified in the *Final Zone E RFI Work Plan* include paints and solvents. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the RFI objectives for AOC 525, soil and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.19.1 Soil Sampling and Analysis

Soil was sampled in one round at AOC 525 from the locations shown in Figure 10.19.1. The *Final Zone E RFI Work Plan*, proposed collecting three soil samples from the upper interval and three samples from the lower interval. Soil samples were also collected at both intervals for the shallow monitoring well location proposed at this site.

All proposed samples were collected and were submitted for analysis at DQO Level III for organotins and the standard suite of parameters which includes VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. No samples were selected as duplicates at AOC 525. Table 10.19.1.1 summarizes soil sampling at AOC 525.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◓ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.19.1
SOIL BORING LOCATIONS
AOC #525
BUILDING 223
PAINT SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-19-1

Table 10.19.1.1
AOC 525
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	Standard Suite[a], organotins	Standard Suite[a], organotins	None
Lower	4	4	Standard Suite[a], organotins	Standard Suite[a], organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, and pesticides/PCBs

10.19.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.19.2.1. Inorganic analytical results for soil are summarized in Table 10.19.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.19.2.1
AOC 525
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Acetone	Upper	2/4	52.0 - 4,500	2,280	20,000,000	0
	Lower	4/4	49.0 - 3,900	1,020	NA	NA
2-Butanone (MEK)	Upper	1/4	8,700	8,700	100,000,000	0
Methylene chloride	Upper	3/4	2.00 - 4.00	2.67	760,000	0
	Lower	3/4	3.00 - 11.0	6.00	NA	NA
Xylene (Total)	Lower	1/4	2.00	2.00	NA	NA

Table 10.19.2.1
AOC 525
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs						
Acenaphthene	Upper	1/4	100	100	12,000,000	0
	Lower	1/4	94.0	94.0	NA	NA
Dibenzofuran	Upper	1/4	90.0	90.0	820,000	0
Di-n-butylphthalate	Lower	1/4	140	140	NA	NA
Dimethyl phthalate	Upper	1/4	92.0	92.0	100.000,000	0
	Lower	1/4	160	160	NA	NA
Fluoranthene	Upper	1/4	140	140	8,200,000	0
	Lower	4/4	89.0 - 310	177	NA	NA
Fluorene	Upper	1/4	170	170	8,200,000	0
	Lower	1/4	94.0	94.0	NA	NA
Phenanthrene	Upper	1/4	520	520	8,200,000	0
	Lower	3/4	86.0 - 330	185	NA	NA
Pyrene	Upper	1/4	130	130	6,100,000	0
	Lower	3/4	150 - 280	213	NA	NA
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Lower	2/4	0.0980 - 117	58.5	NA	NA
Benzo(a)anthracene	Lower	1/4	100	100	NA	NA
Benzo(b)fluoranthene	Lower	1/4	88.0	88.0	NA	NA
Benzo(k)fluoranthene	Lower	1/4	93.0	93.0	NA	NA
Benzo(a)pyrene	Lower	1/4	97.0	97.0	NA	NA
Chrysene	Lower	2/4	98.0 - 180	139	NA	NA

Table 10.19.2.1
AOC 525
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Pesticides						
4,4'-DDD	Upper	1/4	8.20	8.20	24,000	0
	Lower	2/4	5.80 - 30.0	17.9	NA	NA
4,4'-DDE	Lower	3/4	4.50 - 58.0	25.8	NA	NA
4,4'-DDT	Upper	1/4	3.60	3.60	17,000	0
	Lower	2/4	4.40 - 5.10	4.75	NA	NA
Dieldrin	Upper	1/4	3.20	3.20	360	0
Endrin	Upper	3/4	4.60 - 43.0	18.9	61,000	0
	Lower	1/4	40.0	40.0	NA	NA
Heptachlor	Upper	4/4	3.30 - 54.0	17.2	1,300	0
	Lower	1/4	24.0	24.0	NA	NA

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial soil RBC established

Table 10.19.2.2
AOC 525
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	4/4	3,760 - 4,640	4,290	100,000	26,600	0
	Lower	4/4	4,550 - 5,560	5,010	NA	41,100	NA

Table 10.19.2.2
AOC 525
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Antimony (Sb)	Upper	1/4	0.490	0.490	82	1.77	0
	Lower	3/4	0.540 - 0.950	0.703	NA	1.60	NA
Arsenic (As)	Upper	4/4	1.60 - 4.00	2.65	3.80	23.9	0
	Lower	4/4	3.00 - 5.10	4.23	NA	19.9	NA
Barium (Ba)	Upper	4/4	9.80 - 22.3	16.4	14,000	130	0
	Lower	4/4	22.6 - 52.9	38.0	NA	94.1	NA
Beryllium (Be)	Upper	4/4	0.110 - 0.200	0.150	1.30	1.70	0
	Lower	4/4	0.240 - 0.390	0.315	NA	2.71	NA
Cadmium (Cd)	Upper	1/4	0.130	0.130	100	1.50	0
	Lower	3/4	0.120 - 0.520	0.357	NA	0.960	NA
Calcium (Ca)	Upper	4/4	141 - 11,200	3,550	NA	NA	NA
	Lower	4/4	5,340 - 15,000	9,040	NA	NA	NA
Chromium (Cr)	Upper	4/4	3.80 - 6.20	5.05	1,000	94.6	0
	Lower	4/4	10.2 - 23.8	17.5	NA	75.2	NA
Cobalt (Co)	Upper	4/4	1.50 - 9.60	4.43	12,000	19.0	0
	Lower	4/4	1.90 - 8.40	3.75	NA	14.9	NA
Copper (Cu)	Upper	4/4	1.40 - 13.1	5.60	8,200	66.0	0
	Lower	4/4	12.1 - 53.2	30.5	NA	152	NA
Cyanide (CN)	Upper	1/4	0.290	0.290	4,100	0.500	0
Iron (Fe)	Upper	4/4	879 - 3,260	2,000	61,000	NA	0
	Lower	4/4	6,410 - 11,700	8,920	NA	NA	NA
Lead (Pb)	Upper	4/4	2.20 - 52.5	18.4	1,300	265	0
	Lower	4/4	51.0 - 382	188	NA	173	NA

Table 10.19.2.2
AOC 525
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Magnesium (Mg)	Upper	4/4	105 - 387	216	NA	NA	NA
	Lower	4/4	488 - 1,050	810	NA	NA	NA
Manganese (Mn)	Upper	4/4	3.00 - 31.9	15.3	4,700	302	0
	Lower	4/4	48.7 - 109	87.7	NA	881	NA
Mercury (Hg)	Upper	1/4	0.0800	0.0800	61	2.60	0
	Lower	4/4	0.0700 - 0.150	0.123	NA	1.59	NA
Nickel (Ni)	Upper	4/4	2.20 - 4.70	2.98	4,100	77.1	0
	Lower	4/4	3.70 - 8.00	5.23	NA	57.0	NA
Potassium (K)	Upper	1/4	172	172	NA	NA	NA
	Lower	4/4	248 - 640	424	NA	NA	NA
Selenium (Se)	Lower	2/4	0.630 - 0.720	0.675	NA	2.40	NA
Silver (Ag)	Upper	1/4	0.940	0.940	1,000	NA	0
	Lower	2/4	0.310 - 0.540	0.425	NA	NA	NA
Sodium (Na)	Upper	3/4	49.3 - 125	77.4	NA	NA	NA
	Lower	4/4	54.7 - 114	89.6	NA	NA	NA
Vanadium (V)	Upper	4/4	3.20 - 5.40	4.48	1,400	94.3	0
	Lower	4/4	8.20 - 17.8	12.8	NA	155	NA
Zinc (Zn)	Upper	4/4	4.20 - 52.1	26.1	61,000	827	0
	Lower	4/4	54.5 - 315	151	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Four VOCs were detected in soil samples collected at AOC 525. Six detections occurred in the upper interval and eight in the lower interval. No VOCs were detected above their respective industrial RBC in the upper interval. Methylene chloride exceeded its SSL in the lower interval sample at 525SB001.

Semivolatile Organic Compounds in Soil

Thirteen SVOCs were detected in soil samples collected at AOC 525. Seven detections occurred in the upper-interval and 20 in the lower-interval. No SVOCs were detected above their respective industrial RBC in the upper interval or respective SSL in the lower interval.

Pesticides and PCBs in Soil

Six pesticides were detected in soil samples collected at AOC 525. Ten detections occurred in the upper-interval and nine in the lower-interval. No pesticide exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

No PCBs were detected in the soil samples collected at AOC 525.

Other Organic Compounds in Soil

No organotins were detected in soil samples submitted for laboratory analysis from AOC 525.

Inorganic Elements in Soil

Twenty-three metals were detected in soil samples collected at AOC 525. Sixty-nine detections occurred in the upper-interval and 82 occurred in the lower interval. No metal exceeded both its respective industrial RBC and RC in the upper interval or respective SSL and RC in the lower interval.

10.19.3 Groundwater Sampling and Analysis

One shallow monitoring well, NBCE525001, was installed and sampled to assess groundwater quality at AOC 525 as shown in Figure 10.19.2. Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, TDS, and organotins. No samples were selected as duplicates at this site. Table 10.19.3.1 summarizes groundwater sampling and analysis at AOC 525.

Table 10.19.3.1
AOC 525
Groundwater Sampling Summary

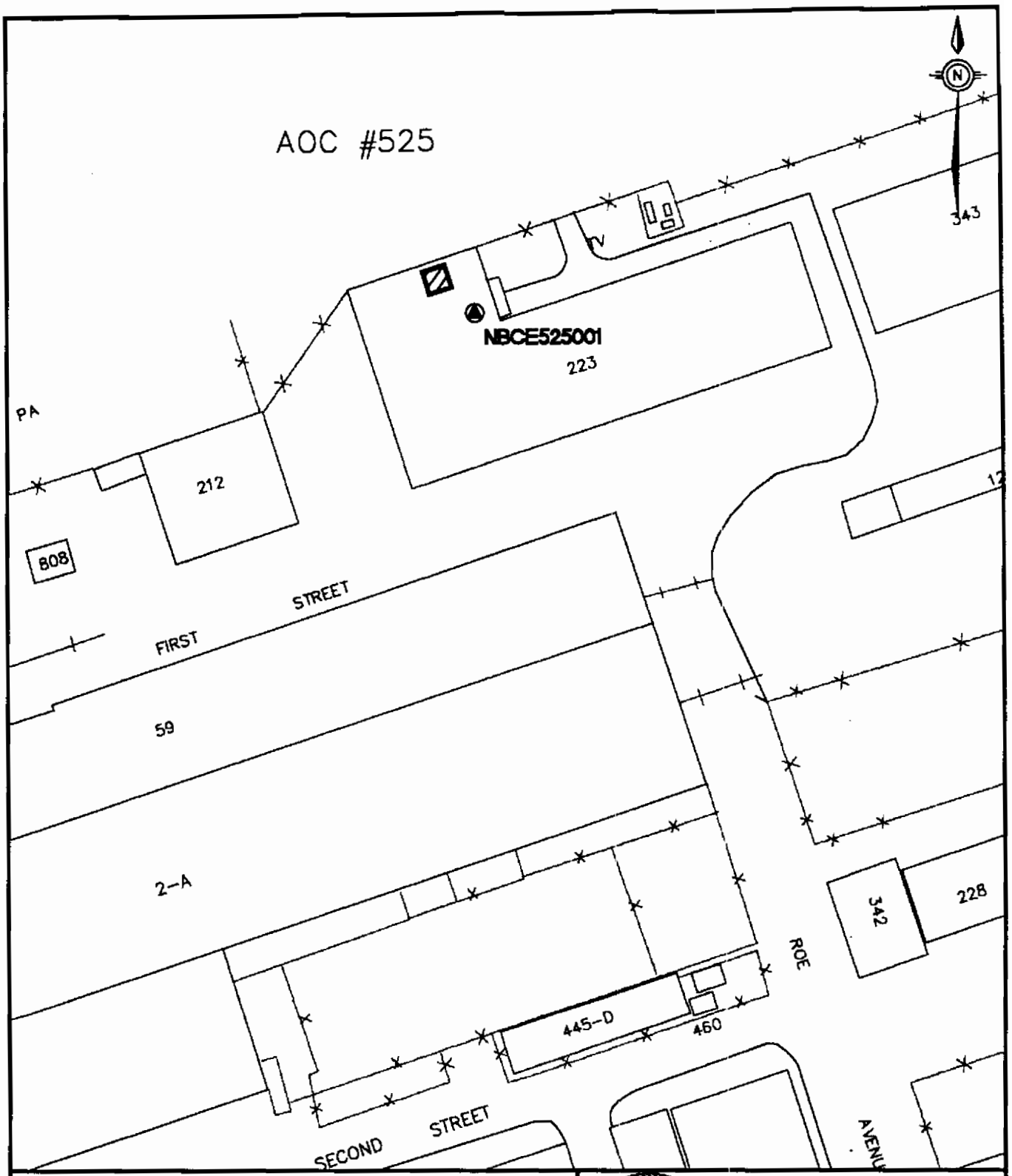
Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	1	1	Standard Suite[a], chlorides, TDS, sulfates, and organotins	Standard Suite[a], chlorides, sulfates, TDS, and organotins	None

Note:
a = Standard Suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

The shallow monitoring well was installed at 12.5 feet bgs in the surficial aquifer in accordance with Section 3.3 of this report.

10.19.4 Nature of Contamination in Groundwater

No organic compounds were detected in groundwater. Inorganic analytical results for groundwater are summarized in Table 10.19.4.1. Appendix H contains the complete data report for all samples collected in Zone E.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.19.2
MONITORING WELL LOCATIONS
AOC #525
BUILDING 223
PAINT SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-19-2

Table 10.19.4.1
AOC 525
Inorganic Detections for First Quarter Groundwater
Shallow Monitoring Wells (μg/L)

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/1	309	309	3,700	2,810	NA	0
Iron (Fe)	1/1	276	276	1,100	NA	NA	0
Magnesium (Mg)	1/1	4,540	4,540	NA	NA	NA	NA
Manganese (Mn)	1/1	905	905	84.0	2,560	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC, MCL, or RC established

Inorganic Elements in Groundwater

Shallow Groundwater

Four metals were detected in the one shallow groundwater sample collected at AOC 525. No metal exceeded both its tap-water RBC and shallow groundwater RC.

10.19.5 Fate and Transport Assessment for AOC 525

AOC 525 is a paint booth in Building 223, surrounded by concrete and asphalt paving. Environmental media sampled as part of the AOC 525 RFI include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for AOC 525 include soil to groundwater, groundwater to surface water, and emission of VOCs from surface soil to air.

10.19.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.19.5.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based SSLs considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Three organic compounds — 2-butanone (MEK), methylene chloride, and dieldrin — were detected in AOC 525 soil above groundwater protection SSLs. 2-Butanone and dieldrin exceeded their generic groundwater protection SSLs in one surface soil sample only (525SB004). Methylene chloride exceeded its groundwater protection SSL in one subsurface soil sample (525SB001). None of these organic constituents was detected in first-quarter groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer. No inorganic constituents were detected in soil above their respective groundwater protection SSLs or RCs.

10.19.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.19.5.1 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to RBCs 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) RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No constituents were detected in first-quarter groundwater samples at AOC 525 that exceeded tap water RBCs, RCs, or saltwater surface water chronic screening levels.

10.19.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.19.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 525 is 34,700:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.19.5.4 Soil-to-Air Cross-Media Transport

Table 10.19.5.3 lists the VOCs detected in surface soil samples collected at AOC 525 along with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at AOC 525. 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 expected to be significant at AOC 525.

10.19.5.5 Fate and Transport Summary

In the first-tier screen, two organic compounds — 2-butanone and dieldrin -- were detected above their generic groundwater protection SSLs in the same surface soil sample (525SB004). Methylene chloride was detected above its generic groundwater protection SSL in one subsurface soil sample (525SB001). No constituents were detected in first-quarter groundwater samples at concentrations exceeding tap water RBCs, RCs, or saltwater surface water chronic screening levels.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.19.5.1
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: Tier One
NAVBASE-Charleston, Zone E: AOC 525
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	4500	3900	ND	NA	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	8700	ND	ND	NA	4000	1900	NA	UG/KG	UG/L	YES	NO	NO
Methylene chloride	4	11	ND	NA	10	4.1	2560	UG/KG	UG/L	YES	NO	NO
Xylene (total)	ND	2	ND	NA	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	100	94	ND	NA	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	ND	100	ND	NA	800	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	ND	97	ND	NA	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	ND	88	ND	NA	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	ND	93	ND	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	ND	180	ND	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	90	ND	ND	NA	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	140	ND	ND	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Dimethylphthalate	92	160	ND	NA	1200000	370000	580	UG/KG	UG/L	NO	NO	NO
Fluoranthene	140	310	ND	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	170	94	ND	NA	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenanthrene	520	330	ND	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	130	280	ND	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
4,4'-DDD	8.2	30	ND	NA	8000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	ND	58	ND	NA	27000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	3.6	5.1	ND	NA	16000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Dieldrin	3.2	ND	ND	NA	2	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO
Endrin	43	40	ND	NA	500	11	0.0023	UG/KG	UG/L	NO	NO	NO
Heptachlor	54	24	ND	NA	11500	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	4640	5560	309	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	0.49	0.95	ND	NA	2.5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	4	5.1	ND	NA	23.9	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	22.3	52.9	ND	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.2	0.39	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.13	0.52	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	6.2	23.8	ND	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	9.6	8.4	ND	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	13.1	53.2	ND	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.29	ND	ND	NA	20	730	37.3	MG/KG	UG/L	NO	NO	NO
Lead	52.5	382	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	31.9	109	905	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.08	0.15	ND	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	4.7	8	ND	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	ND	0.72	ND	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.94	0.54	ND	NA	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Vanadium	5.4	17.8	ND	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	52.1	315	ND	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.19.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 525
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Volatile Organic Compounds																
2-Butanone (MEK)	8700	ND	ND	NA	4000	1900	NA	1900	6.59E+07	1900	3.47E+04	1.04E+07	UG/KG	UG/L	NO	NO
Methylene chloride	4	11	ND	NA	10	4.1	2560	4.1	1.42E+05	5	2.85E+04	2.85E+04	UG/KG	UG/L	NO	NO
Pesticides/PCB Compounds																
Dieldrin	3.2	ND	ND	NA	2	0.0042	0.0019	0.0019	6.59E+01	0.005	1.32E+04	2.64E+03	UG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 34,700: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.19.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 525
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	4500	62000000	UG/KG	NO
2-Butanone (MEK)	8700	10000	UG/KG	NO
Methylene chloride	4	7000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996. The value for 2-Butanone (MEK) was estimated.

10.19.6 Fixed-Point Risk Evaluation for AOC 525

10.19.6.1 Site Background and Investigative Approach

AOC 525 is a paint booth (number 35) in Building 223. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of four surface soil samples were considered in the AOC 525 FRE. One monitoring well was installed into the shallow aquifer as part of the 1995 RFI. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 525 FRE. Sections 10.19.1 and 10.19.3 contain summaries of the sampling effort for AOC 525 soil and groundwater.

10.19.6.2 Fixed-Point Risk Evaluation for Soil

Table 10.19.6.1 provides CPSS summaries for AOC 525 soil and identifies COPCs based on comparison to residential and industrial RBCs and RCs. No COPCs were identified for AOC 525 soil for either the residential or industrial scenarios. Arsenic was detected at a concentration above both its residential and industrial RBC, and beryllium was detected at a concentration above its residential RBC. Arsenic and beryllium were both eliminated from consideration in the AOC 525 FRE based on comparison to their RCs. Wilcoxon rank sum test did not result in the inclusion of any inorganic parameter that had been screened out based on RC.

10.19.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.19.6.2 provides CPSS summaries for AOC 525 groundwater and identifies COPCs based on comparison to residential RBCs and RCs. No COPCs were identified for AOC 525 groundwater. Manganese was detected at a concentration exceeding its tap water RBC, however, it was eliminated from consideration in the shallow groundwater FRE based on comparison to its RC. AOC 525 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses,

and as a result, manganese was eliminated from the shallow groundwater FRE based on direct comparison of its maximum concentration to its RC.

10.19.6.4 FRE Summary

Data collected for AOC 525 were screened according to the process presented in Section 7.3.4. No COPCs were identified subsequent to this screening.

Table 10.19.6.1
Chemicals Present in Site Samples
AOC 525 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Ind. RBC	Ref.
Inorganics													
Aluminum (Al)		4	4	3760 - 4640	4292.5	NA - NA	7800	100000	26600	MG/KG			
Antimony (Sb)		1	4	0.49 - 0.49	0.49	0.44 - 0.45	3.1	82	1.77	MG/KG			
Arsenic (As)		4	4	1.6 - 4	2.65	NA - NA	0.43	3.8	23.9	MG/KG	4	1	
Barium (Ba)		4	4	9.8 - 22.3	16.425	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		4	4	0.11 - 0.2	0.15	NA - NA	0.15	1.3	1.7	MG/KG	2		
Cadmium (Cd)		1	4	0.13 - 0.13	0.13	0.11 - 0.11	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	4	4	141 - 11200	3545	NA - NA	NA	NA	NA	MG/KG	4		
Chromium (Cr)		4	4	3.8 - 6.2	5.05	NA - NA	39	1000	94.6	MG/KG			
Cobalt (Co)		4	4	1.5 - 9.6	4.4	NA - NA	470	12000	19	MG/KG			
Copper (Cu)		4	4	1.4 - 13.1	5.6	NA - NA	310	8200	66	MG/KG			
Cyanide (CN)		1	4	0.29 - 0.29	0.29	0.22 - 0.23	160	4100	0.5	MG/KG			
Iron (Fe)	N	4	4	879 - 3260	2000	NA - NA	NA	NA	NA	MG/KG	1		
Lead (Pb)		4	4	2.2 - 52.5	18.4	NA - NA	400	400	265	MG/KG			
Magnesium (Mg)	N	4	4	105 - 387	216	NA - NA	NA	NA	NA	MG/KG	4		
Manganese (Mn)		4	4	3 - 31.9	15.3	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)		1	4	0.08 - 0.08	0.08	0.02 - 0.02	2.3	61	2.6	MG/KG			
Nickel (Ni)		4	4	2.2 - 4.7	2.98	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N	1	4	172 - 172	172	165 - 170	NA	NA	NA	MG/KG	1		
Silver (Ag)		1	4	0.94 - 0.94	0.94	0.22 - 0.23	39	1000	NA	MG/KG			
Sodium (Na)	N	3	4	49.3 - 125	77.4	11 - 11	NA	NA	NA	MG/KG	3		
Vanadium (V)		4	4	3.2 - 5.4	4.48	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		4	4	4.2 - 52.1	26.08	NA - NA	2300	61000	827	MG/KG			
Pesticides													
4,4'-DDD		1	3	8.2 - 8.2	8.2	2.8 - 27	2700	24000	NA	UG/KG			
4,4'-DDT		1	3	3.6 - 3.6	3.6	2.8 - 27	1900	17000	NA	UG/KG			
Dieldrin		1	3	3.2 - 3.2	3.2	2.8 - 27	40	360	NA	UG/KG			
Endrin		3	3	4.6 - 43	18.9	NA - NA	2300	61000	NA	UG/KG			
Heptachlor		3	3	4.7 - 54	21.8	NA - NA	140	1300	NA	UG/KG			

Table 10.19.6.1
Chemicals Present in Site Samples
AOC 525 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Screening Concentration: Reference	Screening Concentration: Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RBC	Number Exceeding: Ref.
Semivolatile Organics												
Acenaphthene	1	4	100 - 100	100	720 - 740	470000	12000000	NA	UG/KG			
Dibenzofuran	1	4	90 - 90	90	720 - 740	31000	820000	NA	UG/KG			
Dimethyl phthalate	1	4	92 - 92	92	720 - 740	78000000	100000000	NA	UG/KG			
Fluoranthene	1	4	140 - 140	140	720 - 740	310000	8200000	NA	UG/KG			
Fluorene	1	4	170 - 170	170	720 - 740	310000	8200000	NA	UG/KG			
Phenanthrene	1	4	520 - 520	520	720 - 740	310000	8200000	NA	UG/KG			
Pyrene	1	4	130 - 130	130	720 - 740	230000	6100000	NA	UG/KG			
Volatile Organics												
2-Butanone (MEK)	1	4	8700 - 8700	8700	11 - 11	4700000	100000000	NA	UG/KG			
Acetone	2	4	52 - 4500	2276	11 - 11	780000	20000000	NA	UG/KG			
Methylene chloride	3	4	2 - 4	2.67	700 - 700	85000	760000	NA	UG/KG			

Notes:
N - Essential nutrient
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram
SQL - Sample quantitation limit
RBC - Risk-based concentration
NA - Not applicable

Table 10.19.6.2
Chemicals Present in Site Samples
AOC 525 - Shallow Groundwater
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Screening Conc. Reference	Units	Number Exceeding Res.	Number Exceeding Ref.
Inorganics											
Aluminum (Al)		1	1	309 - 309	309	NA - NA	3700	2810	UG/L		
Iron (Fe)	N	1	1	276 - 276	276	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	4540 - 4540	4540	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	1	905 - 905	905	NA - NA	84	2560	UG/L	1	

Notes:
N - Essential nutrient
UG/L - micrograms per liter
SQL - Sample quantitation limit
NA - Not applicable

10.19.7 Corrective Measures Considerations

For AOC 525, the upper and lower soil intervals were investigated. Based on the analytical results and the FRE, no COC requiring further evaluation through the CMS process was identified for the soil intervals or shallow groundwater.

Residential use of the site is not expected, based on current site uses and the nature of surrounding buildings and current reuse plans call for continued commercial/industrial use. Furthermore, the site is paved with concrete. No further action is recommended for the soil interval. Manganese was detected at a concentration exceeding its tap water RBC, however, it was eliminated as a COC based on comparison to its RC.

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10.20 AOC 528, Steam Cleaning Shop

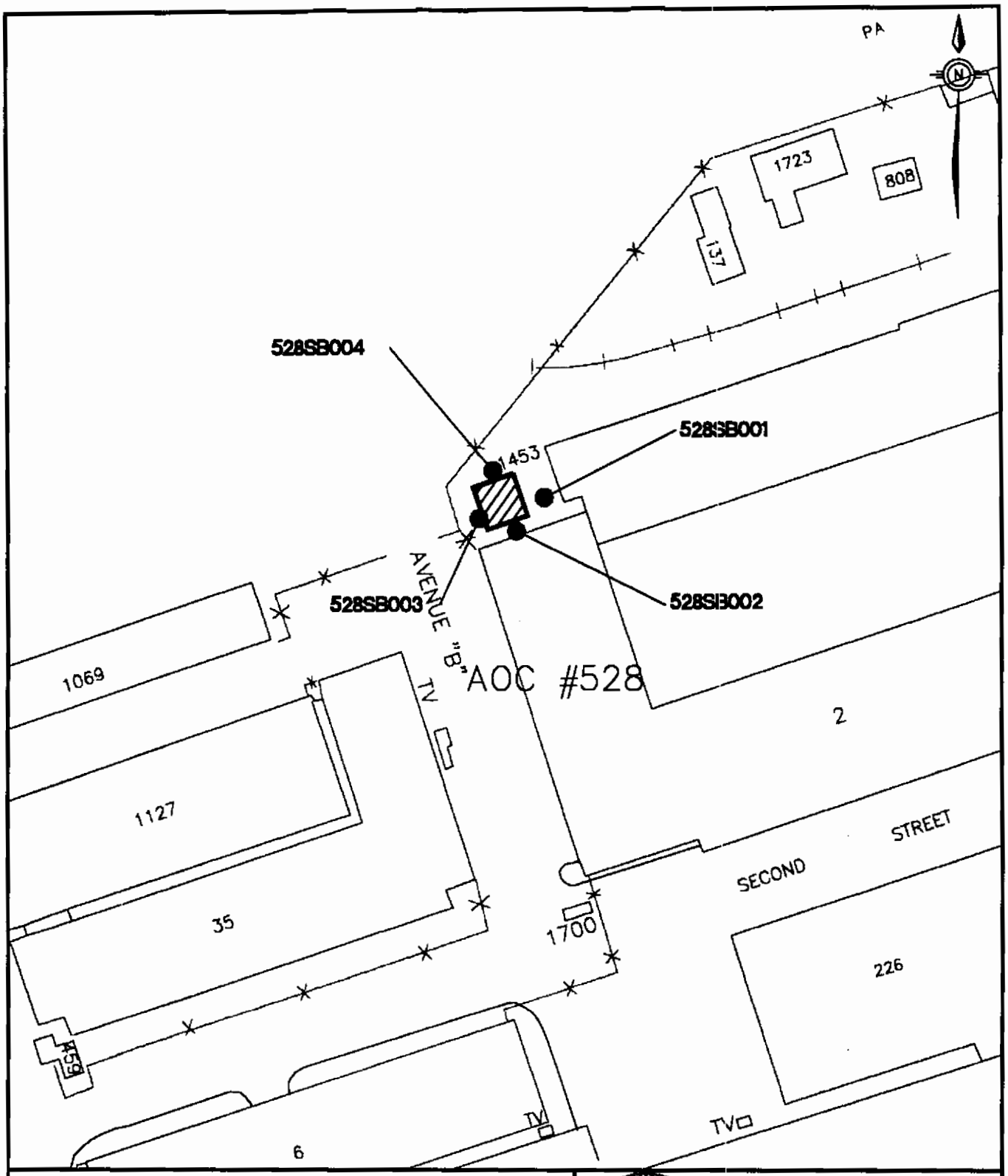
AOC 528 consists of a former steam cleaning shop which was used to clean boiler parts. Boiler tubes, preserved with Cosmoline® grease to prevent rust, were received at the boiler shop. The Cosmoline® was removed in Building 59 by a bath of kerosene, and all remaining grease was removed in another bath of hot water, trisodiumphosphate, caustic, and detergents. After the second bath, the tubes were steam rinsed at the steam cleaning shop. Although this operation did not generate hazardous waste, it did produce approximately 800 gallons of contaminated kerosene semi-annually. The contents of the second bath and the steam cleaning operation were discharged to the sanitary sewer. Before installation of the sanitary sewer, waste was discharged to the Cooper River via the combined sewer system.

Materials of concern at AOC 528 indicated in the *Final Zone E RFI Work Plan* are caustics, petroleum hydrocarbons, and kerosene. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 528, soil, groundwater, and sediment were sampled in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.20.1 Soil Sampling and Analysis

Soil was sampled in one round at AOC 528 from the locations shown in Figure 10.20.1. The *Final Zone E RFI Work Plan* proposed collecting three soil samples from the upper interval and three samples from the lower interval. Soil samples were also collected from both intervals at the shallow monitoring well location proposed for the site. All four of the proposed upper-interval samples and the four lower-interval samples were collected.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.20.1
SOIL BORING LOCATIONS
AOC #528
STEAM CLEANING SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-20-1

All samples were submitted for analysis of VOCs, SVOCs, and pH at DQO Level III. One lower-interval soil sample was selected as a duplicate and analyzed at DQO Level IV for Appendix IX parameters which included the suite of analyses proposed for the site, plus a more comprehensive list of VOCs and SVOCs, as well as herbicides, dioxins, hexavalent chromium, and organophosphorus pesticides. Table 10.20.1.1 summarizes soil sampling at AOC 528.

Table 10.20.1.1
AOC 528
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	4	4	VOCs, SVOCs, pH	VOCs, SVOCs, pH	One sample was inadvertently analyzed for organotins, pesticides, metals, and cyanide
Lower	4	4	VOCs, SVOCs, pH	VOCs, SVOCs, pH	One sample was inadvertently analyzed for organotins, pesticides, metals, and cyanide

10.20.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.20.2.1. Inorganic analytical results for soil are summarized in Table 10.20.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.20.2.1
AOC 528
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
2-Butanone (MEK)	Lower	1/4	3.00	3.00	NA	NA

Table 10.20.2.1
AOC 528
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Benzo(g,h,i)perylene	Lower	1/4	150	150	NA	NA
Butylbenzylphthalate	Upper	1/4	160	160	41,000,000	0
Fluoranthene	Upper	1/4	220	220	8,200,000	0
	Lower	1/4	360	360	NA	NA
Phenanthrene	Upper	1/4	90.0	90.0	8,200,000	0
	Lower	1/4	200	200	NA	NA
Pyrene	Upper	1/4	190	190	6,100,000	0
	Lower	1/4	340	340	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	1/4	123	123	780	0
	Lower	1/4	252	252	NA	NA
Benzo(a)anthracene	Upper	1/4	110	110	7,800	0
	Lower	1/4	180	180	NA	NA
Benzo(b)fluoranthene	Lower	1/4	200	200	NA	NA
Benzo(k)fluoranthene	Upper	1/4	190	190	78,000	0
	Lower	1/4	190	190	NA	NA
Benzo(a)pyrene	Upper	1/4	110	110	780	0
	Lower	1/4	200	200	NA	NA
Chrysene	Upper	1/4	120	120	780,000	0
	Lower	1/4	210	210	NA	NA
Indeno(1,2,3-cd)pyrene	Lower	1/4	120	120	NA	NA

Table 10.20.2.1
AOC 528
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
Dioxin Equiv.	Lower	1/1	0.00740	0.00740	NA	NA
OCDD	Lower	1/1	7.38	7.38	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.20.2.2
AOC 528
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Aluminum (Al)	Upper	1/1	4,310	4,310	100,000	26,600	0
	Lower	1/1	4,300	4,300	NA	41,100	NA
Arsenic (As)	Upper	1/1	2.80	2.80	3.80	23.9	0
	Lower	1/1	1.40	1.40	NA	19.9	NA
Barium (Ba)	Upper	1/1	23.3	23.3	14,000	130	0
	Lower	1/1	26.0	26.0	NA	94.1	NA
Beryllium (Be)	Upper	1/1	0.370	0.370	1.30	1.70	0
	Lower	1/1	0.330	0.330	NA	2.71	NA
Cadmium (Cd)	Upper	1/1	0.420	0.420	100	1.50	0
	Lower	1/1	0.340	0.340	NA	0.960	NA
Calcium (Ca)	Upper	1/1	55,300	55,300	NA	NA	NA
	Lower	1/1	9,790	9,790	NA	NA	NA

Table 10.20.2.2
AOC 528
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Chromium (Cr)	Upper	1/1	9.40	9.40	1,000	94.6	0
	Lower	1/1	5.80	5.80	NA	75.2	NA
Cobalt (Co)	Upper	1/1	3.20	3.20	12,000	19.0	0
	Lower	1/1	0.960	0.960	NA	14.9	NA
Copper (Cu)	Upper	1/1	161	161	8,200	66.0	0
	Lower	1/1	121	121	NA	152	NA
Iron (Fe)	Upper	1/1	3,620	3,620	61,000	NA	0
	Lower	1/1	2,790	2,790	NA	NA	NA
Lead (Pb)	Upper	1/1	52.0	52.0	1,300	265	0
	Lower	1/1	33.7	33.7	NA	173	NA
Magnesium (Mg)	Upper	1/1	741	741	NA	NA	NA
	Lower	1/1	253	253	NA	NA	NA
Manganese (Mn)	Upper	1/1	132	132	4,700	302	0
	Lower	1/1	176	176	NA	881	NA
Mercury (Hg)	Upper	1/1	0.130	0.130	61	2.60	0
	Lower	1/1	0.680	0.680	NA	1.59	NA
Nickel (Ni)	Upper	1/1	11.2	11.2	4,100	77.1	0
	Lower	1/1	3.90	3.90	NA	57.0	NA
Sodium (Na)	Upper	1/1	62.1	62.1	NA	NA	NA
Tin (Sn)	Upper	1/1	14.1	14.1	100,000	59.4	0
	Lower	1/1	13.1	13.1	NA	9.23	NA
Vanadium (V)	Upper	1/1	5.20	5.20	1,400	94.3	0
	Lower	1/1	3.60	3.60	NA	155	NA
Zinc (Zn)	Upper	1/1	99.0	99.0	61,000	827	0
	Lower	1/1	81.7	81.7	NA	886	NA

Table 10.20.2.2
AOC 528
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
pH (SU)VOCs							
pH	Upper	4/4	7.99 - 10.2	8.76	NA	NA	NA
	Lower	4/4	7.11 - 8.19	7.65	NA	NA	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established
SU = Standard units

Volatile Organic Compounds in Soil

One VOC — 2-butanone — was detected in soil samples collected at AOC 528. A single detection occurred in the lower interval at a concentration below the 2-butanone SSL.

Semivolatile Organic Compounds in Soil

Eleven SVOCs were detected in soil samples collected at AOC 528. Eight detections occurred in the upper interval and 10 in the lower interval. No SVOCs exceeded their respective industrial RBC in the upper interval or respective SSL in the lower interval.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 528. The BEQ was calculated for one upper-interval sample at 123 μg/kg, below the benzo(a)pyrene industrial RBC of 780 μg/kg.

Pesticides in Soil

No pesticides were detected in soil samples collected at AOC 528.

Other Organic Compounds in Soil

One dioxin was detected in soil samples submitted for analysis from AOC 528. The detection occurred in the lower interval below the compound's respective SSL. No upper-interval samples were submitted for dioxin analysis.

Inorganic Elements in Soil

Nineteen metals were detected in soil samples collected at AOC 528. Nineteen detections occurred in the upper-interval and 18 occurred in the lower-interval. No metal exceeded both its respective industrial RBC and background RC in the upper-interval or respective SSL and background RC in the lower-interval.

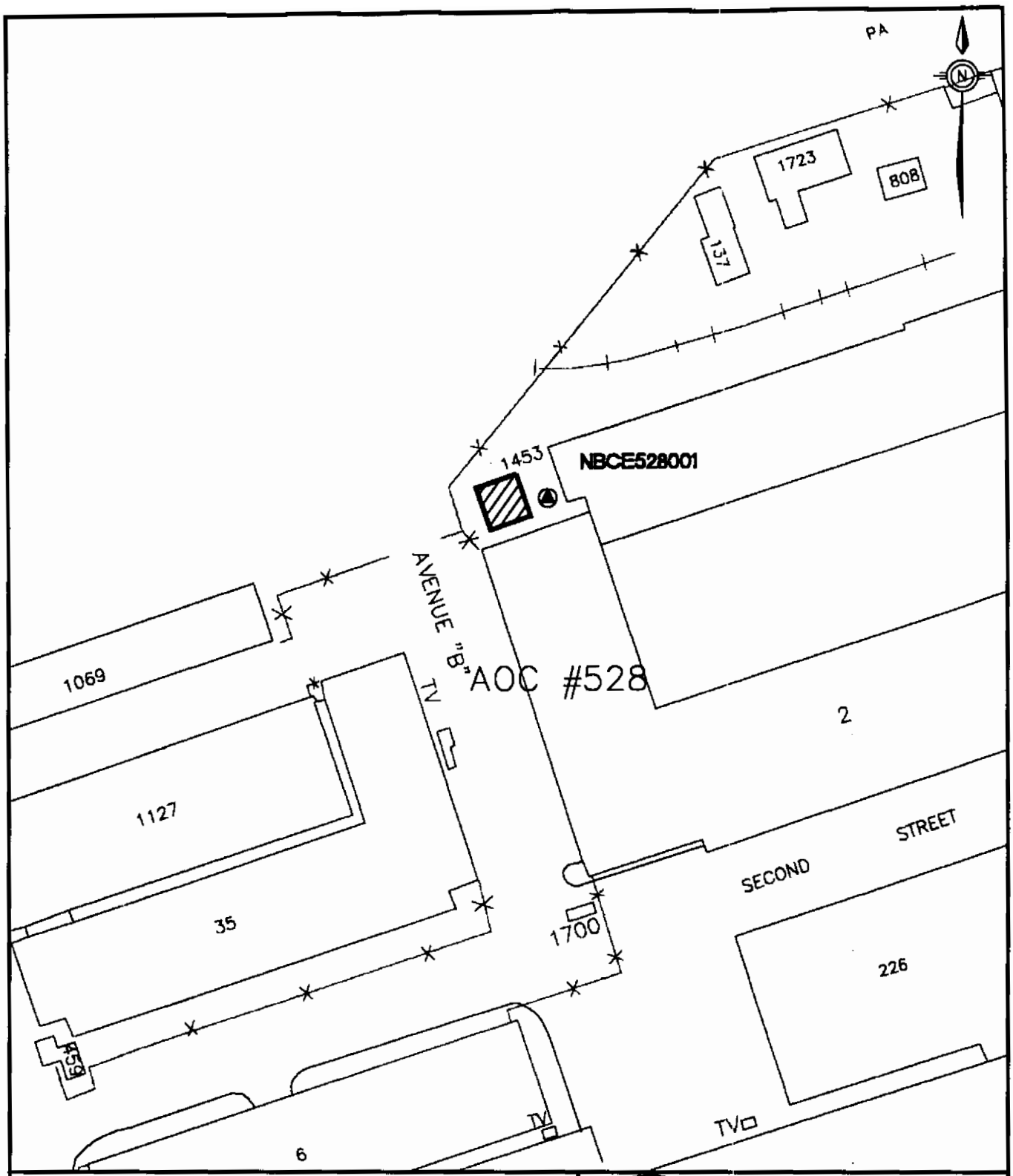
10.20.3 Groundwater Sampling and Analysis

One shallow monitoring well, NBCE528001, was installed and sampled to assess groundwater quality at AOC 528 as shown in Figure 10.20.2. Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, pH, metals, chlorides, sulfates, and TDS. No samples were selected as duplicates at this site. Table 10.20.3.1 summarizes groundwater sampling and analysis at AOC 528.

Table 10.20.3.1
AOC 528
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	1	1	VOCs, SVOCs, and pH	VOCs, SVOCs, pH, metals, chlorides, sulfates, and TDS	Additional parameters were added to further characterize the groundwater at the site.

The shallow monitoring well was installed at 13.5 feet bgs in the surficial aquifer in accordance with Section 3.3 of this report.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.20.2
MONITORING WELL LOCATIONS
AOC #528
STEAM CLEANING
SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-20-2

10.20.4 Nature of Contamination in Groundwater

No organic compounds were detected in the shallow groundwater monitoring well at AOC 528. Table 10.20.4.1 summarizes the inorganic analytical results for groundwater. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.20.4.1
AOC 528
Inorganic Detections for First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Arsenic (As)	1/1	9.60	9.60	0.0450	18.7	50.0	0
Calcium (Ca)	1/1	136,000	136,000	NA	NA	NA	NA
Iron (Fe)	1/1	4,410	4,410	1,100	NA	NA	1
Magnesium (Mg)	1/1	34,200	34,200	NA	NA	NA	NA
Manganese (Mn)	1/1	518	518	84.0	2,560	NA	0
Nickel (Ni)	1/1	3.10	3.10	73.0	15.2	100	0
Potassium (K)	1/1	15,800	15,800	NA	NA	NA	NA
Vanadium (V)	1/1	2.10	2.10	26.0	11.4	NA	0
pH (SU)							
pH	1/1	6.42	6.42	NA	NA	NA	NA

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established
SU = Standard units

Inorganic Elements in Groundwater

Shallow Groundwater

Eight metals were detected in the one shallow groundwater sample collected at AOC 528. One metal — iron — exceeded its respective tap-water RBC.

Iron was detected in well NBCE528001 (4,410 μg/L), exceeding its tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

pH in Groundwater

Shallow Groundwater

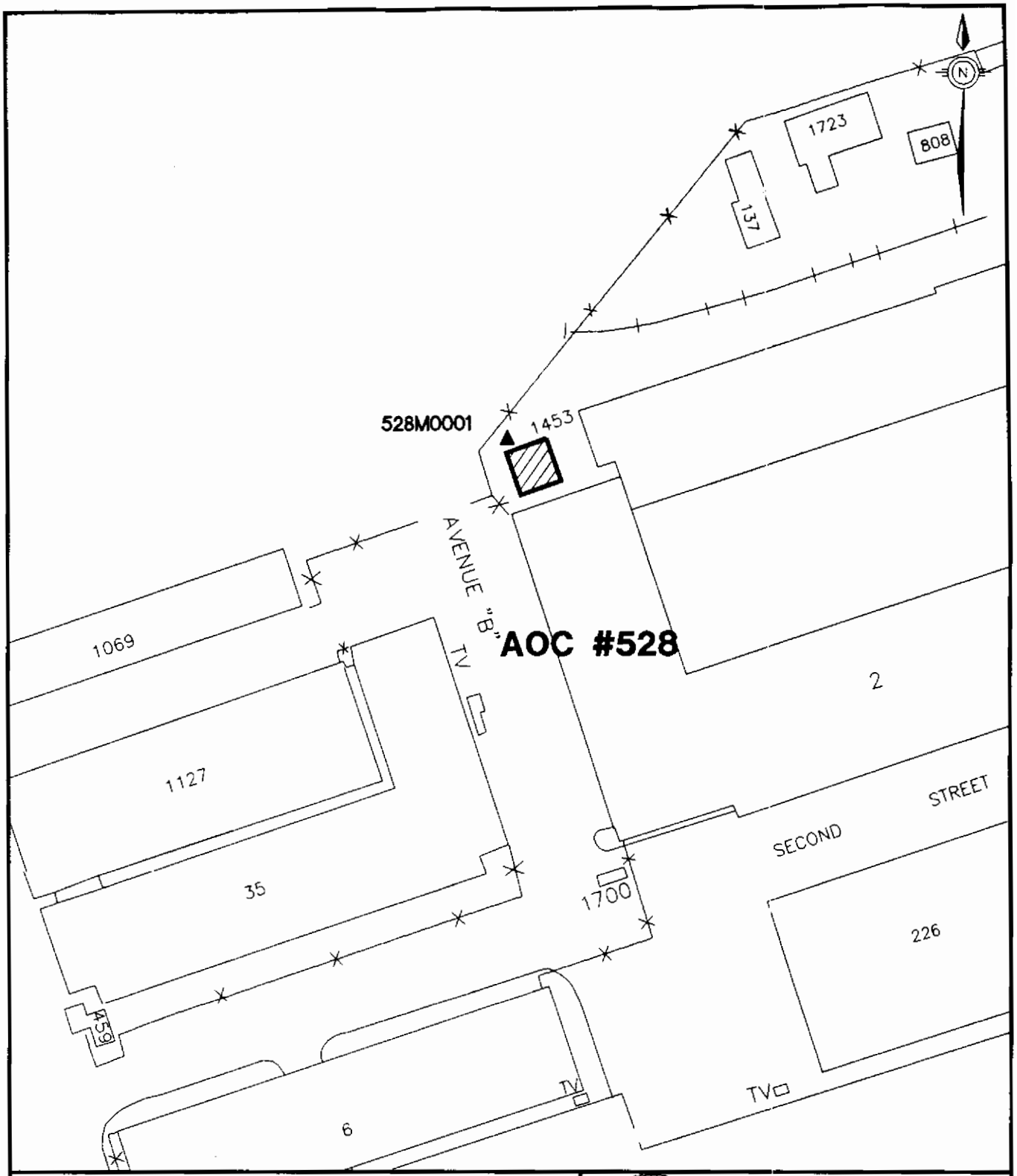
The pH of the groundwater sample from well NBCE528001 was 6.42 SU. No RBC or RC has been established for pH.

10.20.5 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting one sediment sample at AOC 528 from the location shown in Figure 10.20.3. One sediment sample was collected and submitted for analysis at DQO Level III for VOCs, SVOCs, and pH. No samples were selected as duplicates at this site. Table 10.20.5.1 summarizes sediment sampling and analysis at AOC 528.

Table 10.20.5.1
AOC 528
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
1	1	VOCs, SVOCs, and pH	VOCs, SVOCs, and pH	None



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.20.3
SEDIMENT SAMPLE LOCATIONS
AOC #528
STEAM CLEANING
SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-20-3

10.20.6 Nature of Contamination in Sediment

Table 10.20.6.1 summarizes the organic analytical results for sediment. Table 10.20.6.2 summarizes the inorganic analytical results for sediment. Appendix H contains the complete analytical report for all samples collected in Zone E. Sediment analytical results were evaluated in Section 8, Ecological Risk Assessment, of this report.

Table 10.20.6.1
AOC 528
Organic Compounds Detected in Sediment (μg/kg)

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
VOCs					
Benzene	1/2	3.00	3.00	200	0
Chloromethane	1/2	5.00	5.00	440	0
Tetrachloroethene	1/2	5.00	5.00	110	0
Xylene (Total)	1/2	4.00	4.00	100,000	0
SVOCs					
Anthracene	1/2	700	700	61,000,000	0
Benzo(g,h,i)perylene	2/2	390 - 1,100	745	8,200,000	0
Benzoic acid	1/2	67.0	67.0	100,000,000	0
bis(2-Ethylhexyl)phthalate	1/2	17,000	17,000	410,000	0
Butylbenzylphthalate	1/2	710	710	41,000,000	0
Dibenzofuran	1/2	190	190	820,000	0
Di-n-butylphthalate	1/2	180	180	NA	NA
Di-n-octyl phthalate	2/2	340 - 15,000	7,670	4,100,000	0
Fluoranthene	2/2	310 - 8,000	4,160	8,200,000	0
Phenanthrene	2/2	140 - 4,600	2,370	8,200,000	0
Pyrene	2/2	290 - 5,500	2,900	6,100,000	0

Table 10.20.6.1
AOC 528
Organic Compounds Detected in Sediment (μg/kg)

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents)					
B(a)P Equivalent	2/2	411 - 2,280	1,350	780	1
Benzo(a)anthracene	2/2	190 - 2,200	1,200	7,800	0
Benzo(b)fluoranthene	1/2	1,600	1,600	7,800	0
Benzo(k)fluoranthene	2/2	630 - 1,400	1,020	7,800	0
Benzo(a)pyrene	2/2	260 - 1,300	780	780	1
Chrysene	2/2	320 - 2,500	1,410	780,000	0
Dibenz(a,h)anthracene	2/2	94.0 - 490	292	780	0
Indeno(1,2,3-cd)pyrene	2/2	310 - 980	645	7,800	0
Pesticides					
Dieldrin	1/1	370	370	360	1
Endosulfan II	1/1	160	160	1,200	0
Endrin	1/1	170	170	61,000	0
Endrin aldehyde	1/1	490	490	61,000	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Industrial Soil RBC
NA = No industrial RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS SSVs.

Table 10.20.6.2
AOC 528
Inorganic Detections in Sediment

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Inorganic Elements (mg/kg)					
Aluminum (Al)	1/1	15,900	15,900	100,000	0
Antimony (Sb)	1/1	15.3	15.3	82	0
Arsenic (As)	1/1	6.60	6.60	3.8	1
Barium (Ba)	1/1	99.8	99.8	14,000	0
Beryllium (Be)	1/1	0.120	0.120	1.3	0
Cadmium (Cd)	1/1	10.7	10.7	100	0
Calcium (Ca)	1/1	42,200	42,200	NA	NA
Chromium (Cr)	1/1	107	107	1,000	0
Cobalt (Co)	1/1	21.1	21.1	12,000	NA
Copper (Cu)	1/1	134,000	134,000	8,200	1
Iron (Fe)	1/1	25,100	25,100	61,000	NA
Lead (Pb)	1/1	364	364	1,300	0
Magnesium (Mg)	1/1	1,170	1,170	NA	NA
Manganese (Mn)	1/1	3,150	3,150	4,700	0
Nickel (Ni)	1/1	6,480	6,480	4,100	1
Potassium (K)	1/1	433	433	NA	NA
Silver (Ag)	1/1	26.5	26.5	1,000	0
Sodium (Na)	1/1	3,370	3,370	NA	NA
Tin (Sn)	1/1	336	336	100,000	0
Vanadium (V)	1/1	15.9	15.9	1,400	0
Zinc (Zn)	1/1	17,100	17,100	61,000	0

Table 10.20.6.2
AOC 528
Inorganic Detections in Sediment

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial Soil RBC	Number of Samples Exceeding RBC
Inorganic Elements (mg/kg)					
pH (SU)					
pH	1/1	7.01	7.01	NA	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Industrial soil RBC
NA = No industrial soil RBC established
SU = Standard Units
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS SSVs.

Volatile Organic Compounds in Sediment

Four VOCs were detected in sediment samples collected at AOC 528. Four detections occurred in the upper interval (sediment samples collected from upper interval only). No VOCs were detected above their respective industrial soil RBCs.

Semivolatile Organic Compounds in Sediment

Eighteen SVOCs were detected in sediment samples collected at AOC 528. Twenty-nine detections occurred in the upper interval. One SVOC — benzo(a)pyrene — was detected above its respective industrial soil RBC.

Benzo(a)pyrene was detected in two of two upper-interval samples with a range of 260 to 1,300 μg/kg and a mean of 780 μg/kg. One sample (528M0001, 1,300 μg/kg) exceeded the benzo(a)pyrene industrial soil RBC of 780 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 528. The BEQ was calculated for two samples with a range of 411 to 2,280 μg/kg. One sample (528M0001, 2,280 μg/kg) exceeded the benzo(a)pyrene soil industrial RBC of 780 μg/kg.

Pesticides and PCBs in Sediment

Four pesticides were detected in sediment samples collected at AOC 528. One pesticide (dieldrin) exceeded its respective industrial soil RBC. Dieldrin was detected in one of one samples (528M0001) at 370 μg/kg exceeding its industrial soil RBC of 360 μg/kg. No PCBs were detected in sediment samples submitted for laboratory analysis at AOCs 538 and 539.

Inorganic Elements in Sediment

Twenty-one metals were detected in sediment samples collected at AOC 528. Three metals — arsenic, copper, and nickel — exceeded their respective industrial soil RBC.

Arsenic was detected in one of one samples at 6.60 mg/kg exceeding its industrial soil RBC of 3.8 mg/kg; copper was detected in one of one samples at 134,000 mg/kg exceeding its industrial RBC of 8,200 mg/kg; and nickel was detected in one of one samples at 6,480 mg/kg exceeding its industrial RBC of 4,100 mg/kg. All exceedances occurred in sample 528M0001.

10.20.7 Fate and Transport Assessment for AOC 528

AOC 528 consists of a former steam cleaning shop which was used to clean boiler parts. Process water from secondary stages of the steam cleaning operation was discharged to the sanitary sewer. Before installation of the sanitary sewer, waste was discharged to the Cooper River via the combined sewer system. The entire surface area of AOC 528 is paved with either concrete or asphalt. Environmental media sampled as part of the AOC 528 CSI included surface soil, subsurface soil, sediment, and shallow groundwater. Potential constituent migration pathways

investigated for AOC 528 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of VOCs from surface soil to air.

10.20.7.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.20.7.1 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) RCs. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 10:1, with no attenuation of constituents in soil (DAF=10).

Copper, the only constituent detected in the tier-one soil-to-groundwater screening, was detected in one surface soil sample at a concentration marginally above its RC. No organic constituents were detected in AOC 528 soil above groundwater protection SSLs.

10.20.7.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.20.7.1 also compares maximum detected organic compound concentrations in shallow groundwater samples to RBCs 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) RCs for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. Based on tier-one screening, groundwater migration was not considered a significant pathway for AOC 528, as no constituents exceeded their screening criteria for either groundwater or surface water impacts.

10.20.7.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.20.7.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 528 is 73,800:1 (see Table 6.2.1).

Copper was the only constituent with a first-tier sample concentration exceeding a screening standard. Its concentrations in soil did not exceed the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.20.7.4 Surface Soil-to-Sediment Cross-Media Transport

Tables 10.20.6.1 and 10.20.6.2 summarize the constituent concentrations detected in sediment samples at AOC 528. Several PAHs and inorganic constituents were detected in both surface soil and catch-basin sediment samples. Since the entire site is paved, it is unlikely that AOC 528 surface soil is a source of contamination in catch-basin sediment. It is more likely that sediment contamination is the result of vehicular traffic on roads located immediately adjacent to AOC 528. Fate and transport for constituents detected in sediments from catch basins will be examined in the Zone L RFI report.

10.20.7.5 Soil-to-Air Cross-Media Transport

No VOCs were detected in AOC 528 surface soil. As a result, the soil-to-air migration pathway is not considered to be significant at AOC 528.

10.20.7.6 Fate and Transport Summary

The single constituent exceeding first-tier screening values did not exceed the adjusted screening values of the second-tier comparisons, indicating that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.20.7.1
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: Tier One
NAVBASE-Charleston, Zone E: AOC 528
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
2-Butanone (MEK)	ND	3	ND	NA	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	ND	ND	NA	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
1,2-Dichloroethene (total)	ND	ND	ND	NA	200	55	NA	UG/KG	UG/L	NO	NO	NO
Trichloroethene	ND	ND	ND	NA	30	1.6	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Benzo(g,h,i)perylene	150	160	ND	NA	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	110	180	ND	NA	800	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	110	200	ND	NA	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	ND	200	ND	NA	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	190	190	ND	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	120	210	ND	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	ND	120	ND	NA	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	220	360	ND	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Phenanthrene	90	200	ND	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	190	340	ND	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	ND	0.0074	ND	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	4310	4300	ND	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	2.8	1.4	9.6	NA	23.9	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	23.3	26	ND	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.37	0.33	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.42	0.034	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	9.4	5.8	ND	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	3.2	0.96	ND	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	161	121	ND	NA	152	1500	2.9	MG/KG	UG/L	YES	NO	NO
Lead	52	33.7	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	132	176	518	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.013	0.68	ND	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	11.2	3.9	3.1	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	ND	ND	ND	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Tin	14.1	13.1	ND	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	5.2	3.6	2.1	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	99	81.7	ND	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.20.7.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 528
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Inorganic Compounds																
Copper	161	121	ND	ND	458	1500	2.9	2.9	2.14E+05	1300	1.65E+02	7.54E+03	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 73,800: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

10.20.8 Fixed-Point Risk Evaluation for AOC 528

10.20.8.1 Site Background and Investigative Approach

AOC 528 is a former steam cleaning shop which was in operations along the western side of Building 59. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

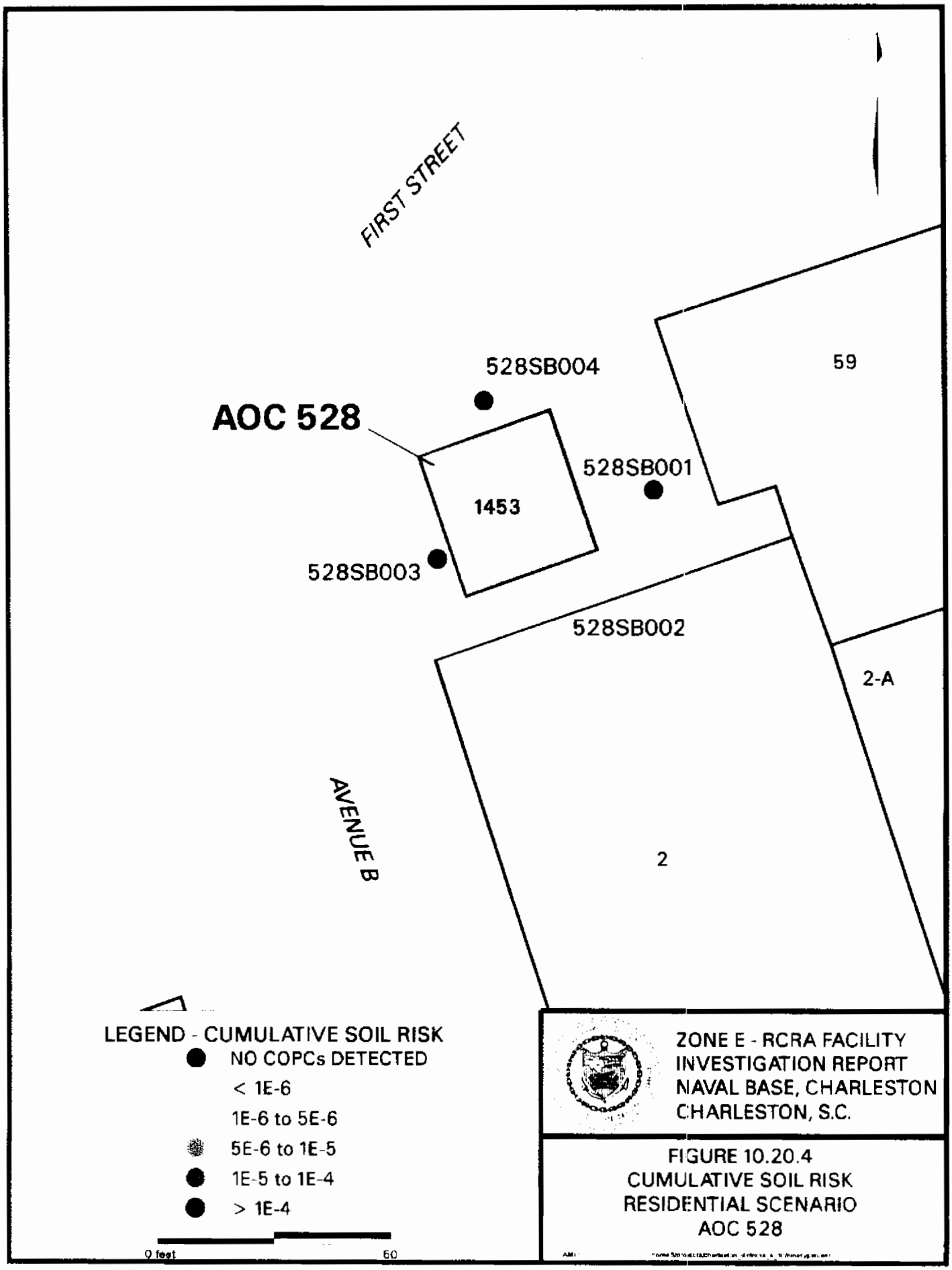
A total of four surface soil samples were considered in the AOC 528 FRE. One monitoring well was installed into the shallow aquifer as part of the 1995 RFI. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 528 FRE. Sections 10.20.1 and 10.20.3 contain summaries of the sampling effort for AOC 528 soil and groundwater.

10.20.8.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.20.8.1 provides CPSS summaries for AOC 528 soil and identifies COPCs based on comparison to residential and industrial RBCs and RC concentrations. Based on residential RBCs, BEQs were identified as COPCs for AOC 528. Arsenic and beryllium were detected in AOC 528 soil at concentrations above their respective RBCs but were eliminated from consideration in the residential FRE based on comparison to their RCs. Because only one sample was analyzed for inorganic parameters, Wilcoxon rank sum test analyses were not performed. As a result, arsenic was eliminated from the surface soil FRE based on direct comparison of its maximum concentration to its RC.

Table 10.20.8.2 summarizes the residential COPCs detected at each AOC528 sample location with contribution to risk and hazard. As shown, BEQs contribute to a risk projection of 2E-06 at sample location 528SB002. BEQs were not detected in the remaining three samples. Figure 10.20.4 is a spatial presentation of residential risk estimates for AOC 528 soil.


FIRST STREET
AVENUE B
AOC 528
528SB004
528SB001
528SB003
528SB002
1453
59
2-A
2
LEGEND - CUMULATIVE SOIL RISK
NO COPCs DETECTED
< 1E-6
1E-6 to 5E-6
5E-6 to 1E-5
1E-5 to 1E-4
> 1E-4
0 feet
50
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.20.4
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 528

No COPCs were identified in AOC 528 surface soil that would have contributed to HI projections.

Industrial Scenario

Based on industrial RBCs, no COPCs were identified for AOC 528 surface soil.

10.20.8.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.20.8.3 provides CPSS summaries for AOC 528 groundwater and identifies COPCs. No COPCs were identified for AOC 528 groundwater. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding RCs for inorganics. Arsenic and manganese were detected in AOC 528 shallow groundwater at a concentration above their respective RBCs, but were eliminated from consideration in the FRE for shallow groundwater, based on comparison to their respective RCs. AOC 528 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses, and as a result, arsenic and manganese were eliminated from the shallow groundwater FRE based on direct comparison of their maximum concentrations to their RCs.

10.20.8.4 Uncertainty

AOC 528 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined SWMU 106, 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.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 528. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

Arsenic and beryllium were present in AOC 528 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their RC. As a result, their contribution to soil pathway risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 concentrations close to its RBCs (e.g. within 10% of its RBCs).

Arsenic and manganese were present in AOC 528 groundwater at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their RCs. As a result, their contribution to groundwater pathway risk/hazard has not been considered in this FRE.

10.20.8.5 Fixed-Point Risk Evaluation Summary

The risk and hazard posed by contaminants at AOC 528 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Table 10.20.8.2 such that a risk (E-06) that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO. Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

BEQs were detected in one AOC 528 surface soil sample at concentrations above their residential RGOs.

Soil — Site Worker Scenario

No COPCs were identified for the industrial scenario.

Groundwater — Residential Scenario

No COPCs were identified for the groundwater pathways.

Tab. J.20.8.1
Chemicals Present in Site Samples
AOC 528 - Surface Soil
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Carcinogenic PAHs													
B(a)P Equiv.	*	1	4	123.02 - 123.02	123.02	1594.59 - 1802.58	88	780	NA	UG/KG	1		
Benzo(a)anthracene		1	4	110 - 110	110	690 - 780	880	7800	NA	UG/KG			
Chrysene		1	4	120 - 120	120	690 - 780	88000	780000	NA	UG/KG			
Benzo(k)fluoranthene		1	4	190 - 190	190	690 - 780	8800	78000	NA	UG/KG			
Benzo(a)pyrene		1	4	110 - 110	110	690 - 780	880	780	NA	UG/KG			
Inorganics													
Aluminum (Al)		1	1	4310 - 4310	4310	NA - NA	7800	100000	26600	MG/KG			
Arsenic (As)		1	1	2.8 - 2.8	2.8	NA - NA	0.38	3.8	23.9	MG/KG			
Barium (Ba)		1	1	23.3 - 23.3	23.3	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		1	1	0.37 - 0.37	0.37	NA - NA	0.15	1.3	1.7	MG/KG			
Cadmium (Cd)		1	1	0.42 - 0.42	0.42	NA - NA	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	1	1	55300 - 55300	55300	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)		1	1	9.4 - 9.4	9.4	NA - NA	39	1000	94.6	MG/KG			
Cobalt (Co)		1	1	3.2 - 3.2	3.2	NA - NA	470	12000	19	MG/KG			
Copper (Cu)		1	1	161 - 161	161	NA - NA	310	8200	66	MG/KG			1
Iron (Fe)	N	1	1	3620 - 3620	3620	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)		1	1	52 - 52	52	NA - NA	400	1300	265	MG/KG			
Magnesium (Mg)	N	1	1	741 - 741	741	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)		1	1	132 - 132	132	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)		1	1	0.13 - 0.13	0.13	NA - NA	2.3	61	2.6	MG/KG			
Nickel (Ni)		1	1	11.2 - 11.2	11.2	NA - NA	160	4100	77.1	MG/KG			
Sodium (Na)	N	1	1	62.1 - 62.1	62.1	NA - NA	NA	NA	NA	MG/KG			
Tin (Sn)		1	1	14.1 - 14.1	14.1	NA - NA	4700	6100	59.4	MG/KG			
Vanadium (V)		1	1	5.2 - 5.2	5.2	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		1	1	99 - 99	99	NA - NA	2300	61000	827	MG/KG			
Semivolatiles Organics													
Butylbenzylphthalate		1	4	160 - 160	160	690 - 750	1600000	41000000	NA	UG/KG			
Fluoranthene		1	4	220 - 220	220	690 - 780	310000	8200000	NA	UG/KG			
Phenanthrene		1	4	90 - 90	90	690 - 780	310000	8200000	NA	UG/KG			
Pyrene		1	4	190 - 190	190	690 - 780	230000	6100000	NA	UG/KG			

Notes:
* - Identified as a residential COPC
N - Essential nutrient
SQL - Sample quantitation limit
NA - Not applicable
UG/KG - Micrograms per kilograms
MG/KG - Milligrams per kilograms

Table 10.20.8.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 528
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
528	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
528	B002	B(a)P Equiv.	123.02	UG/KG	2.0372	100.00	NA	
		Total			2.0372		NA	
528	B003	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
528	B004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	

Table 10.20.8.3
Chemical Present in Site Samples
AOC 528 - Groundwater
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Shallow Wells											
Inorganics											
Arsenic (As)		1	1	3.1 - 3.1	3.1	NA - NA	0.045	18.7	UG/L	1	
Calcium (Ca)	N	1	1	136000 - 136000	136000	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	1	1	4410 - 4410	4410	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	34200 - 34200	34200	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	1	518 - 518	518	NA - NA	84	2560	UG/L	1	
Nickel (Ni)		1	1	3.1 - 3.1	3.1	NA - NA	73	15.2	UG/L		
Potassium (K)	N	1	1	15800 - 15800	15800	NA - NA	NA	NA	UG/L		
Vanadium (V)		1	1	2.1 - 2.1	2.1	NA - NA	26	11.4	UG/L		

Notes:
N - Essential nutrient
SQL - Sample quantitation limit
NA - Not applicable
UG/L - Micrograms per liter

10.20.9 Corrective Measures Considerations

For AOC 528, the upper and lower soil intervals and the shallow groundwater were investigated. Based on the analytical results and the FRE, one COC requiring further evaluation through the CMS process was identified for soil.

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 paved with concrete and asphalt. All soil samples were collected from beneath the pavement.

BEQs were detected in one of four soil sample locations (528SB002) and the equated risk is 2E-06. This risk is between USEPA's acceptable risk range of 1E-06 to 1E-04. Since the site is paved and the risk is within USEPA's acceptable risk range, no further action is recommended. No COPCs were identified in the shallow groundwater for AOC 528.

Potential corrective measures for the impacted medium and respective COC are in Table 10.20.9.1.

Table 10.20.9.1
Potential Corrective Measures for AOC 528

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	No Action

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10.21 AOC 530, Paint and Oil Storage, Building 35

Building 35 was used to store paint and oil from 1913 to 1939. Additions were made to the building in the 1930s. The Publication and Printing Service was housed in Building 35 from 1949 to 1979. This service supplied the printing needs of much of the 6th Naval District. Before 1979, wastes generated at Building 35 included an unknown quantity of ferric chloride acid etching bath, lithographic developing solution, and photographic developing solution. Most recently, Building 35 has been used as a training facility for welding students.

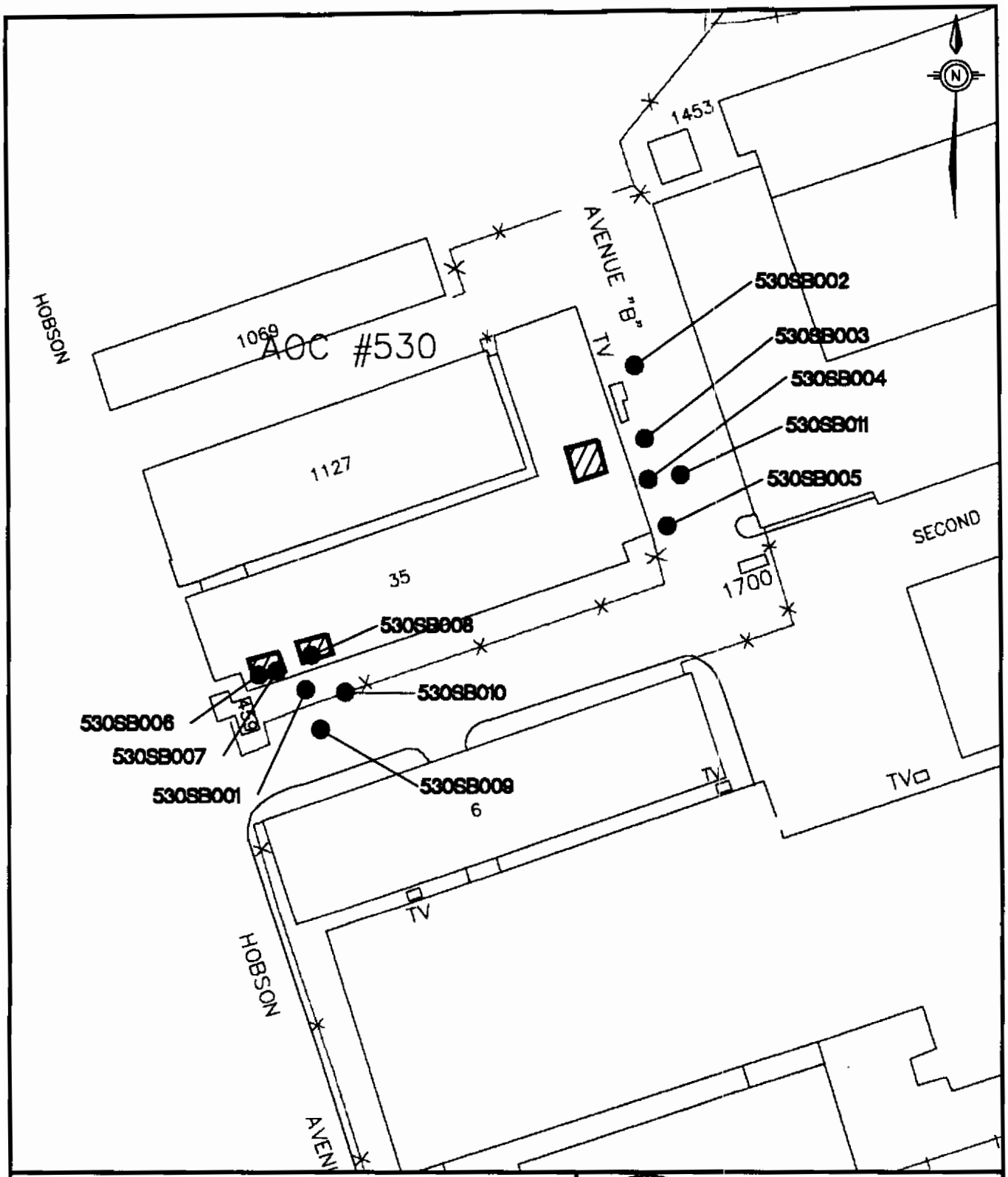
Materials of concern identified in the *Final Zone E RFI Work Plan* include alcohols, paints, solvents, petroleum hydrocarbons, and heavy metals. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 530, soil and groundwater were sampled in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.21.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 530 from the locations shown in Figure 10.21.1. The *Final Zone E RFI Work Plan*, proposed collecting three surface soil samples, four soil samples from the upper interval and four samples from the lower interval. Soil samples were also collected at both intervals for the two shallow monitoring well locations proposed at this site.

First-round Sampling — During first-round sampling, all three surface soil samples, all six of the proposed upper-interval samples, and all six of the proposed lower-interval samples were collected.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◓ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.21.1
SOIL BORING LOCATIONS
AOC #530
PAINT AND OIL STORAGE
BUILDING 35

DWG DATE: 09/02/97 | DWG NAME: 10-21-1

One sample location proposed in the *Final Zone E RFI Work Plan* was collected and identified as an AOC 531 sample due to its proximity to AOC 531.

All first-round samples were submitted for analysis at DQO Level III for VOCs, SVOCs and metals. One lower-interval sample selected as a duplicate was analyzed at DQO Level IV for Appendix IX analytical parameters, which includes herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins in addition to the suite of parameters proposed for the site. AOCs 530 and 531 have two sample locations in common, due to their close proximity. The data from these sample locations was used to help characterize each site, while eliminating the need for two additional samples. These locations are 531SB001 and 530SB006. Table 10.21.1.1 summarizes soil sampling at AOC 530.

Table 10.21.1.1
AOC 530
First Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Surface	3	3	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	None
Upper	6	6	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One sample was identified as an AOC 531 sample
Lower	6	6	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One sample was identified as an AOC 531 sample

Second-round Sampling — Second-round sampling was performed at AOC 530 after first-round analytical results were compared to USEPA Region III RBCs (April 1996). Parameters exceeding RBCs included SVOCs and metals. Section 10.21.2 details specific parameters and locations which exceeded RBCs.

Three upper-interval and three lower-interval samples were proposed during second-round sampling to determine the extent of constituents detected during the initial round of soil sampling. All three proposed upper-interval and lower-interval samples were collected.

All second-round samples were submitted for analysis at DQO Level III for SVOCs and metals based on the first round results. No samples were selected as duplicates at this site. Table 10.21.1.2 summarizes the second round of soil sampling at AOC 530.

Table 10.21.1.2
AOC 530
Second Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	3	3	SVOCs and metals	SVOCs and metals	None
Lower	3	3	SVOCs and metals	SVOCs and metals	None

10.21.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.21.2.1. Inorganic analytical results for soil are summarized in Table 10.21.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.21.2.1
AOC 530
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	5/8	24.0 - 480	135	20,000,000	0
	Lower	5/5	11.0 - 35.0	23.2	NA	NA

Table 10.21.2.1
AOC 530
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Methylene chloride	Upper	3/8	1.000 - 4.00	2.33	760,000	0
	Lower	3/5	1.000 - 2.00	1.67	NA	NA
1,1,2,2-Tetrachloroethane	Upper	1/8	8.00	8.00	29,000	0
Toluene	Upper	3/8	2.00 - 6.00	3.67	41,000,000	0
	Lower	3/5	1.000 - 2.00	1.33	NA	NA
Trichlorofluoromethane	Lower	1/1	1.000	1.000	NA	NA
Vinyl acetate	Lower	1/5	11.0	11.0	NA	NA
Xylene (Total)	Upper	1/8	2.00	2.00	100,000,000	0
SVOCs (μg/kg)						
Acenaphthene	Upper	6/11	38.0 - 11,000	3,300	12,000,000	0
	Lower	1/8	210	210	NA	NA
Acenaphthylene	Upper	5/11	43.0 - 2,300	961	8,200,000	0
Anthracene	Upper	7/11	110 - 32,000	7,270	61,000,000	0
	Lower	1/8	350	350	NA	NA
Benzo(g,h,i)perylene	Upper	7/11	700 - 18,000	6,280	8,200,000	0
	Lower	3/8	200 - 540	413	NA	NA
Benzoic acid	Upper	2/11	66.0 - 70.0	68	100,000,000	0
bis(2-Ethylhexyl)phthalate	Lower	1/8	300	300	NA	NA
Dibenzofuran	Upper	6/11	42.0 - 10,000	2,880	820,000	0
	Lower	1/8	75.0	75	NA	NA
2,4-Dimethylphenol	Upper	1/11	88.0	88	4,100,000	0
Fluoranthene	Upper	7/11	1,500 - 90,000	26,800	8,200,000	0
	Lower	2/8	1,200 - 2,100	1,650	NA	NA

Table 10.21.2.1
AOC 530
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Fluorene	Upper	6/11	52.0 - 12,000	3,810	8,200,000	0
	Lower	1/8	140	140	NA	NA
2-Methylnaphthalene	Upper	5/11	94.0 - 10,000	5,290	8,200,000	0
	Lower	1/8	76.0	76	NA	NA
Naphthalene	Upper	5/11	61.0 - 23,000	6,960	8,200,000	0
Phenanthrene	Upper	7/11	480 - 100,000	26,600	8,200,000	0
	Lower	2/8	470 - 1,700	1,090	NA	NA
Pyrene	Upper	7/11	1,200 - 74,000	23,500	6,100,000	0
	Lower	2/8	780 - 1,500	1,140	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	7/11	1,390 - 57,300	16,500	780	7
	Lower	2/8	917 - 1,060	989	NA	NA
Benzo(a)anthracene	Upper	7/11	670 - 49,000	13,800	7,800	3
	Lower	2/8	490 - 660	575	NA	NA
Benzo(b)fluoranthene	Upper	4/11	940 - 3,900	2,260	7,800	0
	Lower	1/8	650	650	NA	NA
Benzo(k)fluoranthene	Upper	7/11	610 - 57,000	14,800	78,000	0
	Lower	2/8	480 - 690	585	NA	NA
Benzo(a)pyrene	Upper	7/11	900 - 38,000	10,900	780	7
	Lower	2/8	620 - 700	660	NA	NA
Chrysene	Upper	7/11	720 - 46,000	13,300	780,000	0
	Lower	2/8	620 - 650	635	NA	NA

Table 10.21.2.1
AOC 530
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
Dibenz(a,h)anthracene	Upper	7/11	270 - 12,000	3,380	780	4
	Lower	2/8	180 - 190	185	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	7/11	570 - 18,000	5,880	7,800	3
	Lower	2/8	430 - 520	475	NA	NA
Dioxins (ng/kg)						
Dioxin Equiv.	Lower	1/1	0.257	0.257	NA	NA
1234678-HpCDD	Lower	1/1	2.83	2.83	NA	NA
123678-HxCDF	Lower	1/1	1.90	1.90	NA	NA
OCDD	Lower	1/1	31.9	31.9	NA	NA
OCDF	Lower	1/1	7.23	7.23	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.21.2.2
AOC 530
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	11/11	2,310 - 7,650	4,040	100,000	26,600	0
	Lower	8/8	1,910 - 4,050	3,140	NA	41,100	NA
Antimony (Sb)	Upper	4/11	1.40 - 3.50	2.43	82.0	1.77	0
	Lower	1/8	1.70	1.70	NA	1.60	NA
Arsenic (As)	Upper	9/11	1.70 - 83.8	24.2	3.80	23.9	3
	Lower	4/8	0.790 - 7.40	2.68	NA	19.9	NA

Table 10.21.2.2
AOC 530
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Barium (Ba)	Upper	9/11	9.70 - 118	59.2	14,000	130	0
	Lower	7/8	6.90 - 19.8	13.1	NA	94.1	NA
Beryllium (Be)	Upper	8/11	0.170 - 0.410	0.259	1.30	1.70	0
	Lower	4/8	0.150 - 0.190	0.180	NA	2.71	NA
Cadmium (Cd)	Upper	8/11	0.0600 - 7.60	2.84	100	1.50	0
	Lower	1/8	0.0500	0.0500	NA	0.960	NA
Calcium (Ca)	Upper	11/11	584 - 138,000	16,600	NA	NA	NA
	Lower	7/8	202 - 778	528	NA	NA	NA
Chromium (Cr)	Upper	11/11	2.50 - 32.6	11.0	1,000	94.6	0
	Lower	8/8	2.10 - 4.70	3.18	NA	75.2	NA
Cobalt (Co)	Upper	11/11	0.360 - 37.5	4.98	12,000	19.0	0
	Lower	5/8	0.310 - 2.20	1.14	NA	14.9	NA
Copper (Cu)	Upper	11/11	1.30 - 236	68.0	8,200	66.0	0
	Lower	7/8	0.460 - 17.1	4.34	NA	152	NA
Iron (Fe)	Upper	10/11	1,550 - 13,000	5,570	61,000	NA	0
	Lower	7/8	1,190 - 2,270	1,830	NA	NA	NA
Lead (Pb)	Upper	11/11	3.60 - 1,060	336	1,300	265	0
	Lower	8/8	1.30 - 47.7	11.2	NA	173	NA
Magnesium (Mg)	Upper	11/11	97.7 - 1750	521	NA	NA	NA
	Lower	7/8	91.6 - 163	122	NA	NA	NA
Manganese (Mn)	Upper	10/11	28.2 - 138	75.3	4,700	302	0
	Lower	7/8	7.30 - 53.0	27.5	NA	881	NA
Mercury (Hg)	Upper	9/11	0.0300 - 9.10	3.46	61	2.60	0
	Lower	2/8	0.0700 - 0.480	0.275	NA	1.59	NA
Nickel (Ni)	Upper	11/11	1.20 - 30.9	9.65	4,100	77.1	0
	Lower	7/8	0.960 - 1.90	1.39	NA	57.0	NA

Table 10.21.2.2
AOC 530
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Potassium (K)	Upper	9/11	54.5 - 729	290	NA	NA	NA
	Lower	5/8	49.3 - 94.4	69.0	NA	NA	NA
Selenium (Se)	Upper	5/11	0.440 - 0.790	0.680	1,000	1.70	0
Silver (Ag)	Upper	4/11	0.480 - 4.20	1.72	1,000	NA	0
Sodium (Na)	Upper	9/11	18.5 - 173	69.4	NA	NA	NA
	Lower	7/8	12.8 - 205	66.8	NA	NA	NA
Thallium (Tl)	Upper	1/11	1.40	1.40	16	2.80	0
Tin (Sn)	Upper	3/11	1.30 - 13.5	9.33	100,000	59.4	0
	Lower	1/8	0.800	0.800	NA	9.23	NA
Vanadium (V)	Upper	11/11	1.90 - 11.9	6.25	1,400	94.3	0
	Lower	8/8	1.70 - 2.70	2.29	NA	155	NA
Zinc (Zn)	Upper	11/11	5.20 - 1,490	411	61,000	827	0
	Lower	8/8	2.20 - 51.5	11.2	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC or RC established

Volatile Organic Compounds in Soil

Seven VOCs were detected in soil samples collected at AOC 530. Thirteen detections occurred in both the upper and the lower-intervals. No VOCs were detected above their respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty-one SVOCs were detected in soil samples collected at AOC 530. One hundred and seventeen detections occurred in the upper-interval and 28 in the lower-interval. Four SVOCs —

benzo(a)anthracene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzo(a)pyrene — exceeded their respective industrial RBC in the upper interval. No SVOCs exceeded their respective SSL in the lower interval.

Benzo(a)anthracene was detected in seven of 11 upper-interval samples with a range of 670 to 49,000 μg/kg and a mean of 13,800 μg/kg. Three upper-interval samples (530SB006, 20,000 μg/kg; 530SB007, 15,000 μg/kg; and 530SB008, 49,000 μg/kg) exceeded the benzo(a)anthracene industrial RBC of 7,800 μg/kg.

Dibenz(a,h)anthracene was detected in seven of 11 upper-interval samples with a range of 270 to 12,000 μg/kg and a mean of 3,380 μg/kg. Four upper-interval samples (530SB004, 930 μg/kg; 530SB006, 4,400 μg/kg; 530SB007, 5,000 μg/kg; and 530SB008, 12,000 μg/kg) exceeded the dibenz(a,h)anthracene industrial RBC of 780 μg/kg.

Indeno(1,2,3-cd)pyrene was detected in seven of 11 upper-interval samples with a range of 570 to 18,000 μg/kg and a mean of 5,880 μg/kg. Three upper-interval samples (530SB006, 7,900 μg/kg; 530SB007, 8,600 μg/kg; and 530SB008, 18,000 μg/kg) exceeded the indeno(1,2,3-cd)pyrene industrial RBC of 7,800 μg/kg.

Benzo(a)pyrene was detected in seven of 11 upper-interval samples with a range of 900 to 38,000 μg/kg and a mean of 10,900 μg/kg. The following seven upper-interval samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg:

530SB001 (2,900 μg/kg)	530SB007 (14,000 μg/kg)	530SB010 (1,200 μg/kg)
530SB004 (4,200 μg/kg)	530SB008 (38,000 μg/kg)	
530SB006 (15,000 μg/kg)	530SB009 (900 μg/kg)	

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 530. The upper-interval BEQ was calculated for seven samples with a range of 1,390 to 57,300 μg/kg and a mean of 16,500 μg/kg. The following seven samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg:

530SB001 (4,437 μg/kg)	530SB007 (21,596 μg/kg)	530SB010 (1,937 μg/kg)
530SB004 (6,603 μg/kg)	530SB008 (57,300 μg/kg)	
530SB006 (22,370 μg/kg)	530SB009 (1,394 μg/kg)	

Other Organic Compounds in Soil

Four dioxins were detected in soil samples submitted for analysis from AOC 530. All four detections occurred in the lower interval below the compounds' respective SSLs. No upper-interval samples were submitted for dioxin analysis.

Inorganic Elements in Soil

Twenty-four metals were detected in soil samples collected at AOC 530. Two hundred and eight detections occurred in the upper-interval and 119 occurred in the lower-interval. One metal — arsenic — exceeded both its respective industrial RBC and RC in the upper interval. No metal exceeded both its respective SSL and RC in the lower interval.

Arsenic was detected in nine of 11 upper-interval samples with a range of 1.70 to 83.8 mg/kg and a mean of 24.2 mg/kg. Three upper-interval samples (530SB001, 68.3 mg/kg; 530SB008, 39 mg/kg; and 530SB010, 83.8 mg/kg) exceeded both the arsenic industrial RBC of 3.80 mg/kg and the RC of 23.9 mg/kg.

10.21.3 Groundwater Sampling and Analysis

Two deep monitoring wells and two shallow monitoring wells were installed and sampled to assess groundwater quality at AOC 530 as shown in Figure 10.21.2. The wells were installed as follows:

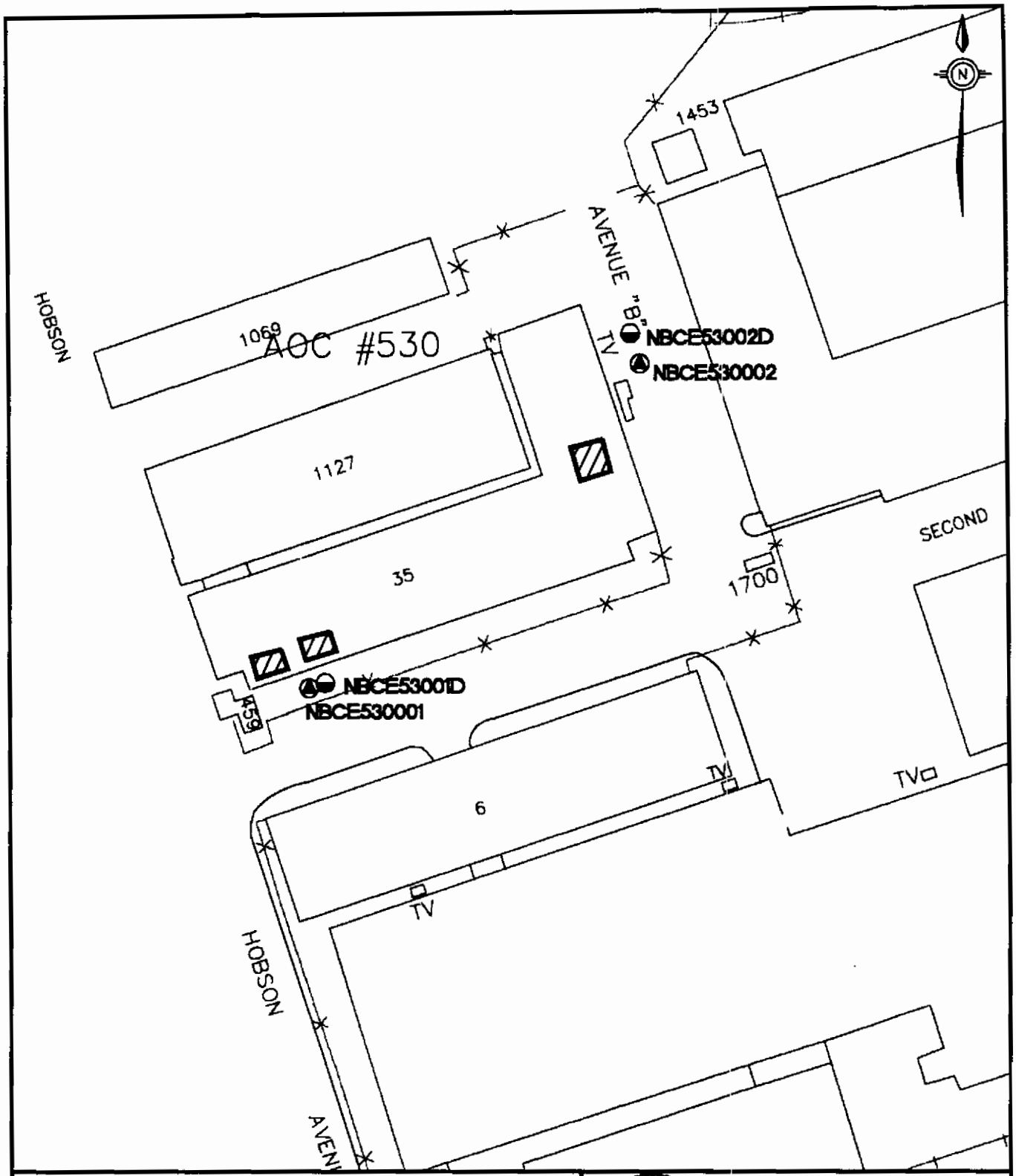
- Shallow Wells — NBCE530001, NBCE530002
- Deep Wells — NBCE53001D, NBCE53002D

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, chlorides, sulfates, and TDS. One duplicate sample from a deep monitoring well was collected and submitted for analysis at DQO Level IV for the suite of parameters listed above as well as herbicides, organophosphorus pesticides, dioxin, and hexavalent chromium. Table 10.21.3.1 summarizes groundwater sampling and analysis at AOC 530.

Table 10.21.3.1
AOC 530
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2	2	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	VOCs, SVOCs, metals chlorides, sulfates, and TDS	None
Deep	2	2	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	None

The shallow monitoring wells were installed at 12.5 and 13 feet bgs in the surficial aquifer. The deep wells were installed at 41.3 and 46.9 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.2.3 of this report.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.21.2
MONITORING WELL LOCATIONS
AOC #530
PAINT AND OIL STORAGE
BUILDING 35

DWG DATE: 09/02/97 | DWG NAME: 10-21-2

10.21.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow groundwater are summarized in Table 10.21.4.1. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.21.4.2 and 10.21.4.3, respectively. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.21.4.1
AOC 530
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
1,1-Dichloroethene	1/2	1.000	1.000	0.0440	7.00	1
SVOCs						
2-Methylnaphthalene	1/2	11.0	11.0	150	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.21.4.2
AOC 530
Inorganic Detections for First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	2/2	553 - 790	672	3,700	2,810	NA	0
Arsenic (As)	1/2	24.2	24.2	0.0450	18.7	50.0	1
Beryllium (Be)	1/2	0.320	0.320	0.0160	0.43	4.00	0
Calcium (Ca)	2/2	36,200 - 94,000	65,100	NA	NA	NA	NA

Table 10.21.4.2
AOC 530
Inorganic Detections for First Quarter Groundwater (µg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Cobalt (Co)	2/2	1.000 - 1.20	1.10	220	2.5	NA	0
Iron (Fe)	2/2	2,300 - 4,610	3,460	1,100	NA	NA	2
Lead (Pb)	½	2.30	2.30	NA	4.8	15.0*	0
Magnesium (Mg)	2/2	3,520 - 3,650	3,590	NA	NA	NA	NA
Manganese (Mn)	2/2	50.5 - 133	91.8	84.0	2,560	NA	0
Tin (Sn)	1/2	3.60	3.60	2,200	NA	NA	0
Zinc (Zn)	1/2	14.9	14.9	1,100	27.3	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established
* = TTAL

Table 10.21.4.3
AOC 530
Inorganic Detections for First Quarter Groundwater (µg/L)
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Beryllium (Be)	1/2	0.430	0.430	0.0160	1.2	4.00	0
Calcium (Ca)	2/2	62,300 - 66,500	64,400	NA	NA	NA	NA
Iron (Fe)	2/2	241 - 493	367	1,100	NA	NA	0
Magnesium (Mg)	2/2	2,860 - 8,190	5,530	NA	NA	NA	NA
Manganese (Mn)	2/2	92.0 - 118	105	84.0	869	NA	0
Zinc (Zn)	2/2	5.00 - 42.6	23.8	1,100	11.8	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

VOCs in Groundwater

Shallow Groundwater

One VOC was detected in shallow groundwater samples collected at AOC 530. 1,1-dichloroethene was detected in one of two samples in well NBCE530001 (1.00 μg/L), exceeding its respective tap-water RBC of 0.0440 μg/L. The detection did not exceed the 1,1-dichloroethene MCL of 7.00 μg/L.

SVOCs in Groundwater

Shallow Groundwater

One SVOC — 2-methylnaphthalene — was detected in shallow groundwater samples collected at AOC 530. The SVOC did not exceed its respective tap-water RBC. No MCL has been established for 2-methylnaphthalene.

Inorganic Elements in Groundwater

Shallow Groundwater

Eleven metals were detected in shallow groundwater samples collected at AOC 530. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and shallow groundwater RC.

Arsenic was detected in one of two samples in well NBCE530001 (24.2 μg/L), exceeding both its tap-water RBC of 0.0450 μg/L and shallow groundwater RC of 18.7 μg/L. The detection did not exceed the arsenic MCL of 50.0 μg/L.

Iron was detected in two of two samples with a range of 2,300 to 4,610 μg/L and a mean of 3,460 μg/L. Two samples from wells NBCE530001(4,610 μg/L) and NBCE530002 (2,300 μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

Deep Groundwater

Six metals were detected in deep groundwater samples collected at AOC 530. No metal exceeded both its respective tap-water RBC and deep groundwater RC.

10.21.5 Fate and Transport Assessment for AOC 530

AOC 530 consists of portions of Building 35 which was used to store paint and oil and house the Publication and Printing Service. Most recently, Building 35 has been used as a welding training facility. The majority of AOC 530 is paved with either concrete or asphalt. Environmental media sampled as part of the AOC 530 RFI include surface soil, subsurface soil, and shallow and deep groundwater. Potential constituent migration pathways investigated for AOC 530 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.21.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.21.5.1 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 reference 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 10:1, with no attenuation of constituents in soil (DAF=10).

Seven organic constituents — benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluroanthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and 1,1,2,2-tetrchloroethane — were detected in AOC 530 soil above groundwater protection SSLs. All of these organics were detected at concentrations above their generic SSLs in surface soil samples collected at the southwest corner of Building 35, along Second Street and Hobson Avenue. No organic constituent was detected in subsurface soil at a concentration above its generic SSL or reported in first-quarter groundwater samples.

Seven inorganics — antimony, arsenic, cadmium, cobalt, copper, lead, and mercury — were detected in surface soil above their respective generic SSLs or background reference values. All of these inorganic constituents were detected at concentrations above their groundwater protection screening values in surface soil samples collected at the southwest corner of Building 35, along Second Street and Hobson Avenue. They were not detected in any AOC 530 subsurface soil sample at concentrations exceeding their groundwater protection SSLs. Additionally, antimony, cadmium, copper, and mercury were not detected in first-quarter groundwater samples. Of the inorganics detected at concentrations exceeding SSLs, arsenic was the only inorganic also detected in first-quarter groundwater samples at a concentration above its groundwater protection screening concentration.

10.21.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.21.5.1 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 reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Arsenic and 1,1-dichloroethene were detected in AOC 530 shallow groundwater above their groundwater screening values. Arsenic was reported at a concentration exceeding its background reference value in the first quarter groundwater sample collected from monitoring well NBCE530001. 1,1-Dichloroethene was detected at a concentration exceeding its tap water RBC in the first-quarter groundwater sample collected from monitoring well NBCE530002. Arsenic was detected at concentrations below its background reference value and 1,1-dichloroethene was

reported as nondetect in samples collected from the shallow aquifer for the three subsequent quarterly sampling events.

10.21.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.21.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a potential threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined AOC 530 is 29,500:1 (see Table 6.2.1).

With the exception of arsenic, none of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that most of the site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River. Arsenic was detected at concentrations above the second-tier screening level in three surface soil samples (530SB001, 530SB008, and 530SB010) but was not detected in subsurface soil samples at concentrations exceeding its first-tier or second-tier screening levels.

10.21.5.4 Soil-to-Air Cross-Media Transport

Table 10.21.5.3 lists the VOCs detected in surface soil samples collected at AOC 530 along with corresponding soil-to-air volatilization screening levels. Minimal site surface soil is exposed at AOC 530. Additionally, no VOCs maximum concentration exceeded its respective soil-to-air

volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at AOC 530.

10.21.5.5 Fate and Transport Summary

All of the exceedances of first-tier groundwater protection screening occurred only in surface soil. In the first-tier screen, three metals — arsenic, cobalt, and lead — detected above their generic SSLs or background reference concentrations in soil were also present in groundwater samples. Arsenic was the only metal whose maximum groundwater concentrations exceeded its groundwater screening values; however, much lower concentrations of arsenic were reported in subsequent quarterly samples. The organic constituents that were identified through tier-one groundwater protection screening were not detected in first quarter groundwater samples. 1,1-Dichloroethene was detected in one first-quarter shallow groundwater sample at a concentration above its tap water RBC, but it was not detected in any subsequent quarterly groundwater sample. With the exception of arsenic and 1,1-dichloroethene, subsequent quarterly groundwater data is consistent with first-quarter results, thus adding credibility to conclusions based on first-quarter groundwater data.

Concentrations of arsenic detected in three surface soil samples (530SB001, 530SB008, and 530SB010), but not in subsurface samples, exceeded the adjusted SSLs of the second-tier comparisons by a maximum ratio of just over 2:1. However, the maximum concentrations of arsenic detected in groundwater did not exceed its second-tier surface water screening value. This relationship indicates that while arsenic surface soil concentrations may potentially generate leachate above the surface water quality standard after allowing for the dilutional effects of the receiving surface water body, current subsurface soil and groundwater data do not support this conclusion. If attenuation of arsenic in the vadose zone and aquifer were considered in the screening comparison, the dispersed elevated concentrations of arsenic in surface soil would not constitute a threat to water in the Cooper River.

Table 10.21.5.1
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: Tier One
NAVBASE-Charleston, Zone E: AOC 530
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	480	35	ND	ND	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
1,1-Dichloroethene	ND	ND	1	ND	30	0.044	2240	UG/KG	UG/L	NO	YES	NO
Methylene chloride	4	2	ND	ND	10	4.1	2560	UG/KG	UG/L	NO	NO	NO
1,1,2,2-Tetrachloroethane	8	ND	ND	ND	1.5	0.052	90.2	UG/KG	UG/L	YES	NO	NO
Toluene	6	2	ND	ND	6000	750	37	UG/KG	UG/L	NO	NO	NO
Trichlorofluoromethane	ND	1	ND	ND	13000	1300	NA	UG/KG	UG/L	NO	NO	NO
Vinyl acetate	ND	11	ND	ND	85000	37000	NA	UG/KG	UG/L	NO	NO	NO
Xylene (total)	2	ND	ND	ND	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	11000	210	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	2300	ND	ND	ND	150000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	32000	350	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	70	ND	ND	ND	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	18000	540	ND	ND	2.3E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	49000	660	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	38000	700	ND	ND	4000	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	3900	650	ND	ND	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	57000	690	ND	ND	24500	0.92	NA	UG/KG	UG/L	YES	NO	NO
Chrysene	46000	650	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	12000	190	ND	ND	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	18000	520	ND	ND	7000	0.092	NA	UG/KG	UG/L	YES	NO	NO
Dibenzofuran	10000	75	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
2,4-Dimethylphenol	88	ND	ND	ND	4500	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	ND	300	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	90000	2100	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	12000	140	ND	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	10000	76	11	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	23000	ND	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	100000	1700	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	74000	1500	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	ND	0.257	NA	ND	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	7650	4050	790	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	3.5	1.7	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	83.8	7.4	24.2	ND	23.9	18.7	36	MG/KG	UG/L	YES	YES	NO
Barium	118	19.8	ND	ND	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.41	0.19	0.32	0.43	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	7.6	0.05	ND	ND	4	18	9.3	MG/KG	UG/L	YES	NO	NO
Chromium (total)	32.6	4.7	ND	ND	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	37.5	2.2	1.2	ND	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	236	17.1	ND	ND	152	1500	2.9	MG/KG	UG/L	YES	NO	NO
Lead	1060	47.7	2.3	ND	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	138	53	133	118	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	9.1	0.48	ND	ND	2.6	11	0.2	MG/KG	UG/L	YES	NO	NO
Nickel	30.9	1.9	ND	ND	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.79	ND	ND	ND	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	4.2	ND	ND	ND	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	1.4	ND	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO

Table 10.21.5.1
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: Tier One
NAVBASE-Charleston, Zone E: AOC 530
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Tin	13.5	0.8	3.6	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	11.9	2.7	ND	ND	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	1490	51.5	14.9	42.6	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.21.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 530
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Volatile Organic Compounds																
1,1-Dichloroethene	ND	ND	1	ND	30	0.044	2240	0.044	1.30E+03	7	1.85E+02	5.56E+02	UG/KG	UG/L	NO	NO
1,1,2,2-Tetrachloroethane	8	ND	ND	ND	1.5	0.052	90.2	0.052	1.53E+03	0.4	3.84E+03	5.75E+02	UG/KG	UG/L	NO	NO
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	49000	660	ND	ND	800	0.092	NA	0.092	2.71E+03	0.1	2.71E+04	2.17E+06	UG/KG	UG/L	NO	NO
Benzo(a)pyrene	38000	700	ND	ND	4000	0.0092	NA	0.0092	2.71E+02	0.2	1.36E+03	5.43E+05	UG/KG	UG/L	NO	NO
Benzo(b)fluoranthene	3900	650	ND	ND	2500	0.092	NA	0.092	2.71E+03	0.1	2.71E+04	6.79E+06	UG/KG	UG/L	NO	NO
Benzo(k)fluoranthene	57000	690	ND	ND	24500	0.92	NA	0.92	2.71E+04	1	2.71E+04	1.04E+07	UG/KG	UG/L	NO	NO
Dibenzo(a,h)anthracene	12000	190	ND	ND	800	0.0092	NA	0.0092	2.71E+02	0.01	2.71E+04	2.17E+06	UG/KG	UG/L	NO	NO
Indeno(1,2,3-cd)pyrene	18000	520	ND	ND	7000	0.092	NA	0.092	2.71E+03	0.1	2.71E+04	1.04E+07	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	3.5	1.7	ND	ND	2.5	15	NA	15	4.43E+05	6	7.38E+04	1.84E+04	MG/KG	UG/L	NO	NO
Arsenic	83.8	7.4	24.2	ND	14.6	0.045	36	0.045	1.33E+03	50	2.66E+01	3.88E+01	MG/KG	UG/L	YES	NO
Cadmium	7.6	0.05	ND	ND	4	18	9.3	9.3	2.74E+05	5	5.49E+04	2.19E+04	MG/KG	UG/L	NO	NO
Cobalt	37.5	2.2	1.2	ND	1040	2200	NA	2200	6.49E+07	2200	2.95E+04	1.00E+06	MG/KG	UG/L	NO	NO
Copper	236	17.1	ND	ND	458	1500	2.9	2.9	8.56E+04	1300	6.58E+01	3.01E+03	MG/KG	UG/L	NO	NO
Lead	1060	47.7	2.3	ND	400	15	8.5	8.5	2.51E+05	15	1.67E+04	6.69E+05	MG/KG	UG/L	NO	NO
Mercury	9.1	0.48	ND	ND	1.04	11	0.2	0.2	5.90E+03	2	2.95E+03	3.07E+02	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 29,500: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.21.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 530
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	480	62000000	UG/KG	NO
Methylene chloride	4	7000	UG/KG	NO
Toluene	6	520000	UG/KG	NO
1,1,2,2-Tetrachloroethane	8	400	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.21.6 Fixed-Point Risk Evaluation for AOC 530

10.21.6.1 Site Background and Investigative Approach

AOC 530 is the site of a former paint and oil storage area (Building 35). This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a fixed-point risk evaluation (FRE) following the framework presented in Section 7.3.

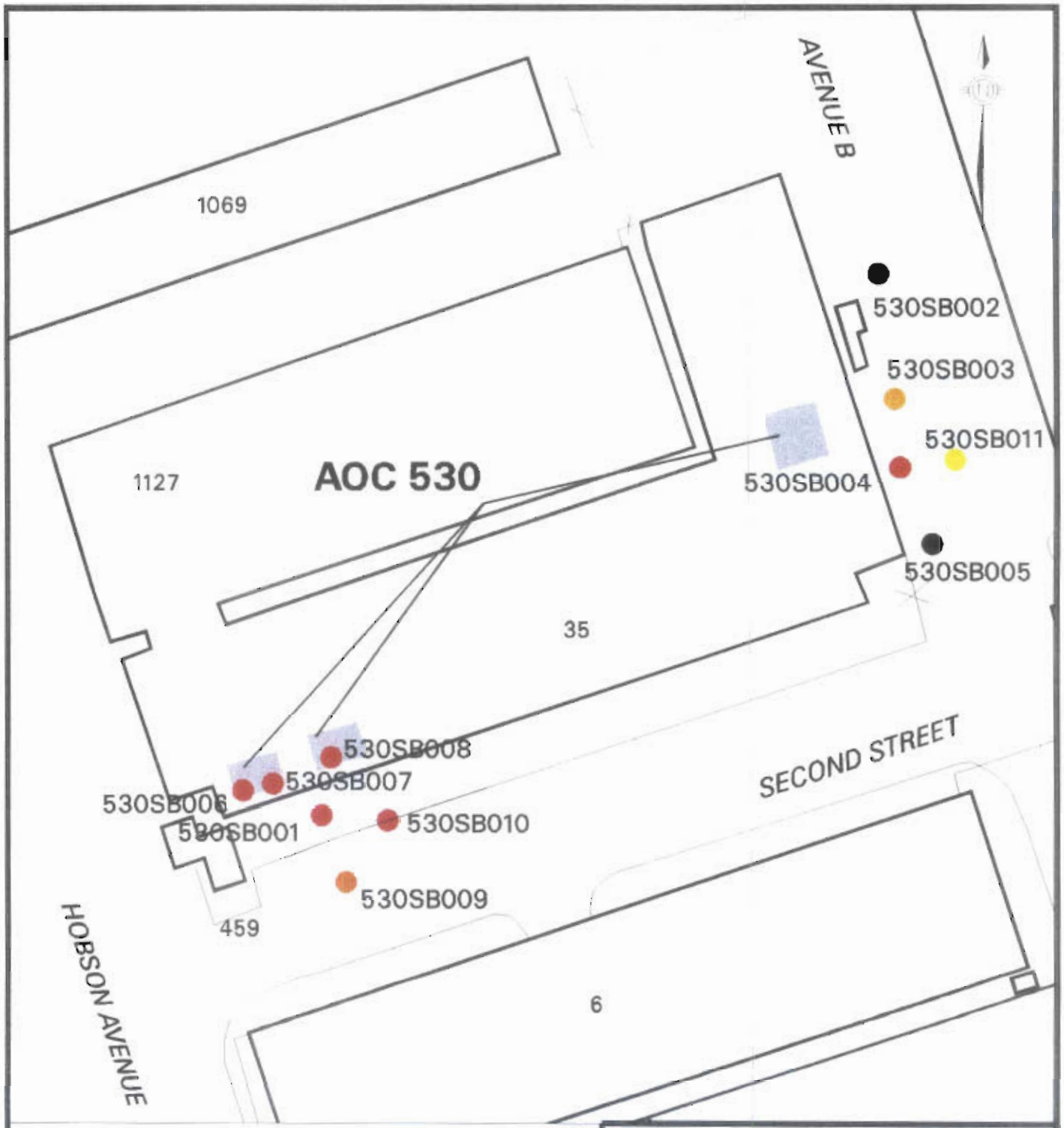
A total of 11 surface soil samples were considered in the AOC 530 FRE. Four monitoring wells were installed as part of the 1995 RFI. Two of these monitoring wells were installed into the shallow aquifer and two were installed into the deep aquifer. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 530 FRE. Sections 10.21.1 and 10.21.3 contain summaries of the sampling effort for AOC 530 soil and groundwater.

10.21.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.21.6.1 provides CPSS summaries for AOC 530 soil and identifies COPCs based on comparison to residential and industrial RBCs and RC reference concentrations. Based on residential RBCs, six COPCs (antimony, arsenic, BEQs, cadmium, lead, and mercury) were identified for AOC 530. Beryllium and thallium were detected in AOC 530 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE 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 based on background concentration.

Table 10.21.6.2 summarizes the residential COPCs detected at each AOC 530 sample location with contribution to risk and hazard. As shown, arsenic and benzo(a)pyrene equivalent compounds are the only contributors to risk for AOC 530 surface soil, exceeding 1E-06 at nine of 11 locations. No COPCs were detected in samples 530SB002 and 530SB005 that would have contributed to risk. Figure 10.21.3 is a spatial presentation of residential risk estimates for



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 100

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

FIGURE 10.21.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 530

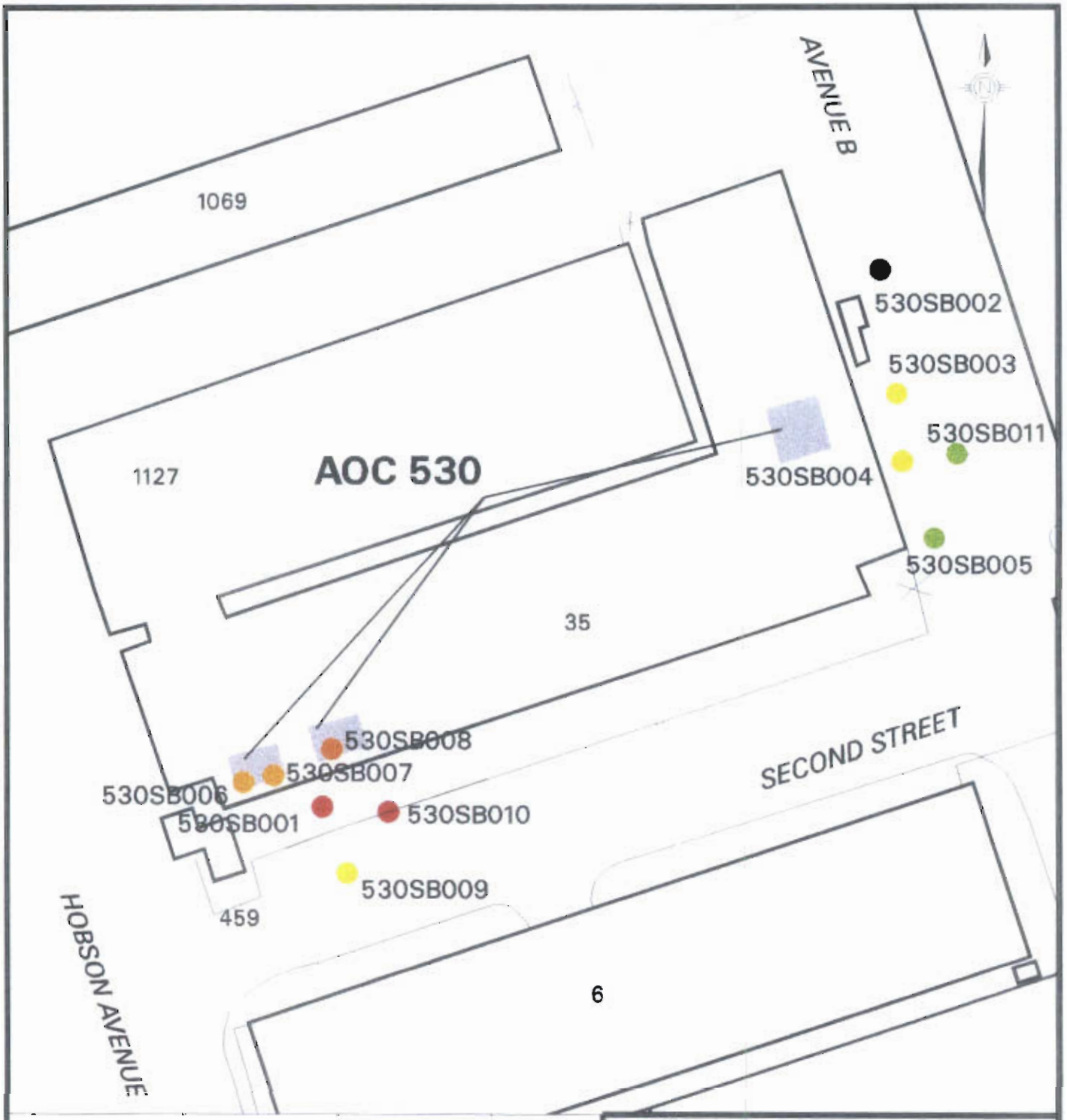
AOC 530 surface soil. For those samples with detected concentrations of carcinogenic COPCs, risk estimates range from 4E-06 to 1E-03 with an arithmetic mean risk of 2E-04 (assuming a deminimus risk of 1E-07 for samples with no carcinogenic COPCs).

Figure 10.21.4 is a spatial presentation of HI estimates for AOC 530 surface soil. As shown, HI projections exceeded the threshold of unity at three of 11 sample locations. No COPCs were detected in samples 530SB002 and 530SB005 that would have contributed to HI estimates. Those samples with concentrations of COPCs contributing to HI estimates had a range of 0.001 to 4 with an arithmetic mean HI of 1 (assuming a deminimus HI of 0.01 for samples with no detected concentrations of COPCs contributing to HI projections. Arsenic was the primary contributor to HI projections at each location.

Industrial Scenario

Based on industrial RBCs, arsenic and BEQs were identified as COPCs for AOC 530 surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.21.6.3 summarizes the industrial COPCs detected at each AOC 530 sample location with contribution to risk and hazard. As shown, arsenic and benzo(a)pyrene equivalent related risk estimates for AOC 530, exceeded 1E-06 at nine of 11 locations, based on the industrial scenario. No carcinogenic COPC were detected in samples collected from locations 530SB002 and 530SB005. Figure 10.21.5 is a spatial presentation of industrial scenario risk estimates for AOC 530 surface soil. For those samples that had detected concentrations of carcinogenic COPCs, risk estimates range from 6E-07 to 2E-04 with an arithmetic mean risk of 4E-05 (assuming a deminimus risk of 1E-07 for samples with no detected concentrations of carcinogenic COPCs).



LEGEND - CUMULATIVE SOIL HAZARD

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

0 feet 100

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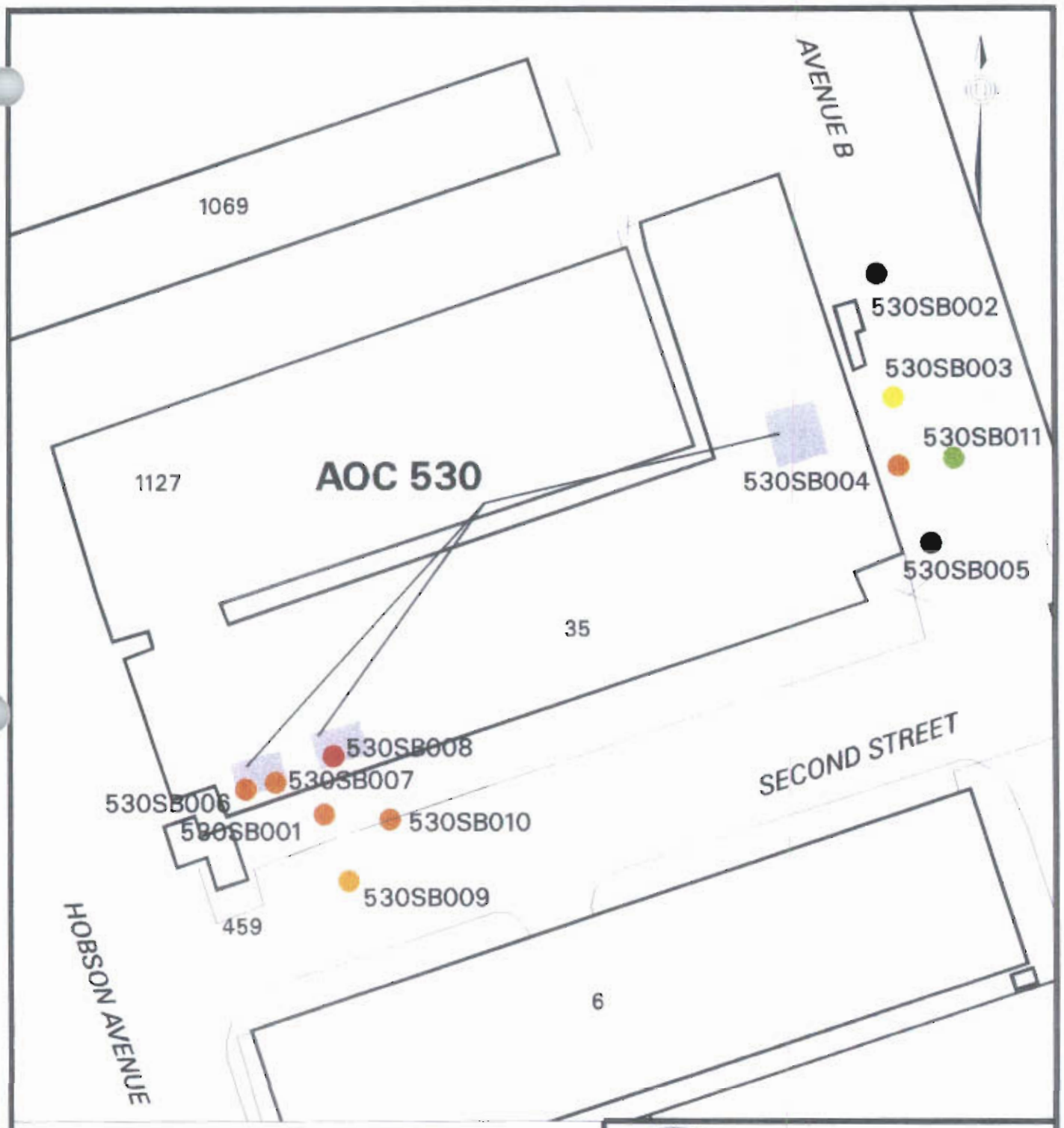
CHARLESTON, S.C.

FIGURE 10.21.4
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
AOC 530



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 100

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NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.21.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
AOC 530

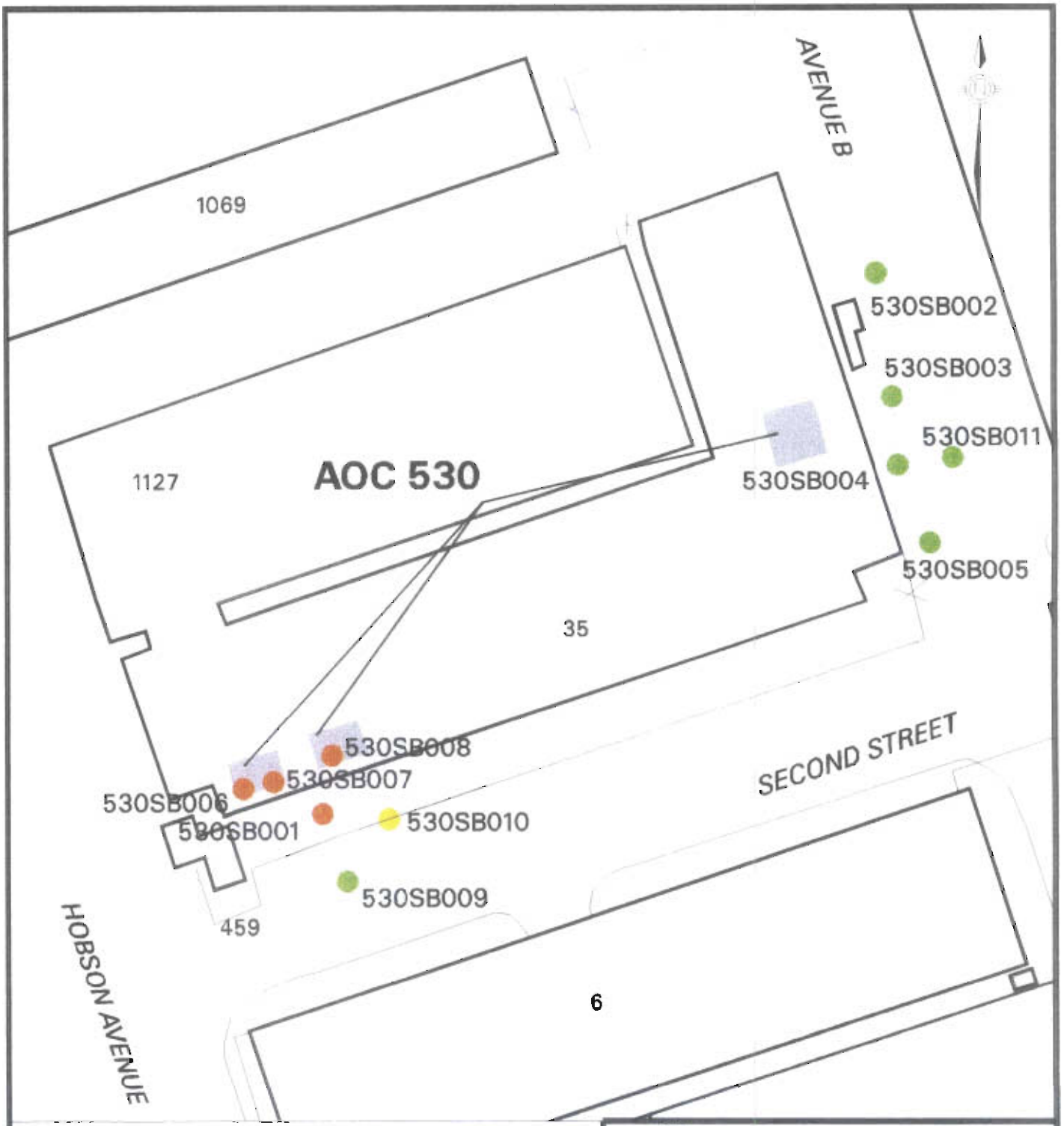
HI projections did not exceed the threshold of unity at any sample locations based on the industrial scenario. HI estimates range from 0.004 to 0.2.

Lead

Lead was detected in all 11 surface soil samples collected at AOC 530. Soil concentrations ranged from 3.6 to 1060 mg/kg and exceeded the residential clean up level of 400 mg/kg in four of 11 samples (530SB001, 5320SB006, 530SB007, and 530SB008). The mean detected lead concentration for AOC 530 is 336 mg/kg which is below the action level of 400 mg/kg, considered protective of children under a residential scenario, and the industrial cleanup level of 1,300 mg/kg, considered protective of adults under an industrial scenario. However, the mean lead soil concentration calculated for the surface soil samples collected at the south west corner of Building 35 (samples 530SB001, 530SB006, 530SB007, 530SB008, 530SB009, and 530SB010) was calculated to be 602 mg/kg. These samples represent an area of approximately 0.2 acres. Figure 10.21.6 is a spatial presentation of lead soil concentrations, using the surface soil background concentration of 265 mg/kg, the residential soil lead cleanup level of 400 mg/kg, and the industrial soil lead cleanup concentration of 1,300 mg/kg as benchmark levels to illustrate the lead soil concentrations AOC 530.

10.21.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.21.6.4 provides CPSS summaries for AOC 530 groundwater and identifies COPCs. Arsenic and 1,1-dichloroethene were identified as groundwater COPCs in the shallow aquifer and no COPCs were identified in the deep aquifer. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. Manganese was detected in AOC 530 shallow groundwater at a concentration above its RBC, but was eliminated from consideration in the FRE for shallow groundwater, based on comparison to its background concentration. The maximum concentrations of both beryllium and manganese reported in the deep well sample exceeded their respective RBCs



LEAD IN SURFACE SOIL

- NON DETECT
- < 265
- 265 - 400
- 401 - 1,300
- > 1,300

0 feet 100

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NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.21.6
DISTRIBUTION OF LEAD
IN SURFACE SOIL
AOC 530

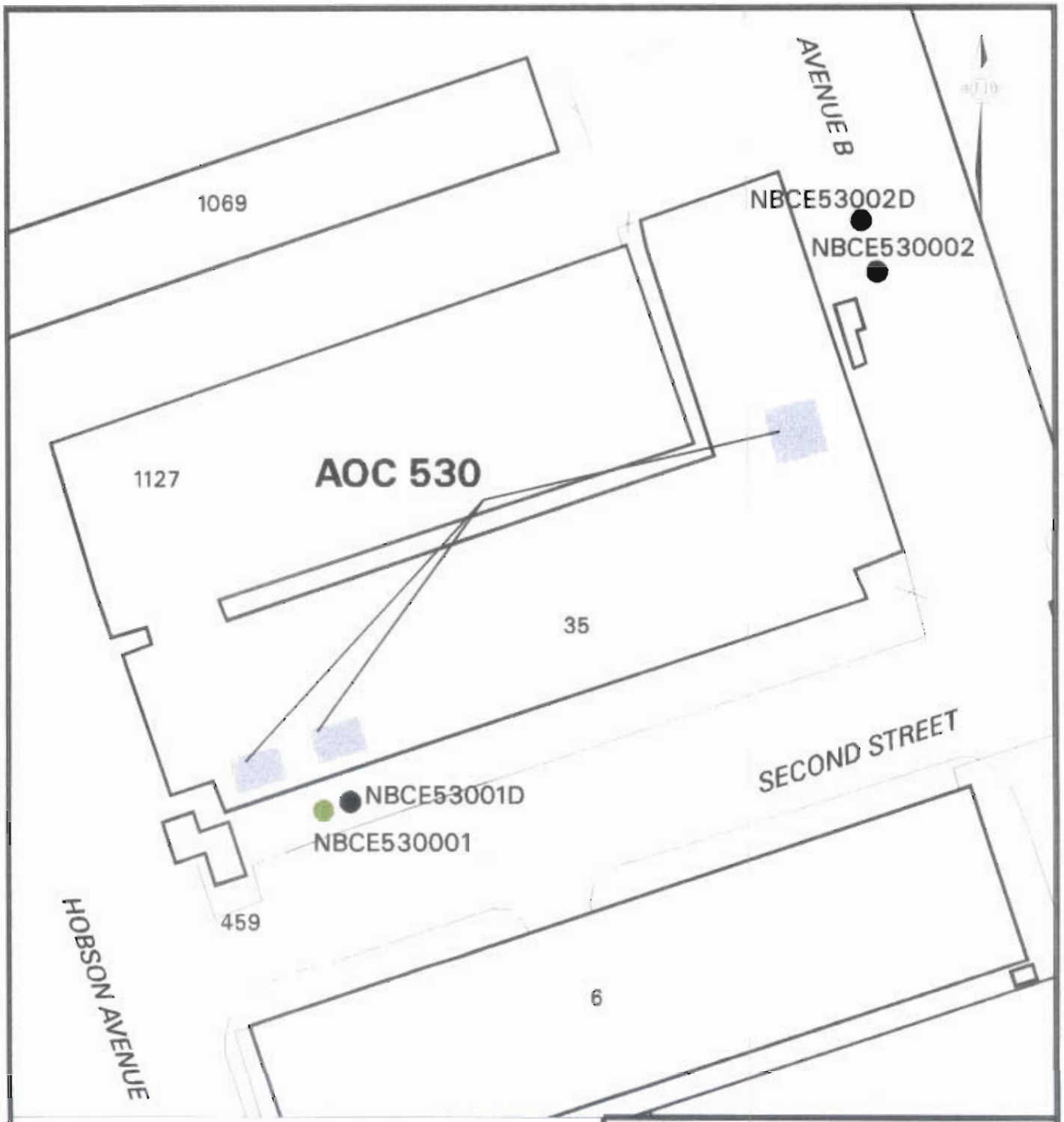
but were eliminated from consideration in the deep groundwater FRE based on comparison to their RCs. AOC 530 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses (less than four samples). As a result, manganese was eliminated from the shallow and deep groundwater FRE, and beryllium was eliminated from the deep groundwater FRC based on direct comparison of their maximum concentrations to their corresponding RCs.

Table 10.21.6.5 summarizes the COPCs identified in AOC 530 monitoring wells sampled during the first quarter. Risk projections above 1E-06 were associated with concentration of arsenic and 1,1-dichloroethene in the first quarter groundwater sample collected from monitoring well NBCE530001. Neither arsenic nor 1,1-dichloroethene were detected in the first quarter groundwater sample collected from monitoring well NBCE530002. Risk estimates were approximately 5E-4 for arsenic, and 1E-5 for 1,1-dichloroethene. No COPCs were reported in first quarter samples collected from either of the deep monitoring wells. Figure 10.21.7 illustrates the groundwater data as a function of point-specific risk projections.

Monitoring well NBCE530001 produced first quarter results corresponding with a HI of approximately 5, primarily due to the concentration of arsenic. No COPC were reported in the first quarter samples collected from the deep monitoring wells. Figure 10.21.8 illustrates the groundwater data as a function of point-specific hazard projections.

10.21.6.4 Uncertainty

AOC 530 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.



LEAD IN GROUNDWATER

- NON DETECT
- < 4.8
- 4.8 - 15
- > 15

0 feet 100

ZONE E - RCRA FACILITY
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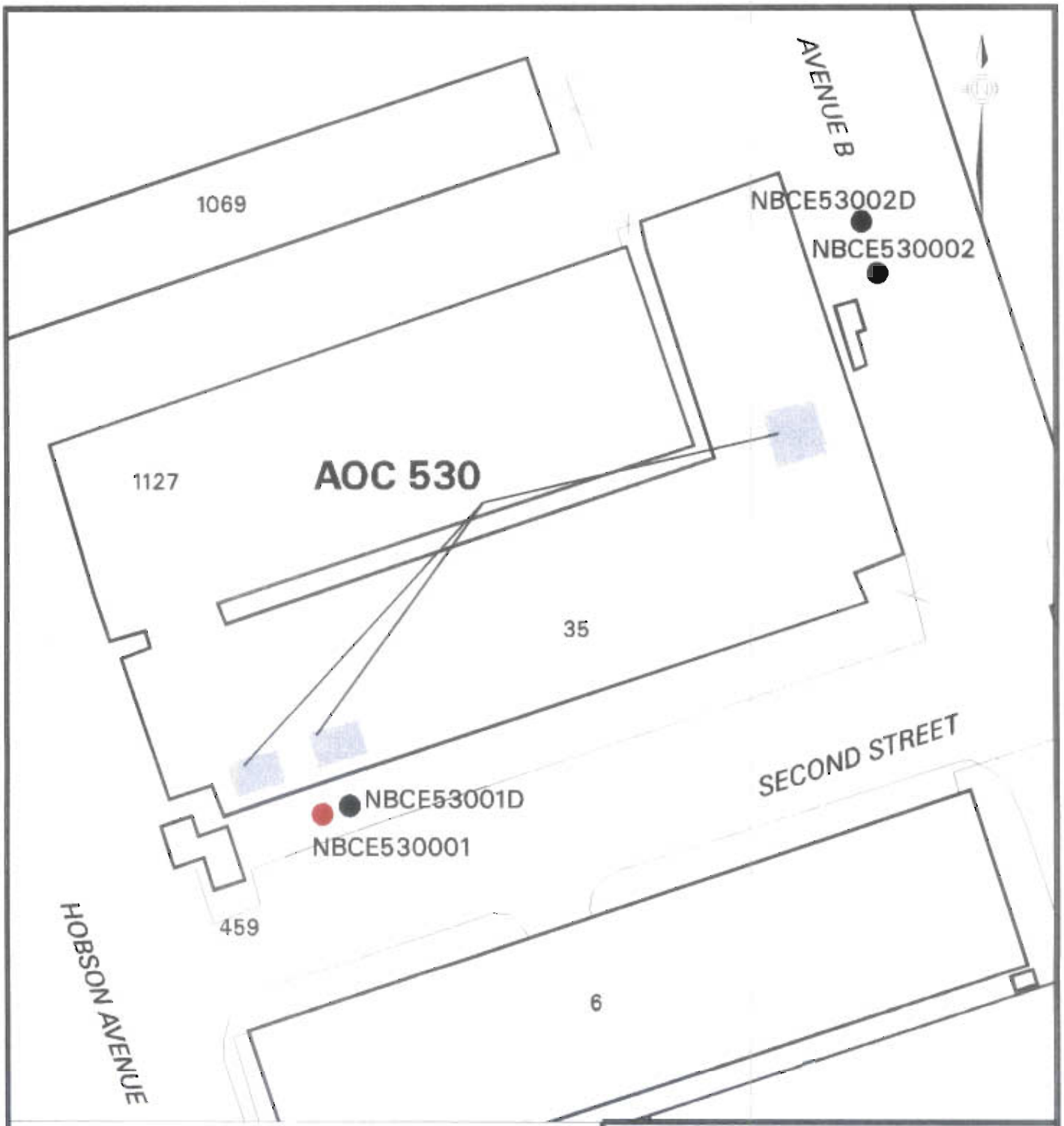
CHARLESTON, S.C.

FIGURE 10.21.7
DISTRIBUTION OF LEAD
IN GROUNDWATER
AOC 530



LEGEND - CUMULATIVE GROUNDWATER HAZARD

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

0 feet 100

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

FIGURE 10.21.8
CUMULATIVE GROUNDWATER HAZARD IN WELLS
AOC 530

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at AOC 530, 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.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 530. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, only aluminum was reported at a concentration close to its RBC (e.g. within 10% of its RBCs). The maximum surface soil concentration of aluminum (7,650 mg/kg) was well below its RC (26,600 mg/kg).

Beryllium and thallium were reported in AOC 530 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their background concentration. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 concentrations close to its RBCs (e.g. within 10% of its RBCs).

Arsenic and 1,1-dichloroethene were contributors to risk and hazard projections for groundwater exposure pathways. Arsenic was detected in five of the eight quarterly samples collected from the shallow aquifer, however, arsenic was only detected in one shallow groundwater sample (first quarter, NBCE530001, 24.2 μg/L) at a concentration above its RC. The mean arsenic shallow groundwater concentration (assuming one-half SQL for nondetects) for all four quarters of samples from NBCE530001 was calculated to be 11.1 μg/L which is below its RC of 18.7 μg/L. 1,1-Dichloroethene was only reported in one of eight groundwater samples collected from the

shallow aquifer over four quarters of sampling. The reported SQL for 1,1-dichloroethene was 5 μg/L. These findings indicate that while arsenic contributes to elevated risk and hazard projections, its temporal average concentration was below its RC. Additionally, since 1,1-dichloroethene was only detected once out of eight shallow groundwater samples, it contribution to risk has likely been overestimated in the AOC 530 FRE.

10.21.6.5 Fixed-Point Risk Evaluation Summary

The risk and hazard posed by contaminants at AOC 530 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.21.6.2, 10.21.6.3, and 10.21.6.5 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Arsenic and benzo(a)pyrene equivalent compounds were detected in AOC 530 surface soil at concentrations above their residential RGOs.

Soil — Site Worker Scenario

Arsenic and benzo(a)pyrene equivalent compounds were detected in AOC 530 surface soil at concentrations above their industrial RGOs.

Groundwater — Residential Scenario

Arsenic and 1,1-dichloroethene were detected in shallow groundwater at concentrations above their RGOs. Arsenic did not exceed its MCLs through four quarters of sampling and its average concentration was below its RC. While 1,1-dichloroethene was detected in one shallow groundwater sample at concentrations above its RGO, it was not detected in subsequent quarterly groundwater samples.

Thallium was detected in third quarter sample collected from all four monitoring wells at concentrations above its MCL. The average concentration for all monitoring wells and all four quarters of sampling, assuming one-half SQL for nondetects (2.2 μg/L), is only marginally above its MCL (2 μg/L). Pentachlorophenol was detected in the third quarter sample from monitoring well NBCE530002 at a concentration of 2 μg/L which is above its MCL of 1 μg/L. Pentachlorophenol was not detected in any other AOC 530 groundwater sample through four quarters of sampling.

Table 10.21.6.1
Chemicals Present in Site Samples
AOC 530 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter			Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RB	Number Exceeding: Ref.
Carcinogenic PAHs																
B(a)P Equiv.	*	*	7	11	1394.82	57316	16522	878.18	1710.14	88	780	NA	UG/KG	7	7	
Benzo(a)anthracene	*	*	7	11	670	49000	13753	380	740	880	7800	NA	UG/KG	6	3	
Benzo(b)fluoranthene	*		4	11	940	3900	2260	380	3800	880	7800	NA	UG/KG	4		
Chrysene			7	11	720	46000	13317	380	740	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	*	7	11	270	12000	3383	380	740	88	780	NA	UG/KG	7	4	
Indeno(1,2,3-cd)pyrene	*	*	7	11	570	18000	5879	380	740	880	7800	NA	UG/KG	5	3	
Benzo(k)fluoranthene	*		7	11	610	57000	14809	380	740	8800	78000	NA	UG/KG	3		
Benzo(a)pyrene	*	*	7	11	900	38000	10886	380	740	88	780	NA	UG/KG	7	7	
Inorganics																
Aluminum (Al)			11	11	2310	7650	4039	NA	NA	7800	100000	26600	MG/KG			
Antimony (Sb)	*		4	11	1.4	3.5	2.43	0.42	0.98	3.1	82	1.77	MG/KG	1		3
Arsenic (As)	*	*	9	11	1.7	83.8	24.16	0.72	1.1	0.43	3.8	23.9	MG/KG	9	6	3
Barium (Ba)			9	11	9.7	118	59.24	11.2	20.3	550	14000	130	MG/KG			
Beryllium (Be)			8	11	0.17	0.41	0.26	0.27	0.27	0.15	1.3	1.7	MG/KG	8		
Cadmium (Cd)	*		8	11	0.06	7.6	2.84	0.11	0.11	3.9	100	1.5	MG/KG	6		3
Calcium (Ca)	N		11	11	584	138000	16626	NA	NA	NA	NA	NA	MG/KG			
Chromium (Cr)			11	11	2.5	32.6	10.99	NA	NA	39	1000	94.6	MG/KG			
Cobalt (Co)			11	11	0.36	37.5	4.98	NA	NA	470	12000	19	MG/KG			1
Copper (Cu)			11	11	1.3	236	68.01	NA	NA	310	8200	66	MG/KG			3
Iron (Fe)	N		10	11	1550	13000	5569	2890	2890	NA	NA	NA	MG/KG			
Lead (Pb)	*		11	11	3.6	1060	336	NA	NA	400	1300	265	MG/KG	4		5
Magnesium (Mg)	N		11	11	97.7	1750	521	NA	NA	NA	NA	NA	MG/KG			
Manganese (Mn)			10	11	28.2	138	75.26	114	114	180	4700	302	MG/KG			
Mercury (Hg)	*		9	11	0.03	9.1	3.46	0.02	0.04	2.3	61	2.6	MG/KG	5		5
Nickel (Ni)			11	11	1.2	30.9	9.65	NA	NA	160	4100	77.1	MG/KG			
Potassium (K)	N		9	11	54.5	729	290	220	223	NA	NA	NA	MG/KG			
Selenium (Se)			5	11	0.44	0.79	0.68	0.34	0.56	39	1000	1.7	MG/KG			
Silver (Ag)			4	11	0.48	4.2	1.72	0.21	0.22	39	1000	NA	MG/KG			
Sodium (Na)	N		9	11	18.5	173	69.39	46.1	188	NA	NA	NA	MG/KG			
Thallium (Tl)			1	11	1.4	1.4	1.40	0.37	0.64	0.63	16	2.8	MG/KG	1		

Table 10.21.6.1
Chemicals Present in Site Samples
AOC 530 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Tin (Sn)	3	11	1.3	13.5	9.33	1.2	11.1	4700	100000	59.4	MG/KG			
Vanadium (V)	11	11	1.9	11.9	6.25	NA	NA	55	14000	94.3	MG/KG			
Zinc (Zn)	11	11	5.2	1490	411	NA	NA	2300	61000	827	MG/KG			2
Semivolatile Organics														
Acenaphthene	6	11	38	11000	3296	370	740	470000	12000000	NA	UG/KG			
Acenaphthylene	5	11	43	2300	961	380	3800	310000	8200000	NA	UG/KG			
Anthracene	7	11	110	32000	7274	380	740	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene	7	11	700	18000	6277	380	740	310000	8200000	NA	UG/KG			
Benzoic acid	2	11	66	70	68	1800	18000	31000000	100000000	NA	UG/KG			
Dibenzofuran	6	11	42	10000	2879	370	740	31000	820000	NA	UG/KG			
2,4-Dimethylphenol	1	11	88	88	88	360	3800	160000	4100000	NA	UG/KG			
Fluoranthene	7	11	1500	90000	26814	380	740	310000	8200000	NA	UG/KG			
Fluorene	6	11	52	12000	3812	370	740	310000	8200000	NA	UG/KG			
2-Methylnaphthalene	5	11	94	10000	5291	370	740	310000	8200000	NA	UG/KG			
Naphthalene	5	11	61	23000	6962	370	740	310000	8200000	NA	UG/KG			
Phenanthrene	7	11	480	100000	26624	380	740	310000	8200000	NA	UG/KG			
Pyrene	7	11	1200	74000	23529	380	740	230000	6100000	NA	UG/KG			
Volatile Organics														
Acetone	5	8	24	480	135	10	27	780000	20000000	NA	UG/KG			
Methylene chloride	3	8	1	4	2.33	5	45	85000	760000	NA	UG/KG			
1,1,2,2-Tetrachloroethane	1	8	8	8	8.00	5	14	3200	29000	NA	UG/KG			
Toluene	3	8	2	6	3.67	5	5	1600000	41000000	NA	UG/KG			
Xylene (Total)	1	8	2	2	2.00	5	14	16000000	100000000	NA	UG/KG			

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

Table 10.21.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 530
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
530	B001	Antimony (Sb)	3.50	MG/KG	NA		0.1200	3.48
530	B001	Arsenic (As)	68.30	MG/KG	178.3997	70.83	3.1218	90.64
530	B001	B(a)P Equiv.	4437.40	UG/KG	73.4847	29.17	NA	
530	B001	Cadmium (Cd)	1.10	MG/KG	NA		0.0151	0.44
530	B001	Lead (Pb)	543.00	MG/KG	NA		NA	
530	B001	Mercury (Hg)	4.10	MG/KG	NA		0.1874	5.44
		Total			251.8844		3.4443	
530	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B002	Arsenic (As)	ND	MG/KG	NA		NA	
530	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
530	B002	Cadmium (Cd)	ND	MG/KG	NA		NA	
530	B002	Lead (Pb)	3.60	MG/KG	NA		NA	
530	B002	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
530	B003	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B003	Arsenic (As)	3.20	MG/KG	8.3584	100.00	0.1463	96.39
530	B003	B(a)P Equiv.	ND	UG/KG	NA		NA	
530	B003	Cadmium (Cd)	ND	MG/KG	NA		NA	
530	B003	Lead (Pb)	11.00	MG/KG	NA		NA	
530	B003	Mercury (Hg)	0.12	MG/KG	NA		0.0055	3.61
		Total			8.3584		0.1517	
530	B004	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B004	Arsenic (As)	3.50	MG/KG	9.1420	7.72	0.1600	95.37
530	B004	B(a)P Equiv.	6603.00	UG/KG	109.3477	92.28	NA	
530	B004	Cadmium (Cd)	0.30	MG/KG	NA		0.0041	2.45
530	B004	Lead (Pb)	41.00	MG/KG	NA		NA	
530	B004	Mercury (Hg)	0.08	MG/KG	NA		0.0037	2.18
		Total			118.4897		0.1677	
530	B005	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B005	Arsenic (As)	ND	MG/KG	NA		NA	
530	B005	B(a)P Equiv.	ND	UG/KG	NA		NA	
530	B005	Cadmium (Cd)	ND	MG/KG	NA		NA	
530	B005	Lead (Pb)	9.50	MG/KG	NA		NA	
530	B005	Mercury (Hg)	0.03	MG/KG	NA		0.0014	100.00
		Total			NA		0.0014	
530	B006	Antimony (Sb)	2.60	MG/KG	NA		0.0891	10.52
530	B006	Arsenic (As)	5.80	MG/KG	15.1496	3.93	0.2651	31.30
530	B006	B(a)P Equiv.	22370.00	UG/KG	370.4542	96.07	NA	
530	B006	Cadmium (Cd)	5.60	MG/KG	NA		0.0767	9.06
530	B006	Lead (Pb)	638.00	MG/KG	NA		NA	
530	B006	Mercury (Hg)	9.10	MG/KG	NA		0.4159	49.11
		Total			385.6038		0.8469	

Table 10.21.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 530
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
530	B007	Antimony (Sb)	2.20	MG/KG	NA		0.0754	7.97
530	B007	Arsenic (As)	8.20	MG/KG	21.4184	5.65	0.3748	39.60
530	B007	B(a)P Equiv.	21596.00	UG/KG	357.6365	94.35	NA	
530	B007	Cadmium (Cd)	7.20	MG/KG	NA		0.0986	10.42
530	B007	Lead (Pb)	1060.00	MG/KG	NA		NA	
530	B007	Mercury (Hg)	8.70	MG/KG	NA		0.3977	42.01
		Total			379.0549		0.9465	
530	B008	Antimony (Sb)	1.40	MG/KG	NA		0.0480	2.19
530	B008	Arsenic (As)	39.00	MG/KG	101.8680	9.69	1.7826	81.37
530	B008	B(a)P Equiv.	57316.00	UG/KG	949.1709	90.31	NA	
530	B008	Cadmium (Cd)	7.60	MG/KG	NA		0.1041	4.75
530	B008	Lead (Pb)	1050.00	MG/KG	NA		NA	
530	B008	Mercury (Hg)	5.60	MG/KG	NA		0.2560	11.68
		Total			1051.0389		2.1907	
530	B009	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B009	Arsenic (As)	3.90	MG/KG	10.1868	30.60	0.1783	90.53
530	B009	B(a)P Equiv.	1394.82	UG/KG	23.0987	69.40	NA	
530	B009	Cadmium (Cd)	0.06	MG/KG	NA		0.0008	0.42
530	B009	Lead (Pb)	42.00	MG/KG	NA		NA	
530	B009	Mercury (Hg)	0.39	MG/KG	NA		0.0178	9.05
		Total			33.2855		0.1969	
530	B010	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B010	Arsenic (As)	83.80	MG/KG	218.8857	87.21	3.8303	96.34
530	B010	B(a)P Equiv.	1938.60	UG/KG	32.1038	12.79	NA	
530	B010	Cadmium (Cd)	0.61	MG/KG	NA		0.0084	0.21
530	B010	Lead (Pb)	279.00	MG/KG	NA		NA	
530	B010	Mercury (Hg)	3.00	MG/KG	NA		0.1371	3.45
		Total			250.9895		3.9758	
530	B011	Antimony (Sb)	ND	MG/KG	NA		NA	
530	B011	Arsenic (As)	1.70	MG/KG	4.4404	100.00	0.0777	95.78
530	B011	B(a)P Equiv.	ND	UG/KG	NA		NA	
530	B011	Cadmium (Cd)	0.25	MG/KG	NA		0.0034	4.22
530	B011	Lead (Pb)	15.60	MG/KG	NA		NA	
530	B011	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			4.4404		0.0811	

Table 10.21.6.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 530
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
530	B001	Arsenic (As)	68.30	MG/KG	25.2373	62.81	0.1570	100.00
530	B001	B(a)P Equiv.	4437.40	UG/KG	14.9413	37.19	NA	
		Total			40.1787		0.1570	
530	B002	Arsenic (As)	ND	MG/KG	NA		NA	
530	B002	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
530	B003	Arsenic (As)	3.20	MG/KG	1.1824	100.00	0.0074	100.00
530	B003	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			1.1824		0.0074	
530	B004	Arsenic (As)	3.50	MG/KG	1.2933	5.50	0.0080	100.00
530	B004	B(a)P Equiv.	6603.00	UG/KG	22.2332	94.50	NA	
		Total			23.5265		0.0080	
530	B005	Arsenic (As)	ND	MG/KG	NA		NA	
530	B005	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
530	B006	Arsenic (As)	5.80	MG/KG	2.1431	2.77	0.0133	100.00
530	B006	B(a)P Equiv.	22370.00	UG/KG	75.3229	97.23	NA	
		Total			77.4661		0.0133	
530	B007	Arsenic (As)	8.20	MG/KG	3.0300	4.00	0.0189	100.00
530	B007	B(a)P Equiv.	21596.00	UG/KG	72.7167	96.00	NA	
		Total			75.7467		0.0189	
530	B008	Arsenic (As)	39.00	MG/KG	14.4108	6.95	0.0897	100.00
530	B008	B(a)P Equiv.	57316.00	UG/KG	192.9910	93.05	NA	
		Total			207.4017		0.0897	
530	B009	Arsenic (As)	3.90	MG/KG	1.4411	23.48	0.0090	100.00
530	B009	B(a)P Equiv.	1394.82	UG/KG	4.6966	76.52	NA	
		Total			6.1376		0.0090	
530	B010	Arsenic (As)	83.80	MG/KG	30.9647	82.59	0.1927	100.00
530	B010	B(a)P Equiv.	1938.60	UG/KG	6.5275	17.41	NA	
		Total			37.4922		0.1927	
530	B011	Arsenic (As)	1.70	MG/KG	0.6282	100.00	0.0039	100.00
530	B011	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.6282		0.0039	

Table 10.21.6.4
Chemicals Present in Site Samples
AOC 530 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Deep Wells											
Inorganics											
Beryllium (Be)		1	2	0.43 - 0.43	0.43	0.3 - 0.3	0.016	1.2	UG/L	1	
Calcium (Ca)	N	2	2	62300 - 66500	64400	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	2	2	241 - 493	367	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	2	2	2860 - 8190	5525	NA - NA	NA	NA	UG/L		
Manganese (Mn)		2	2	92 - 118	105	NA - NA	84	869	UG/L	2	
Zinc (Zn)		2	2	5 - 42.6	23.8	NA - NA	1100	11.8	UG/L		1
Shallow Wells											
Inorganics											
Aluminum (Al)		2	2	553 - 790	671.5	NA - NA	3700	2810	UG/L		
Arsenic (As)	*	1	2	24.2 - 24.2	24.2	2.7 - 2.7	0.045	18.7	UG/L	1	1
Beryllium (Be)		1	2	0.32 - 0.32	0.32	0.3 - 0.3	0.016	0.43	UG/L	1	
Calcium (Ca)	N	2	2	36200 - 94000	65100	NA - NA	NA	NA	UG/L		
Cobalt (Co)		2	2	1 - 1.2	1.1	NA - NA	220	2.5	UG/L		
Iron (Fe)	N	2	2	2300 - 4610	3455	NA - NA	NA	NA	UG/L		
Lead (Pb)		1	2	2.3 - 2.3	2.3	1.7 - 1.7	15	4.8	UG/L		
Magnesium (Mg)	N	2	2	3520 - 3650	3585	NA - NA	NA	NA	UG/L		
Manganese (Mn)		2	2	50.5 - 133	91.75	NA - NA	84	2560	UG/L	1	
Tin (Sn)		1	2	3.6 - 3.6	3.6	2.6 - 2.6	2200	NA	UG/L		
Zinc (Zn)		1	2	14.9 - 14.9	14.9	7.9 - 7.9	1100	27.3	UG/L		

Table 10.21.6.4
Chemicals Present in Site Samples
AOC 530 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Semivolatile Organics											
2-Methylnaphthalene		1	2	11 - 11	11	10 - 10	150	NA	UG/L		
Volatile Organics											
1,1-Dichloroethene	*	1	2	1 - 1	1	5 - 5	0.044	NA	UG/L	1	

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

Table 10.21.6.5
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 530
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
530	G01D	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	
530	G02D	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	
530	G001	1,1-Dichloroethene	1.00	UG/L	11.5264	2.09	0.0142	0.27
530	G001	Arsenic (As)	24.20	UG/L	539.8826	97.91	5.1568	99.73
		Total			551.4090		5.1710	
530	G002	1,1-Dichloroethene	ND	UG/L	NA		NA	
530	G002	Arsenic (As)	ND	UG/L	NA		NA	
		Total			NA		NA	

10.21.7 Corrective Measures Considerations

For AOC 530, the upper and soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and the shallow groundwater. 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.

Arsenic and BEQs were identified as COCs for the upper soil interval. Arsenic and BEQs are the only contributors to risk for AOC 530 surface soil, exceeding 1E-06 at nine of 11 locations. Arsenic was the primary contributor to HI projections at each location. Corrective measures that prevent infiltration and percolation will be considered, along with stabilization.

Lead was detected in all 11 surface soil samples collected at AOC 530. Soil concentrations ranged from 3.6 to 1,060 mg/kg and exceeded the residential clean up level of 400 mg/kg in four of 11 samples (530SB001, 530SB006, 530SB007, and 530SB008). The mean detected lead concentration for the surface soil samples collected at the southwest corner of Building 35 was 602 mg/kg.

Arsenic and 1,1-dichloroethene were identified as COCs in shallow groundwater at concentrations exceeding the risk-based remedial goal options of 0.000045 and 0.00011 mg/L, respectively. Arsenic did not exceed the MCLs through four quarters of sampling and its average concentration was below its RC. While 1,1-dichloroethene was detected in shallow groundwater at concentrations above its RGO, it was not detected in subsequent quarterly groundwater samples. Potential corrective measures for the impacted media and respective COCs are in Table 10.21.7.1. Corrective measures for AOC 530 are detailed in Section 9.

Table 10.21.7.1
Potential Corrective Measures for AOC 530

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic 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	Arsenic and 1,1-dichloroethene	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment

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10.22 AOC 531, Substation and Storage, Building 459

Building 459 was constructed in 1974 and was used for storage and served as an enclosure for a substation. The building has two sections; a metal enclosure containing high-voltage switches and a transformer; and a concrete building containing a battery bank and associated supplies. A 1986 UST Registration document reports the presence of a 20,000-gallon fuel oil tank. No other investigations have been located regarding this facility.

Materials of concern identified in the *Final Zone E RFI Work Plan* include batteries, dielectric fluid, and petroleum hydrocarbons. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

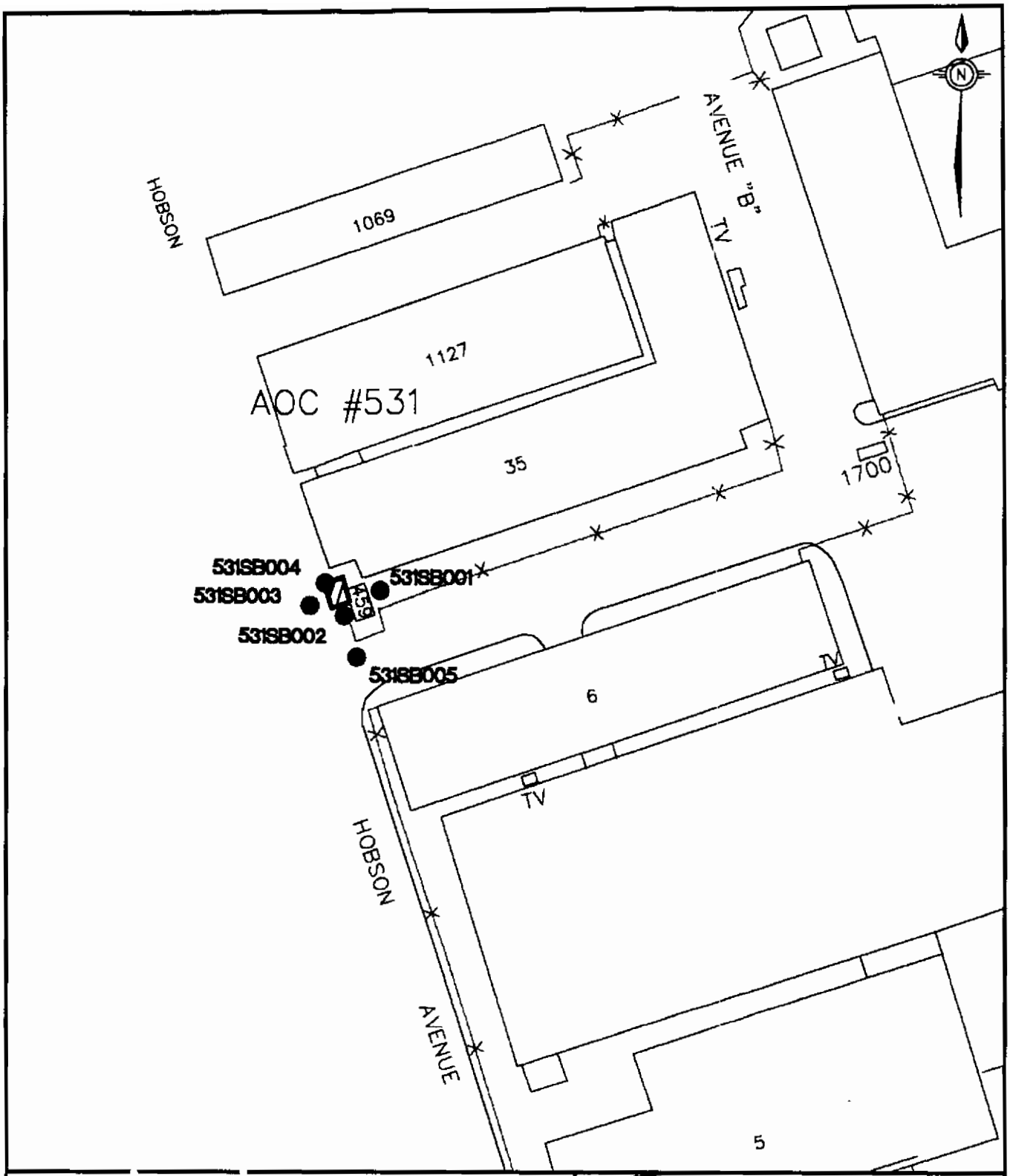
To fulfill the CSI objectives for AOC 531, soil and concrete wipe samples were collected in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.22.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 531 from the locations shown in Figure 10.22.1. The *Final Zone E RFI Work Plan*, proposed collecting two soil samples from the upper interval and two samples from the lower interval.

First-round Sampling — During the first round of sampling, both proposed upper-interval and lower-interval samples were collected. One sample location originally proposed for AOC 530 was designated as an AOC 531 sample and identified as 531SB001.

All first-round samples were submitted for analysis of VOCs, SVOCs, metals, PCBs, and pH at DQO Level III. AOCs 530 and 531 have two sample locations in common, due to their close



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.22.1
SOIL BORING LOCATIONS
AOC #531
SWITCHING SUBSTATION
BUILDING 459

DWG DATE: 09/02/97 | DWG NAME: 10-22-1

proximity. The data from these sample locations, 531SB001 and 530SB006 were used to help characterize each site, while eliminating the need for two additional samples. No samples were selected as duplicates at this site. Table 10.22.1.1 summarizes first-round soil sampling at AOC 531.

Table 10.22.1.1
AOC 531
First-Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	2	3	VOCs, SVOCs, PCBs, metals, and pH	VOCs, SVOCs, PCBs, metals, and pH	One sample to be shared with AOC 530 was identified as 531SB001
Lower	2	3	VOCs, SVOCs, PCBs, metals, and pH	VOCs, SVOCs, PCBs, metals, and pH	One sample to be shared with AOC 530 was identified as 531SB001

Second-round Sampling — Second-round sampling was performed at AOC 531 after first-round analytical results were compared to the USEPA Region III RBCs (April 1996). Parameters exceeding RBCs included SVOCs and metals. Section 10.22.2 details specific parameters and locations which exceeded RBCs.

Three upper-interval and three lower-interval samples were proposed during second-round sampling to determine the extent of constituents detected during the initial round of soil sampling. Two of the three proposed upper-interval samples and two of the three proposed lower-interval samples were collected.

The upper and lower-interval samples proposed at one of the proposed second-round locations could not be collected due to surface and subsurface obstructions in the form of large rocks and subsurface utility lines.

All second-round samples were submitted for analysis at DQO Level III for SVOCs, metals, and pH. No duplicates were selected at this site. Table 10.22.1.2 summarizes the second-round soil sampling at AOC 531.

Table 10.22.1.2
AOC 531
Second-Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	3	2	SVOCs, metals, and pH	SVOCs, metals, and pH	One sample could not be collected
Lower	3	2	SVOCs, metals, and pH	SVOCs, metals, and pH	One sample could not be collected

10.22.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.22.2.1. Inorganic analytical results for soil are summarized in Table 10.22.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.22.2.1
AOC 531
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs						
Toluene	Upper	1/3	1,000	1,000	41,000,000	0
SVOCs						
Acenaphthene	Upper	3/5	130 - 150	137	12,000,000	0
Acenaphthylene	Upper	2/5	86.0 - 140	113	8,200,000	0
Anthracene	Upper	4/5	170 - 1,000	540	61,000,000	0
	Lower	1/5	100	100	NA	NA
Benzo(g,h,i)perylene	Upper	5/5	310 - 3,400	2,060	8,200,000	0
	Lower	4/5	91.0 - 440	183	NA	NA
Benzoic acid	Upper	1/5	40.0	40.0	100,000,000	0
	Lower	1/5	72.0	72.0	NA	NA
4-Chloro-3-methylphenol	Upper	1/5	95.0	95.0	NA	NA
2-Chlorophenol	Upper	1/5	80.0	80.0	1,000,000	0
Dibenzofuran	Upper	1/5	55.0	55.0	820,000	0
Diethylphthalate	Upper	1/5	73.0	73.0	100,000,000	0
Fluoranthene	Upper	5/5	720 - 11,000	5,460	8,200,000	0
	Lower	4/5	200 - 1,300	515	NA	NA
Fluorene	Upper	2/5	84.0 - 100	92.0	8,200,000	0
2-Methylnaphthalene	Upper	1/5	39.0	39.0	8,200,000	0
Naphthalene	Upper	1/5	60.0	60.0	8,200,000	0
Phenanthrene	Upper	5/5	300 - 4,500	2,050	8,200,000	0
	Lower	3/5	100 - 510	243	NA	NA
Pyrene	Upper	5/5	540 - 9,800	5,130	8,200,000	0
	Lower	5/5	110 - 1,100	370	NA	NA

Table 10.22.2.1
AOC 531
Organic Compounds Detected in Soil (μg/kg)

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents)						
B(a)P Equiv.	Upper	5/5	548 - 8,170	4,830	780	4
	Lower	5/5	115 - 914	315	NA	NA
Benzo(a)anthracene	Upper	5/5	340 - 5,200	2,890	7,800	0
	Lower	5/5	92.0 - 550	204	NA	NA
Benzo(b)fluoranthene	Upper	5/5	560 - 6,100	3,760	7,800	0
	Lower	5/5	88.0 - 480	202	NA	NA
Benzo(k)fluoranthene	Upper	3/5	1,600 - 3,200	2,230	78,000	0
	Lower	4/5	130 - 550	255	NA	NA
Benzo(a)pyrene	Upper	5/5	430 - 5,500	3,190	780	4
	Lower	5/5	92.0 - 640	234	NA	NA
Chrysene	Upper	5/5	450 - 5,600	3,050	780,000	0
	Lower	5/5	94.0 - 620	237	NA	NA
Dibenz(a,h)anthracene	Upper	4/5	450 - 1,300	953	780	3
	Lower	1/5	120	120	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	5/5	280 - 3,600	2,000	7,800	0
	Lower	3/5	96.0 - 450	222	NA	NA
PCBs						
Aroclor-1260	Upper	2/3	82.0 - 110	96.0	740	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.22.2.2
AOC 531
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	RC	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Aluminum (Al)	Upper	4/5	1,680 - 4,540	3,400	100,000	26,600	0
	Lower	4/5	3,110 - 3,850	3,480	NA	41,100	NA
Antimony (Sb)	Upper	3/5	0.730 - 2.60	1.35	82	1.77	0
Arsenic (As)	Upper	4/5	2.00 - 76.7	22.0	3.80	23.9	1
	Lower	4/5	0.690 - 15.2	4.66	NA	19.9	NA
Barium (Ba)	Upper	4/5	12.8 - 34.5	23.4	14,000	130	0
	Lower	4/5	7.80 - 12.6	9.50	NA	94.1	NA
Beryllium (Be)	Upper	4/5	0.160 - 0.260	0.220	1.30	1.70	0
	Lower	2/5	0.120 - 0.130	0.125	NA	2.71	NA
Cadmium (Cd)	Upper	3/5	0.190 - 0.300	0.247	100	1.50	0
	Lower	1/5	0.220	0.220	NA	0.960	NA
Calcium (Ca)	Upper	4/5	1,630 - 120,000	36,300	NA	NA	NA
	Lower	4/5	428 - 1,250	797	NA	NA	NA
Chromium (Cr)	Upper	5/5	4.60 - 10.3	6.62	1,000	94.6	0
	Lower	5/5	3.10 - 8.20	4.98	NA	75.2	NA
Cobalt (Co)	Upper	5/5	0.680 - 14.7	7.22	12,000	19.0	0
	Lower	1/5	2.10	2.10	NA	14.9	NA
Copper (Cu)	Upper	4/5	9.80 - 58.7	26.9	8,200	66.0	0
	Lower	4/5	0.710 - 4.60	1.78	NA	152	NA
Iron (Fe)	Upper	4/5	3,490 - 18,500	8,260	61,000	NA	0
	Lower	4/5	1,400 - 1,960	1,620	NA	NA	NA
Lead (Pb)	Upper	4/5	31.2 - 86.8	59.7	1,300	265	0
	Lower	4/5	2.50 - 22.1	8.58	NA	173	NA
Magnesium (Mg)	Upper	4/5	186 - 1,310	567	NA	NA	NA
	Lower	4/5	74.1 - 172	123	NA	NA	NA

Table 10.22.2.2
AOC 531
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	RC	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Manganese (Mn)	Upper	4/5	51.2 - 88.7	62.2	4,700	302	0
	Lower	4/5	8.70 - 15.7	11.9	NA	881	NA
Mercury (Hg)	Upper	5/5	0.0600 - 1.30	0.476	61	2.60	0
	Lower	2/5	0.0400 - 0.0500	0.0450	NA	1.59	NA
Nickel (Ni)	Upper	4/5	2.10 - 47.4	15.7	4,100	77.1	0
	Lower	4/5	0.910 - 2.20	1.33	NA	57.0	NA
Potassium (K)	Upper	4/5	296 - 504	377	NA	NA	NA
	Lower	2/5	64.4 - 112	88.2	NA	NA	NA
Silver (Ag)	Upper	1/5	5.70	5.70	1,000	NA	0
	Lower	1/5	0.270	0.270	NA	NA	NA
Sodium (Na)	Upper	4/5	23.8 - 200	84.8	NA	NA	NA
	Lower	3/5	25.6 - 179	82.7	NA	NA	NA
Thallium (Tl)	Upper	1/5	1.20	1.20	16	2.80	0
Tin (Sn)	Upper	4/5	3.60 - 5.70	4.30	100,000	59.4	0
	Lower	3/5	3.00 - 3.30	3.13	NA	9.23	0
Vanadium (V)	Upper	4/5	3.10 - 9.70	6.10	1,400	94.3	0
	Lower	4/5	1.10 - 2.50	1.93	NA	155	0
Zinc (Zn)	Upper	4/5	16.7 - 152	78.6	61,000	827	0
	Lower	3/5	2.20 - 2.50	2.37	61,000	886	0
pH (SU)							
pH	Upper	4/4	7.83 - 10.1	8.82	NA	NA	NA
	Lower	4/4	7.70 - 8.03	7.82	NA	NA	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC or RC established
SU = Standard units

Volatile Organic Compounds in Soil

One VOC was detected in soil samples collected at AOC 531. Toluene was detected in one of three upper-interval samples at 1,000 μg/kg, below its industrial RBC. VOCs were not detected in lower-interval samples.

Semivolatile Organic Compounds in Soil

Twenty-two SVOCs were detected in soil samples collected at AOC 531. Seventy detections occurred in the upper-interval and 46 in the lower-interval. Two SVOCs — dibenz(a,h)anthracene and benzo(a)pyrene — exceeded their respective industrial RBC in the upper interval. No SVOC exceeded its respective SSL in the lower interval.

Dibenz(a,h)anthracene was detected in four of five upper-interval samples with a range of 450 to 1,300 μg/kg and a mean of 953 μg/kg. Three upper-interval samples (531SB003, 1,300 μg/kg; 531SB004, 1,200 μg/kg; and 531SB005, 1,300 μg/kg) exceeded the dibenz(a,h)anthracene industrial RBC of 780 μg/kg.

Benzo(a)pyrene was detected in five of five upper-interval samples with a range of 430 to 5,500 μg/kg and a mean of 3,190 μg/kg. Four upper-interval samples (531SB002, 1,200 μg/kg; 531SB003, 4,100 μg/kg; 531SB004, 5,500 μg/kg; and 531SB005, 4,700 μg/kg) exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 531. The upper-interval BEQ was calculated for five samples with a range of 548 to 8,170 μg/kg, and a mean of 4,830 μg/kg. Four samples (531SB002, 1,955 μg/kg; 531SB003, 6,604 μg/kg; 531SB004, 8,170 μg/kg; and 531SB005, 6,873 μg/kg) exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

PCBs in Soil

One PCB, Aroclor-1260, was detected in two of three upper-interval samples at AOC 531. The detections did not exceed the Aroclor-1260 industrial RBC in the upper interval. PCBs were not detected in lower-interval soil samples.

Inorganic Elements in Soil

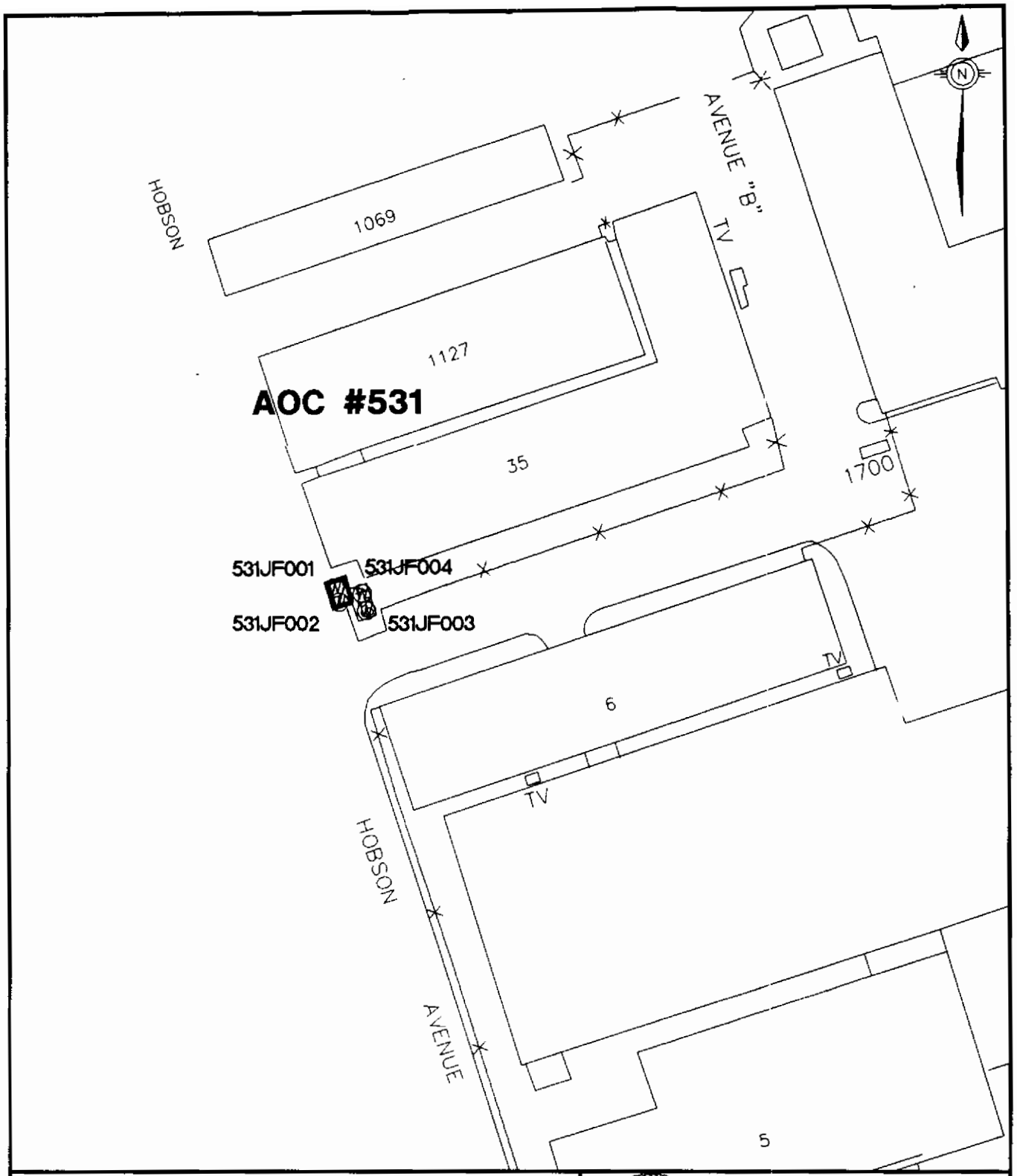
Twenty-three metals were detected in soil samples collected at AOC 531. Eighty-seven detections occurred in the upper interval and 67 occurred in the lower interval. No metal exceeded both its respective industrial RBC and background RC in the upper interval or respective SSL and background RC in the lower interval.

10.22.3 Wipe Sampling and Analysis

Concrete surfaces were sampled at AOC 531 from the locations shown in Figure 10.22.2. The *Final Zone E RFI Work Plan* proposed the collection of four wipe samples at AOC 531. All four wipe samples were collected and submitted for PCB analysis. Table 10.22.3.1 summarizes wipe sampling activity for AOC 531.

Table 10.22.3.1
AOC 531
Wipe Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
4	4	PCB	PCB	No deviation from proposed strategy



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◮ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.22.2
WIPE SAMPLE LOCATIONS
AOC #531
SWITCHING SUBSTATION
BUILDING 459

DWG DATE: 09/02/97 | DWG NAME: 10-22-2

10.22.4 Nature of Contamination in Dust

Table 10.22.4.1 summarizes the wipe sample analytical results for AOC 531. Sample locations were determined in the field and were biased in an attempt to identify worst case situations. Sample locations were selected in the field based on the location of PCB-containing equipment and visual evidence of spills and leaks.

Table 10.22.4.1
AOC 531
Wipe Sampling Analytical Results

Parameter	Frequency of Detection	Range of Detections (μg/wipe)
PCB	0/4	N/A

Note:
μg/wipe = micrograms per wipe sample

PCBs Detected on Surfaces

Four samples were collected at AOC 531 and analyzed for PCBs. No PCBs were detected.

10.22.5 Fate and Transport Assessment for AOC 531

AOC 531 (Building 459) served as an enclosure for an electrical substation. A 1986 UST Registration document reports the presence of a 20,000-gallon fuel oil tank. The site is entirely paved with concrete and asphalt. Environmental media sampled as part of the AOC 531 CSI include surface soil, subsurface soil, and wipe samples. Potential constituent migration pathways investigated for AOC 531 include soil to groundwater (with eventual discharge to surface water), and emission of volatiles from surface soil to air.

10.22.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.22.5.1 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 reference 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 10:1, with no attenuation of constituents in soil (DAF=10).

Four organic compounds — benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene — were detected in AOC 531 soil above groundwater protection SSLs. All four constituents were detected at concentrations above their generic SSLs in three surface soil samples (531SB003, 531SB004, and 531SB005). Additionally, benzo(a)anthracene was detected at a concentration above its generic SSL in surface soil sample 531SB002. These four samples were collected from cores underneath the asphalt of Second Street and Hobson Avenue. None of these PAHs was detected in subsurface soil at a concentration above its generic SSL.

Two inorganics — antimony and arsenic — were detected in a single surface soil sample (531SB002) above their respective generic SSLs or background reference values. They were not detected in any subsurface soil sample at concentrations exceeding their groundwater protection screening values.

10.22.5.2 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.21.5.2 provides a second screening tier for all constituents detected in soil at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in soil are compared to calculated SSLs that are based on RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil that pose a threat to surface water quality, after allowing for dilution of groundwater by

surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined AOC 531 is 177,000:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil pose no threat to human health or the environment in the Cooper River via the soil to groundwater to surface water migration pathway.

10.22.5.3 Soil-to-Air Cross-Media Transport

Table 10.22.5.3 lists the VOCs detected in surface soil samples collected at AOC 531 along with corresponding soil-to-air volatilization screening levels. None of the site's surface soil is exposed at AOC 531. Additionally, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be significant at AOC 531.

10.22.5.4 Fate and Transport Summary

All of the exceedances of first-tier groundwater protection screening were reported from surface soil samples only. There were no exceedances of first-tier groundwater protection screening values in subsurface soil which indicates that soil to groundwater migration of these constituents is not occurring. All surface soil samples with detected concentrations of PAHs above generic SSLs were collected from cores beneath the asphalt of Second Street and Hobson Avenue. Consequently the overlying asphalt is a potential source of PAH compounds. None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.22.5.1
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations: Tier One
NAVBASE-Charleston, Zone E: AOC 531
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Toluene	1000	ND	NA	NA	6000	750	37	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	150	ND	NA	NA	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	140	ND	NA	NA	150000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	1000	100	NA	NA	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	40	72	NA	NA	200000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	3400	440	NA	NA	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	5200	550	NA	NA	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	5500	640	NA	NA	4000	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	6100	480	NA	NA	2500	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	3200	550	NA	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	5600	620	NA	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	1300	120	NA	NA	800	0.0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	3600	450	NA	NA	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
4-Chloro-3-methylphenol	95	ND	NA	NA	3150	180	NA	UG/KG	UG/L	NO	NO	NO
2-Chlorophenol	80	ND	NA	NA	2000	180	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	55	ND	NA	NA	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Diethylphthalate	73	ND	NA	NA	235000	29000	75.9	UG/KG	UG/L	NO	NO	NO
Fluoranthene	11000	1300	NA	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	100	ND	NA	NA	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	39	ND	NA	NA	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	60	ND	NA	NA	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	4500	510	NA	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenol	ND	ND	NA	NA	50000	22000	58	UG/KG	UG/L	NO	NO	NO
Pyrene	9800	1100	NA	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	110	ND	NA	NA	1000	0.0087	0.03	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	4540	3850	NA	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	2.6	ND	NA	NA	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	76.7	15.2	NA	NA	23.9	18.7	36	MG/KG	UG/L	YES	NO	NO
Barium	34.5	12.6	NA	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.26	0.13	NA	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.3	0.22	NA	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	10.3	8.2	NA	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	14.7	2.1	NA	NA	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	58.7	4.6	NA	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	86.8	22.1	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	88.7	15.7	NA	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	1.3	0.05	NA	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	47.4	2.2	NA	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Silver	5.7	0.27	NA	NA	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	1.2	ND	NA	NA	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	5.7	3.3	NA	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	9.7	2.5	NA	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	152	2.5	NA	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.22.5.2
Chemicals Detected in Surface Soil or Subsurface Soil at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 531
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentration *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	5200	550	NA	NA	800	0.092	NA	0.092	1.63E+04	0.1	1.63E+05	1.04E+07	UG/KG	UG/L	NO	NO
Benzo(a)pyrene	5500	640	NA	NA	4000	0.0092	NA	0.0092	1.63E+03	0.2	8.14E+03	3.26E+06	UG/KG	UG/L	NO	NO
Benzo(b)fluoranthene	6100	480	NA	NA	2500	0.092	NA	0.092	1.63E+04	0.1	1.63E+05	1.04E+07	UG/KG	UG/L	NO	NO
Dibenzo(a,h)anthracene	1300	120	NA	NA	800	0.0092	NA	0.0092	1.63E+03	0.01	1.63E+05	1.04E+07	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	2.6	ND	NA	NA	2.5	15	NA	15	2.66E+06	6	4.43E+05	1.11E+05	MG/KG	UG/L	NO	NO
Arsenic	76.7	15.2	NA	NA	14.6	0.045	36	0.045	7.97E+03	50	1.59E+02	2.33E+02	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 177,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.22.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 531
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Toluene	1000	520000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.22.6 Fixed-Point Risk Evaluation for AOC 531

10.22.6.1 Site Background and Investigative Approach

AOC 531 is a substation and storage area in Building 459. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a fixed-point risk evaluation (FRE) following the framework presented in Section 7.3.

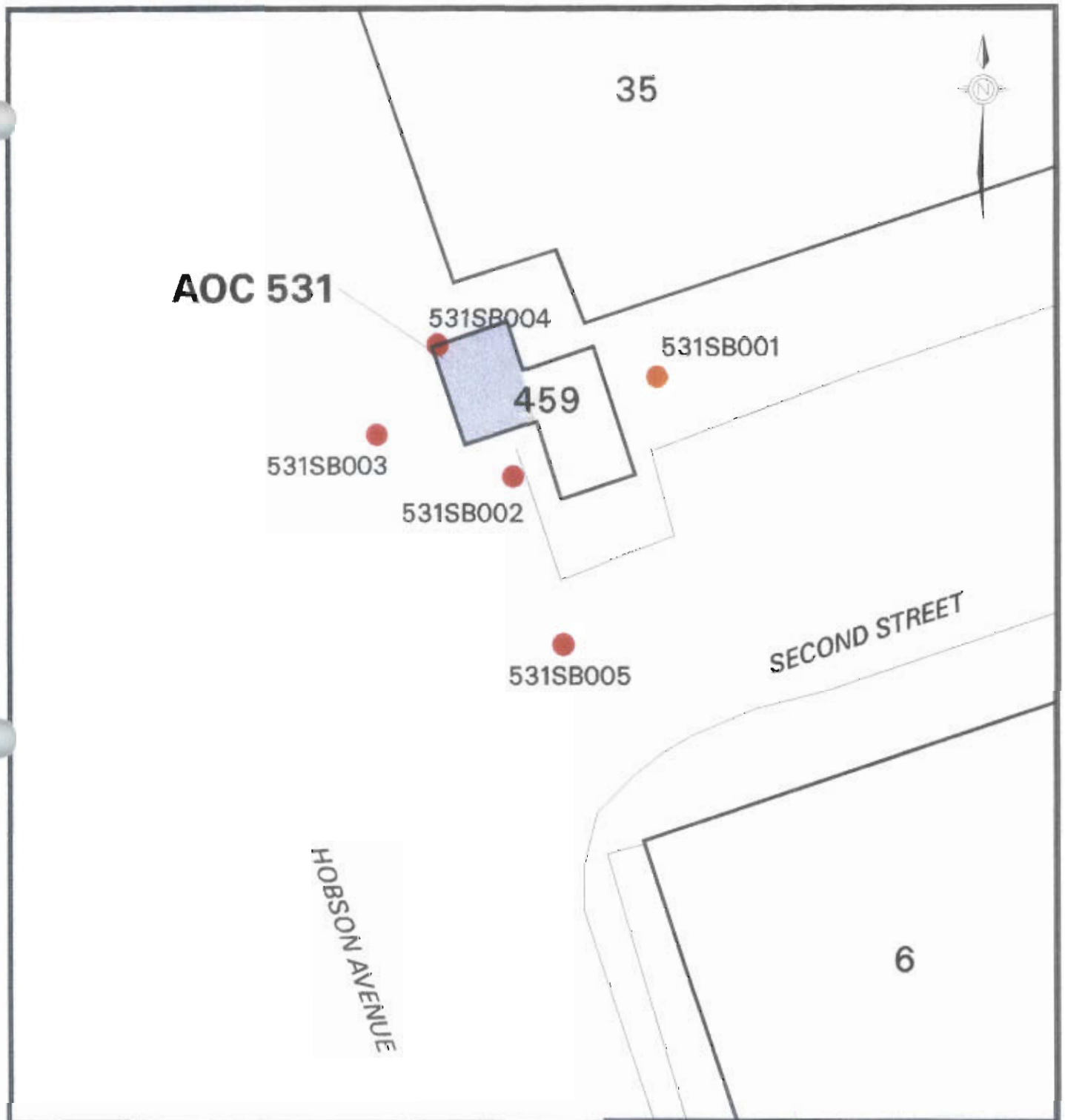
A total of five surface soil samples were considered in the AOC 531 FRE. Groundwater investigation was not part of the RFI sampling activities for this site. Section 10.21.1 contains a summary of the soil sampling effort for AOC 531.

10.22.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.22.6.1 provides CPSS summaries for AOC 531 soil and identifies COPCs based on comparison to residential and industrial RBCs, and RCs. Based on residential RBCs, three COPCs (Aroclor-1260, arsenic, and BEQs) were identified for AOC 531. Beryllium and thallium were detected in AOC 531 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE 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 based on background concentration.

Table 10.22.6.2 summarizes the residential COPCs detected at each AOC 531 sample location with contribution to risk and hazard. As shown, arsenic and benzo(a)pyrene equivalent compounds are the primary contributors to risk for AOC 531 surface soil, exceeding 1E-06 at all five locations. Risk estimates range from 2E-05 to 2E-04 with an arithmetic mean risk of 1E-04. Figure 10.22.3 is a spatial presentation of risk estimates for AOC 531 surface soil.



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 50

ZONE E - DRAFT RECRA
FACILITY INVESTIGATION
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.22.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 531

Figure 10.22.4 is a spatial presentation of HI estimates for AOC 531 surface soil. As shown, HI projections exceeded the threshold of unity at only one sample location. No COPCs were detected in sample 531SB004 that would have contributed to HI estimates.

Those samples with concentrations of COPCs contributing to HI estimates had a range of 0.09 to 4 with an arithmetic mean HI of 0.8 (assuming a deminimus HI of 0.01 for samples with no detected concentrations of COPCs contributing to HI projections). Arsenic was the only contributor to HI projections.

Industrial Scenario

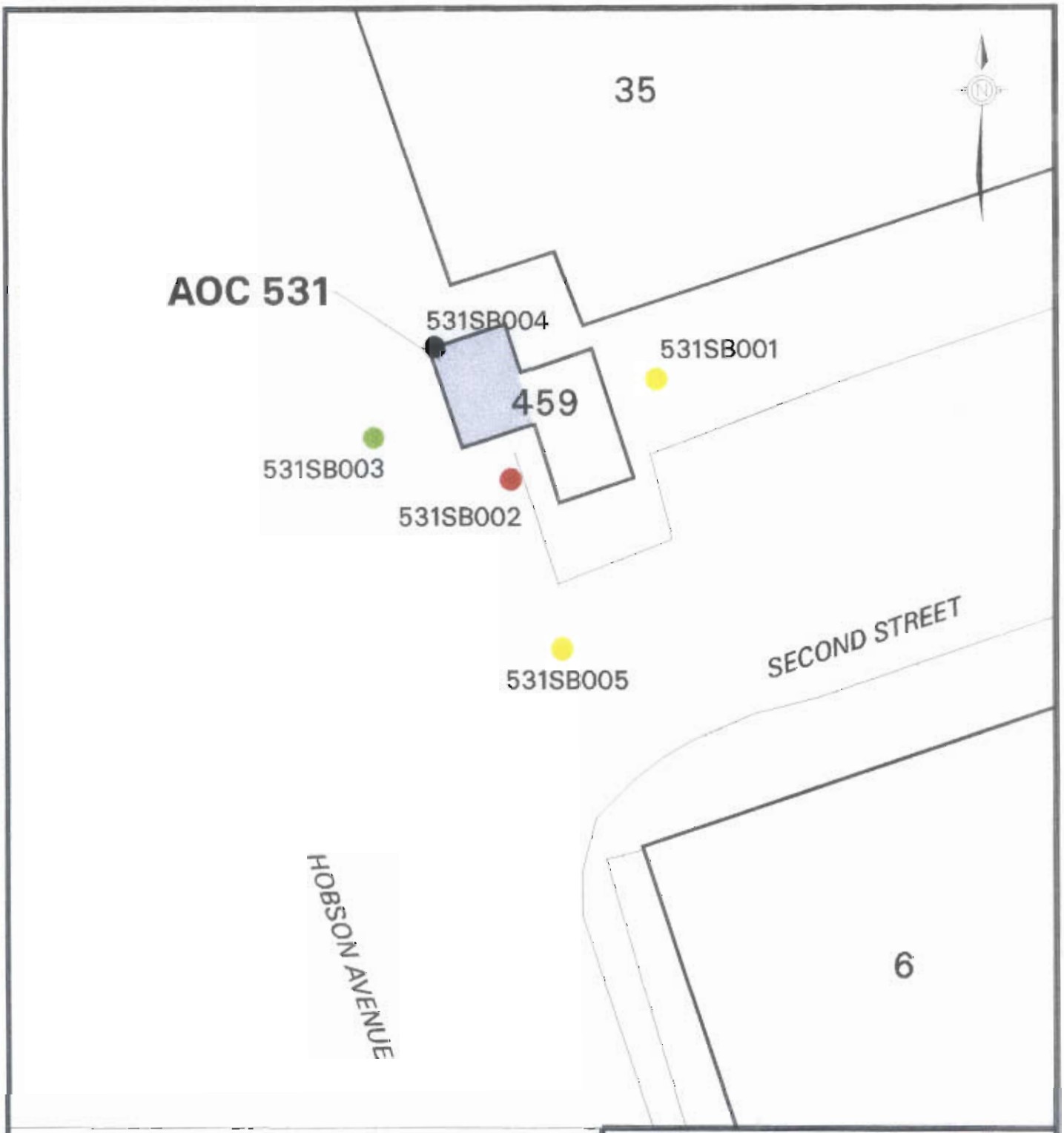
Based on industrial RBCs, arsenic and BEQs were identified as COPCs for AOC 531 surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

Table 10.22.6.3 summarizes the industrial COPCs detected at each AOC 531 sample location with contribution to risk and hazard. As shown, arsenic and benzo(a)pyrene equivalent related risk estimates for AOC 531, exceeded 1E-06 at all five locations, based on the industrial scenario. Risk estimates range from 3E-06 to 3E-05 with an arithmetic mean risk of 2E-05. Figure 10.22.5 is a spatial presentation of risk estimates for AOC 531 surface soil based on an industrial scenario.

HI projections did not exceed the threshold of unity at any sample locations based on the industrial scenario. HI estimates range from 0.005 to 0.2.

10.22.6.3 Uncertainty

AOC 531 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.



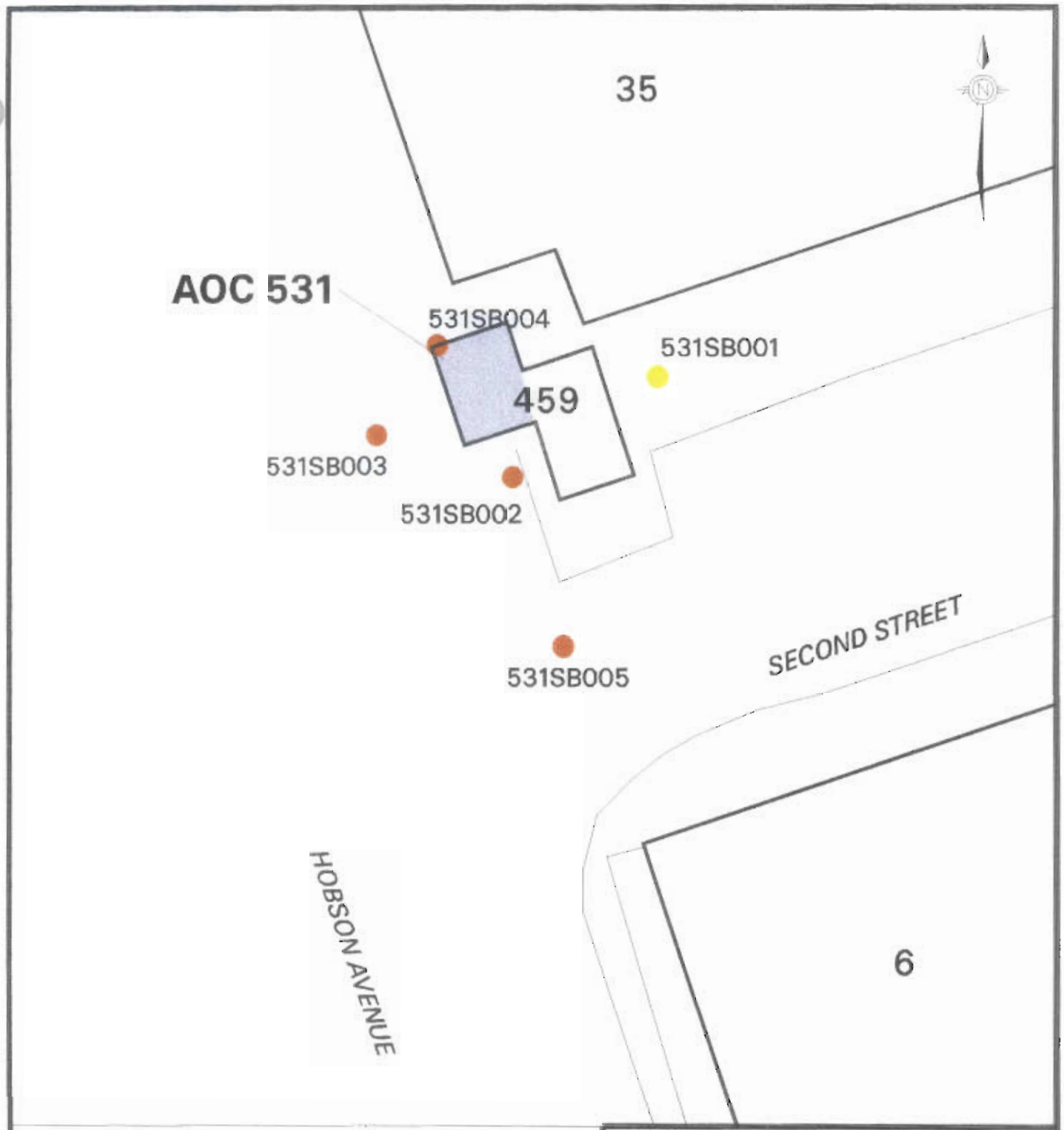
LEGEND - CUMULATIVE SOIL HAZARD

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

0 feet 50

ZONE E - DRAFT RECRA
FACILITY INVESTIGATION
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.22.4
CUMULATIVE SOIL HAZARD
RESIDENTIAL SCENARIO
AOC 531



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 50

ZONE E - DRAFT RECRA
FACILITY INVESTIGATION
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.22.5
CUMULATIVE SOIL RISK
INDUSTRIAL SCENARIO
AOC 531

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

COPC Selection

4-Chloro-3-methylphenol was detected in one of five surface soil samples at a concentration of 95 μg/kg. There are no RBCs listed for this chemical in the Region III RBC tables, nor are there toxicological data with which to calculate a RBC. As a result, 4-chloro-3-methylphenol was not included in the FRE for AOC 531. The maximum 4-chloro-3-methylphenol concentration did not exceed the RBC for 2-chlorophenol (39,000 μg/kg). This minimizes the uncertainty associated with the elimination of 4-chloro-3-methylphenol from consideration in the FRE.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for AOC 531. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, none was reported at a concentration close to its RBC (e.g. within 10% of its RBCs).

Arsenic was a contributor to both risk and hazard projections for residential and industrial soil pathways. Arsenic exceeded its RC in only one of five surface soil samples (531SB002). These findings indicate that while the maximum arsenic concentration was above its RCs, its average concentrations (22.03 mg/kg) was below its RC (23.9 mg/kg).

Beryllium and thallium were reported in AOC 531 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their background concentration. As a result, their contribution to risk/hazard has not been considered in this FRE.

Four of the five surface soil samples were collected through cores established in the asphalt covering of this site. It is conceivable that the concentrations of BEQs detected in surface soil are artifacts of the asphalt covering rather than past site uses.

10.22.6.4 Fixed-Point Risk Evaluation Summary

The risk and hazard posed by contaminants at AOC 531 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. Risk and HI estimates are presented on Tables 10.22.6.2 and 10.22.6.3 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Arsenic and benzo(a)pyrene equivalent compounds were detected in AOC 530 surface soil at concentrations above their residential RGOs. It should be noted that overall site surface soil arsenic concentrations were generally consistent with RCs. Additionally, the asphalt that covers most of this site may explain the presence of BEQs in the surface soil.

Soil — Site Worker Scenario

Arsenic and benzo(a)pyrene equivalent compounds were detected in AOC 530 surface soil at concentrations above their industrial RGOs. It should be noted that overall site surface soil arsenic concentrations were generally consistent with RCs. Additionally, the asphalt that covers most of this site may explain the presence of BEQs in the surface soil.

Table 10.22.6.1
Chemicals Present in Site Samples
AOC 531 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RB	Number Exceeding: Ref.
PCBs													
Aroclor-1260	*	2	3	82 - 110	96	76 - 76	83	740	NA	UG/KG	1		
Carcinogenic PAHs													
B(a)P Equiv.	* *	5	5	548.45 - 8167.6	4830	NA - NA	88	780	NA	UG/KG	5	4	
Benzo(a)anthracene	*	5	5	340 - 5200	2888	NA - NA	880	7800	NA	UG/KG	4		
Benzo(b)fluoranthene	*	5	5	560 - 6100	3764	NA - NA	880	7800	NA	UG/KG	4		
Chrysene		5	5	450 - 5600	3050	NA - NA	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	* *	4	5	450 - 1300	953	750 - 750	88	780	NA	UG/KG	4	3	
Indeno(1,2,3-cd)pyrene	*	5	5	280 - 3600	2000	NA - NA	880	7800	NA	UG/KG	3		
Benzo(k)fluoranthene		3	5	1600 - 3200	2233	740 - 750	8800	78000	NA	UG/KG			
Benzo(a)pyrene	* *	5	5	430 - 5500	3186	NA - NA	88	780	NA	UG/KG	5	4	
Inorganics													
Aluminum (Al)		4	5	1680 - 4540	3400	7270 - 7270	7800	100000	26600	MG/KG			
Antimony (Sb)		3	5	0.73 - 2.6	1.35	0.35 - 0.46	3.1	82	1.77	MG/KG			1
Arsenic (As)	* *	4	5	2 - 76.7	22.03	2.9 - 2.9	0.43	3.8	23.9	MG/KG	4	2	1
Barium (Ba)		4	5	12.8 - 34.5	23.38	29.1 - 29.1	550	14000	130	MG/KG			
Beryllium (Be)		4	5	0.16 - 0.26	0.22	0.31 - 0.31	0.15	1.3	1.7	MG/KG	4		
Cadmium (Cd)		3	5	0.19 - 0.3	0.25	0.09 - 0.11	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	4	5	1630 - 120000	36270	4700 - 4700	NA	NA	NA	MG/KG			
Chromium (Cr)		5	5	4.6 - 10.3	6.62	NA - NA	39	1000	94.6	MG/KG			
Cobalt (Co)		5	5	0.68 - 14.7	7.22	NA - NA	470	12000	19	MG/KG			
Copper (Cu)		4	5	9.8 - 58.7	26.85	6.9 - 6.9	310	8200	66	MG/KG			
Iron (Fe)	N	4	5	3490 - 18500	8255	5340 - 5340	NA	NA	NA	MG/KG			
Lead (Pb)		4	5	31.2 - 86.8	59.7	24.9 - 24.9	400	1300	265	MG/KG			
Magnesium (Mg)	N	4	5	186 - 1310	567.3	488 - 488	NA	NA	NA	MG/KG			
Manganese (Mn)		4	5	51.2 - 88.7	62.2	60.3 - 60.3	180	4700	302	MG/KG			
Mercury (Hg)		5	5	0.06 - 1.3	0.476	NA - NA	2.3	61	2.6	MG/KG			
Nickel (Ni)		4	5	2.1 - 47.4	15.725	3.6 - 3.6	160	4100	77.1	MG/KG			
Potassium (K)	N	4	5	296 - 504	377	260 - 260	NA	NA	NA	MG/KG			
Silver (Ag)		1	5	5.7 - 5.7	5.7	0.22 - 0.23	39	1000	NA	MG/KG			
Sodium (Na)	N	4	5	23.8 - 200	84.8	189 - 189	NA	NA	NA	MG/KG			
Thallium (Tl)		1	5	1.2 - 1.2	1.2	0.39 - 0.57	0.63	16	2.8	MG/KG	1		
Tin (Sn)		4	5	3.6 - 5.7	4.3	2.2 - 2.2	4700	6100	59.4	MG/KG			
Vanadium (V)		4	5	3.1 - 9.7	6.1	9.6 - 9.6	55	1400	94.3	MG/KG			
Zinc (Zn)		4	5	16.7 - 152	78.6	31.8 - 31.8	2300	61000	827	MG/KG			

Table 10.22.6.1
Chemicals Present in Site Samples
AOC 531 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RB	Number Exceeding: Ref.
Semivolatile Organics												
Acenaphthene	3	5	130 - 150	137	720 - 750	470000	12000000	NA	UG/KG			
Acenaphthylene	2	5	86 - 140	113	720 - 750	310000	8200000	NA	UG/KG			
Anthracene	4	5	170 - 1000	540	750 - 750	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene	5	5	310 - 3400	2058	NA - NA	310000	8200000	NA	UG/KG			
Benzoic acid	1	5	40 - 40	40	3500 - 3700	31000000	100000000	NA	UG/KG			
4-Chloro-3-methylphenol	1	5	95 - 95	95	380 - 770	NA	NA	NA	UG/KG			
2-Chlorophenol	1	5	80 - 80	80	380 - 770	39000	1000000	NA	UG/KG			
Dibenzofuran	1	5	55 - 55	55	720 - 770	31000	820000	NA	UG/KG			
Diethylphthalate	1	5	73 - 73	73	720 - 770	6300000	100000000	NA	UG/KG			
Fluoranthene	5	5	720 - 11000	5464	NA - NA	310000	8200000	NA	UG/KG			
Fluorene	2	5	84 - 100	92	720 - 750	310000	8200000	NA	UG/KG			
2-Methylnaphthalene	1	5	39 - 39	39	720 - 770	310000	8200000	NA	UG/KG			
Naphthalene	1	5	60 - 60	60	720 - 770	310000	8200000	NA	UG/KG			
Phenanthrene	5	5	300 - 4500	2050	NA - NA	310000	8200000	NA	UG/KG			
Pyrene	5	5	540 - 9800	5128	NA - NA	230000	6100000	NA	UG/KG			
Volatile Organics												
Toluene	1	3	1 - 1	1	5 - 6	1600000	41000000	NA	UG/KG			

Notes:
* - Identified as a residential scenario COPC
** - Identified as an industrial scenario COPC
N - Essential nutrient
SQL - Sample quantitation limit
NA - Not applicable
UG\KG - micrograms per kilogram
MG\KG - milligrams per kilogram

Table 10.22.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 531
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
531	B001	Aroclor-1260	ND	UG/KG	NA		NA	
531	B001	Arsenic (As)	2.90	MG/KG	7.5748	45.47	0.1326	100.00
531	B001	B(a)P Equiv.	548.45	UG/KG	9.0825	54.53	NA	
		Total			16.6573		0.1326	
531	B002	Aroclor-1260	110.00	UG/KG	0.4991	0.21	NA	
531	B002	Arsenic (As)	76.70	MG/KG	200.3405	85.90	3.5058	100.00
531	B002	B(a)P Equiv.	1955.30	UG/KG	32.3804	13.88	NA	
		Total			233.2199		3.5058	
531	B003	Aroclor-1260	82.00	UG/KG	0.3720	0.32	NA	
531	B003	Arsenic (As)	2.00	MG/KG	5.2240	4.54	0.0914	100.00
531	B003	B(a)P Equiv.	6603.80	UG/KG	109.3610	95.13	NA	
		Total			114.9570		0.0914	
531	B004	Arsenic (As)	ND	MG/KG	NA		NA	
531	B004	B(a)P Equiv.	8167.60	UG/KG	135.2580	100.00	NA	
		Total			135.2580		NA	
531	B005	Arsenic (As)	6.50	MG/KG	16.9780	12.98	0.2971	100.00
531	B005	B(a)P Equiv.	6873.10	UG/KG	113.8207	87.02	NA	
		Total			130.7987		0.2971	

Table 10.22.6.3
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 531
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	HQ	% HQ	Risk (E-06)	% Risk
531	B001	Arsenic (As)	2.90	MG/KG	1.0716	36.72	0.0067	100.00
531	B001	B(a)P Equiv.	548.45	UG/KG	1.8467	63.28	NA	
		Total			2.9183		0.0067	
531	B002	Arsenic (As)	76.70	MG/KG	28.3412	81.15	0.1764	100.00
531	B002	B(a)P Equiv.	1955.30	UG/KG	6.5838	18.85	NA	
		Total			34.9250		0.1764	
531	B003	Arsenic (As)	2.00	MG/KG	0.7390	3.22	0.0046	100.00
531	B003	B(a)P Equiv.	6603.80	UG/KG	22.2359	96.78	NA	
		Total			22.9749		0.0046	
531	B004	Arsenic (As)	ND	MG/KG	NA		NA	
531	B004	B(a)P Equiv.	8167.60	UG/KG	27.5014	100.00	NA	
		Total			27.5014		NA	
531	B005	Arsenic (As)	6.50	MG/KG	2.4018	9.40	0.0149	100.00
531	B005	B(a)P Equiv.	6873.10	UG/KG	23.1427	90.60	NA	
		Total			25.5445		0.0149	

10.22.7 Corrective Measures Considerations

For AOC 531, the upper and lower soil intervals were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for the upper soil interval. 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.

Arsenic and BEQs were identified as COCs in the upper soil interval at concentrations above their risk-based remedial goals of 0.38 and 0.060 mg/kg, respectively. The arithmetic mean risk of arsenic and BEQs is 1E-04, which equals the USEPA's upper acceptable risk. Potential corrective measures for the impacted medium and respective COCs are in Table 10.22.7.1. Corrective measures that prevent infiltration and percolation will be considered, along with stabilization. Corrective measures for AOC 531 are detailed in Section 9.

Table 10.22.7.1
Potential Corrective Measures for AOC 531

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic 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

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10.23 AOC 538, Forge Shop, Building 6; and AOC 539, Propeller Shop, Building 6

AOC 538, a forge shop constructed in 1906, is located in the eastern portion of Building 6. Various metal-working processes have been conducted in the shop. The most recent forge furnaces were oil-fired. Numerous quench oil tanks are also present. AOC 539, propeller shop, is located in the western extension of Building 6, which was added in 1967. The Zyglo process was used here until it was replaced by the existing red dye process in 1979. Zyglo reportedly was rinsed from the propellers onto the floor and then washed outside into the storm sewer. Recent operations use a red dye magnaflux process, the excess waste of which is collected in a portable AST.

Although these sites have never been officially investigated, Code 462.11 (Public Works Department) filled out an Environmental Incident Report on January 25, 1989, responding to a wastewater spill from the magnaflux inspection of propellers into the storm drainage system. The report states that 200 gallons of rinse water with trace amounts of benzene, ethanol, and ethyl acetate were washed to a storm drain in the street because the sanitary sewer drain was blocked (Source: Environmental Incident Report #89-01).

Materials of concern at AOC 538 identified in the *Final Zone E RFI Work Plan* include waste oils, paints, heavy metals, ceramic refractory materials, galvanizing flux, coal and charcoal coke. The material of concern at AOC 539 is Zyglo penetrant (99% 1,1,1-trichloroethane). Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the RFI objectives for AOCs 538 and 539, air, soil, sediment, groundwater and structural surface samples were collected in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

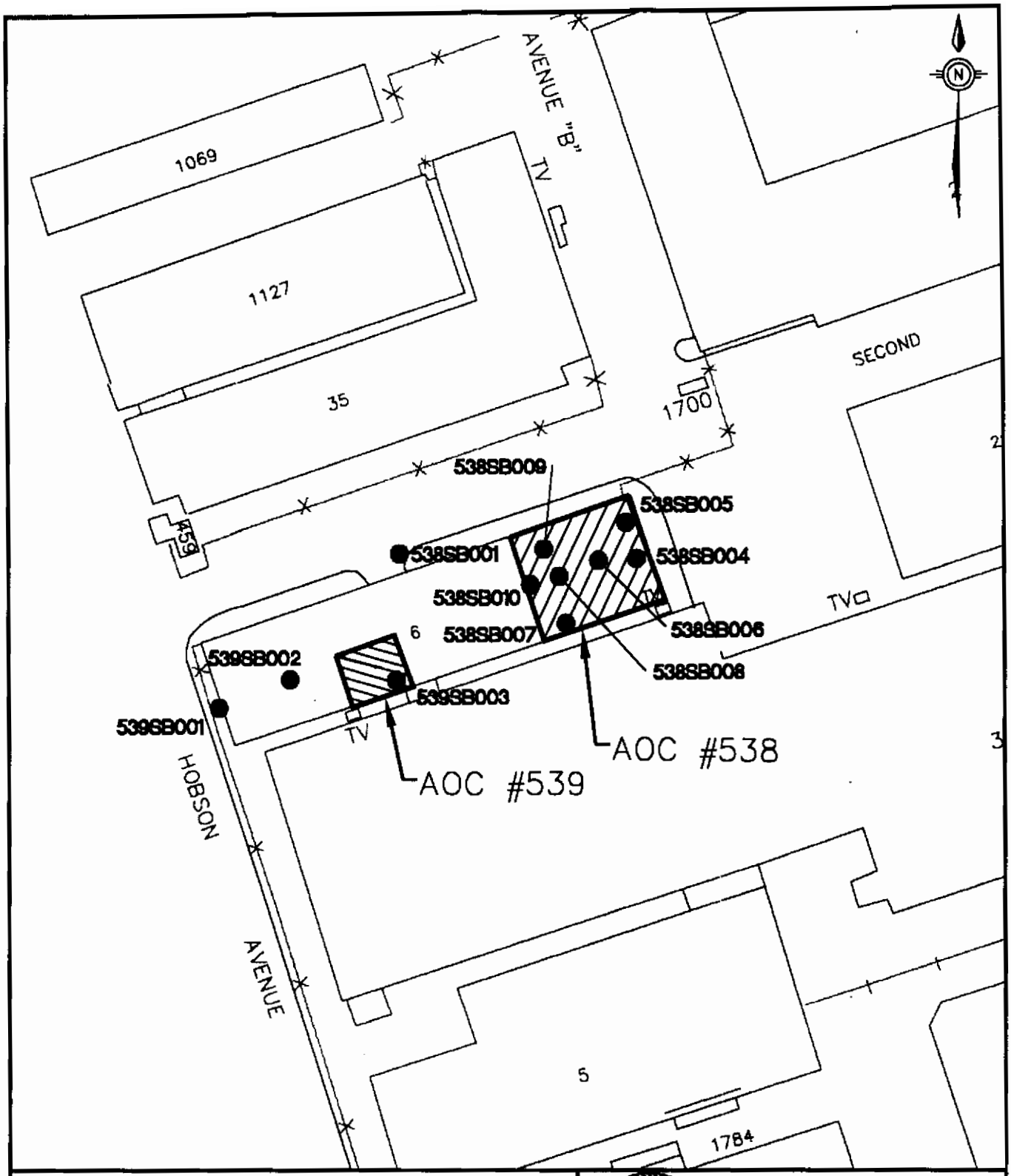
10.23.1 Soil Sampling and Analysis

Soil was sampled in one round at AOCs 538 and 539 from the locations shown in Figure 10.23.1. The *Final Zone E RFI Work Plan*, proposed collecting nine soil samples from the upper interval and nine samples from the lower interval. Soil samples were also collected at both intervals for the three shallow monitoring well locations proposed at this site.

AOC 538 and AOC 542 have two sample locations in common, due to their close proximity. These samples, NBCE538002 and -003 were originally proposed for AOC 538 but were identified with an AOC 542 identification. One of the shallow monitoring wells proposed for AOC 538 was given an AOC 542 identification (NBCE542002) based on its proximity to that site. One soil boring proposed for AOC 538, 538SB003, was also given an AOC 542 identification (542SB006). Therefore, the sequence of sample identification for AOC 538 will not include soil samples from 538002 or 538003. The data from these two sample locations will be used to help characterize each site, while eliminating the need for two additional samples. One soil boring, 538SB010, was also added during the field investigation to further delineate AOC 538.

All thirteen upper-interval samples and twelve of the thirteen proposed lower-interval samples were collected. At AOC 538 one lower-interval sample was not collected due to an obstruction.

All samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. Two samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the suite of parameters proposed for the site plus a more comprehensive list of VOCs, SVOCs, as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.23.1.1 summarizes soil sampling at AOCs 538 and 539.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.23.1
SOIL BORING LOCATIONS
AOC #538, BLDG 6 FORGE SHOP
AOC #539
BUILDING 6, PROPELLER SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-23-1

Table 10.23.1.1
AOCs 538 and 539
Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	12	13	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	One additional sample was collected.
Lower	12	12	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	Subsurface obstructions prevented the collection of one sample, and one additional sample was collected.

10.23.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.23.2.1. Inorganic analytical results for soil are summarized in Table 10.23.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.23.2.1
AOCs 538 and 539
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	7/11	20.0 - 120	54.6	20,000,000	0
	Lower	7/10	15.0 - 37.0	26.4	NA	NA

Table 10.23.2.1
AOCs 538 and 539
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Methylene chloride	Upper	1/11	2.00	2.00	760,000	0
	Lower	1/10	4.00	4.00	NA	NA
Xylene (Total)	Upper	1/11	2.00	2.00	100,000,000	0
	Lower	2/10	2.00	2.00	NA	NA
SVOCs (μg/kg)						
Acenaphthene	Upper	1/11	160	160	12,000,000	0
Anthracene	Upper	1/11	140	140	61,000,000	0
Benzo(g,h,i)perylene	Upper	4/11	71.0 - 400	183	8,200,000	0
	Lower	2/10	37.0 - 44.0	40.5	NA	NA
bis(2-Ethylhexyl)phthalate	Upper	5/11	80.0 - 190	122	410,000	0
	Lower	3/10	65.0 - 150	112	NA	NA
Dibenzofuran	Upper	1/11	160	160	820,000	0
Fluoranthene	Upper	3/11	93.0 - 690	454	8,200,000	0
	Lower	3/10	87.0 - 140	119	NA	NA
Fluorene	Upper	1/11	140	140	8,200,000	0
	Lower	1/10	95.0	95.0	NA	NA
2-Methylnaphthalene	Upper	2/11	44.0 - 450	247	8,200,000	0
	Lower	2/10	73.0 - 220	147	NA	NA
Naphthalene	Upper	1/11	470	470	8,200,000	0
	Lower	2/10	130 - 260	195	NA	NA
Phenanthrene	Upper	4/11	64.0 - 830	331	8,200,000	0
	Lower	1/10	190	190	NA	NA

Table 10.23.2.1
AOCs 538 and 539
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Pyrene	Upper	3/11	150 - 650	430	6,100,000	0
	Lower	3/10	95.0 - 200	138	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	4/11	89.6 - 538	256	780	0
	Lower	3/10	0.150 - 99.4	48.2	NA	NA
Benzo(a)anthracene	Upper	3/11	60.0 - 480	253	7,800	0
	Lower	2/10	45.0 - 57.0	51.0	NA	NA
Benzo(b)fluoranthene	Upper	1/11	62.0	62.0	7,800	0
	Lower	1/10	150	150	NA	NA
Benzo(k)fluoranthene	Upper	4/11	50.0 - 740	288	78,000	0
	Lower	2/10	49.0 - 190	120	NA	NA
Benzo(a)pyrene	Upper	4/11	71.0 - 450	220	780	0
	Lower	2/10	40.0 - 73.0	56.5	NA	NA
Chrysene	Upper	4/11	88.0 - 540	265	780,000	0
	Lower	3/10	61.0 - 150	97.7	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	3/11	58.0 - 320	166	7,800	0
	Lower	1/10	37.0	37.0	NA	NA
Dioxins (ng/kg)						
123789-HxCDD	Lower	1/1	0.963	0.963	NA	NA
Dioxin Equiv.	Lower	1/1	1.83	1.83	NA	NA
1234678-HpCDD	Lower	1/1	72.3	72.3	NA	NA
1234678-HpCDF	Lower	1/1	7.34	7.34	NA	NA
123678-HxCDD	Lower	1/1	0.881	0.881	NA	NA

Table 10.23.2.1
AOCs 538 and 539
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
OCDD	Lower	1/1	807	807	NA	NA
OCDF	Lower	1/1	38.5	38.5	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.23.2.2
AOCs 538 and 539
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	11/11	2,150 - 7,400	3,980	100,000	26,600	0
	Lower	10/10	1,850 - 4,100	3,180	NA	41,100	NA
Antimony (Sb)	Upper	1/11	0.630	0.630	82.0	1.77	0
Arsenic (As)	Upper	11/11	0.550 - 5.30	2.15	3.80	23.9	0
	Lower	10/10	0.700 - 2.30	1.34	NA	19.9	NA
Barium (Ba)	Upper	11/11	5.40 - 27.5	14.1	14,000	130	0
	Lower	10/10	6.00 - 18.8	11.5	NA	94.1	NA
Beryllium (Be)	Upper	8/11	0.110 - 0.200	0.154	1.30	1.70	0
	Lower	6/10	0.130 - 0.220	0.170	NA	2.71	NA
Cadmium (Cd)	Upper	3/11	0.220 - 3.70	1.41	100	1.50	0
	Lower	3/10	0.230 - 1.80	0.767	NA	0.960	NA
Calcium (Ca)	Upper	11/11	384 - 146,000	15,300	NA	NA	NA
	Lower	10/10	153 - 12,800	1,970	NA	NA	NA

Table 10.23.2.2
AOCs 538 and 539
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Chromium (Cr)	Upper	11/11	3.40 - 45.4	10.3	1,000	94.6	0
	Lower	10/10	1.80 - 5.40	3.71	NA	75.2	NA
Cobalt (Co)	Upper	11/11	0.220 - 4.70	1.79	12,000	19.0	0
	Lower	7/10	0.270 - 1.20	0.509	NA	14.9	NA
Copper (Cu)	Upper	11/11	1.50 - 108	27.1	8,200	66.0	0
	Lower	8/10	1.10 - 51.9	10.9	NA	152	NA
Iron (Fe)	Upper	11/11	1,080 - 17,000	5,040	61,000	NA	0
	Lower	10/10	1,210 - 6,650	2,800	NA	NA	NA
Lead (Pb)	Upper	11/11	2.00 - 116	20.4	1,300	265	0
	Lower	10/10	1.40 - 53.7	11.0	NA	173	NA
Magnesium (Mg)	Upper	11/11	134 - 1,440	425	NA	NA	NA
	Lower	10/10	86.9 - 248	147	NA	NA	NA
Manganese (Mn)	Upper	11/11	5.30 - 105	33.3	4,700	302	0
	Lower	10/10	5.50 - 24.7	15.3	NA	881	NA
Mercury (Hg)	Upper	2/11	0.0900 - 0.180	0.135	61	2.60	0
	Lower	2/10	0.0200 - 0.380	0.200	NA	1.59	NA
Nickel (Ni)	Upper	11/11	1.30 - 65.6	9.49	4,100	77.1	0
	Lower	6/10	1.000 - 3.20	2.03	NA	57.0	NA
Potassium (K)	Upper	7/11	223 - 933	508	NA	NA	NA
	Lower	7/10	28.9 - 300	126	NA	NA	NA
Selenium (Se)	Lower	1/10	0.530	0.530	NA	2.40	NA
Silver (Ag)	Lower	1/10	0.210	0.210	NA	NA	NA
Sodium (Na)	Upper	7/11	29.6 - 218	127	NA	NA	NA
	Lower	3/10	29.2 - 70.7	45.0	NA	NA	NA
Thallium (Tl)	Lower	1/10	0.530	0.530	NA	NA	NA

Table 10.23.2.2
AOCs 538 and 539
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Tin (Sn)	Upper	1/11	5.90	5.90	100,000	59.4	0
	Lower	2/10	2.10 - 3.00	2.55	NA	9.23	NA
Vanadium (V)	Upper	11/11	1.80 - 29.2	7.68	1,400	94.3	0
	Lower	10/10	1.80 - 10.6	4.21	NA	155	NA
Zinc (Zn)	Upper	11/11	1.70 - 1,100	122	61,000	827	0
	Lower	10/10	2.50 - 457	69.4	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Three VOCs were detected in soil samples collected at AOCs 538 and 539. Nine detections occurred in the upper-interval and 10 in the lower-interval. No VOCs were detected above their respective industrial RBC in the upper-interval or respective SSL in the lower-interval.

Semivolatile Organic Compounds in Soil

Seventeen SVOCs were detected in soil samples collected at AOCs 538 and 539. Forty-five detections occurred in the upper-interval and 28 in the lower-interval. No SVOCs were detected above their respective industrial RBC in the upper-interval or respective SSL in the lower-interval.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOCs 538 and 539. The upper-interval BEQ was calculated in four samples with a range of 89.6 to 538 μg/kg and a mean of 256 μg/kg. The calculated BEQ did not exceed the benzo(a)pyrene industrial RBC of 780 μg/kg.

Pesticides in Soil

No pesticides were detected in soil samples collected at AOCs 538 and 539.

Other Organic Compounds in Soil

Six dioxins were detected in soil samples collected at AOCs 538 and 539, with all six detections occurring in the lower-interval. No dioxin exceeded its respective SSL in the lower-interval. No upper-interval samples were collected.

Inorganic Elements in Soil

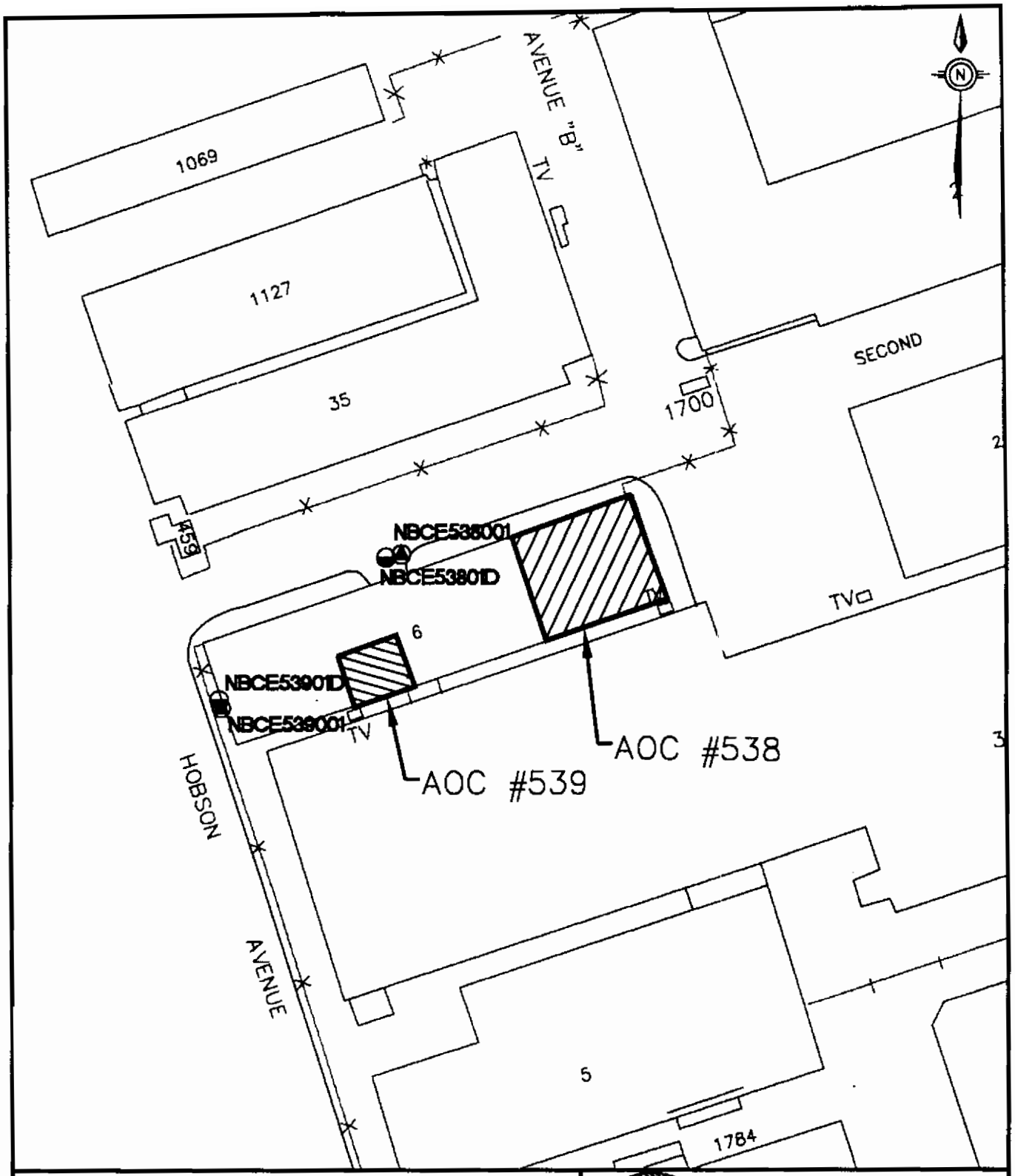
Twenty-four metals were detected in soil samples collected at AOCs 538 and 539. One hundred and eighty-three detections occurred in the upper-interval and 157 occurred in the lower-interval. No metals exceeded both their respective industrial RBC and background RC in the upper-interval or respective SSL and background RC in the lower-interval.

10.23.3 Groundwater Sampling and Analysis

Two deep monitoring wells and two shallow monitoring wells were installed and sampled to assess groundwater quality at AOCs 538 and 539 as shown in Figure 10.23.2. The wells were installed as follows:

- Shallow Wells — NBCE538001, NBCE539001
- Deep Wells — NBCE53801D, NBCE53901D

One shallow monitoring well proposed for AOC 538 was identified as an AOC 542 monitoring well (NBCE542002). Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, chlorides, sulfates, and TDS. One duplicate sample was collected and submitted for analysis at DQO Level IV for the suite of parameters listed above as well as



●
Ⓒ – CORE SAMPLES
◒ – DEEP MONITORING WELLS
◭ – SHALLOW MONITORING WELLS
▲ – SEDIMENT SAMPLES
Ⓣ – THICKNESS SAMPLES
Ⓦ – WIPE SAMPLES
Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.23.2
MONITORING WELL LOCATIONS
AOC #538, BLDG 6 FORGE SHOP
AOC #539
BUILDING 6, PROPELLER SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-23-2

herbicides, organophosphorus pesticides, dioxin, and hexavalent chromium. Table 10.23.3.1 summarizes groundwater sampling and analysis at AOCs 538 and 539.

Table 10.23.3.1
AOCs 538 and 539
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2	2	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	VOCs, SVOCs, metals chlorides, sulfates, and TDS	One shallow well was identified as an AOC 542 monitoring well
Deep	1	2	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	One additional deep well was installed

The shallow monitoring wells were installed at 12.5 feet bgs in the surficial aquifer. The deep wells were installed at 38.2 and 42.8 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.2.3 of this report.

10.23.4 Nature of Contamination in Groundwater

Organic compound and inorganic analytical results for shallow groundwater are summarized in Tables 10.23.4.1 and 10.23.4.2. Organic and inorganic analytical results for deep groundwater are summarized in Tables 10.23.4.3 and 10.23.4.4. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.23.4.1
AOCs 538 and 539
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
Carbon Disulfide	1/2	2	2	100	NA	0
SVOCs						
Fluorene	1/2	1.000	1.000	150	NA	0
2-Methylnaphthalene	1/2	17.0	17.0	150	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level

Table 10.23.4.2
AOC 538
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Deep Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
1,2-Dichloroethene (total)	2/2	3 - 12	7.5	5.50	70.0	1

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level

Table 10.23.4.3
AOCs 538 and 539
Inorganic Detections for First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Arsenic (As)	1/2	60.1	60.1	0.0450	18.7	50.0	1
Calcium (Ca)	2/2	30,700 - 47,900	39,300	NA	NA	NA	NA
Iron (Fe)	2/2	498 - 8,960	4,729	1,100	NA	NA	1
Magnesium (Mg)	2/2	3,430 - 3,970	3,700	NA	NA	NA	NA
Manganese (Mn)	1/2	74.5	74.5	84.0	2,560	NA	0
Mercury (Hg)	1/2	0.2	0.2	1.1	NA	2	0
Selenium (Se)	1/2	5.9	5.9	18.0	NA	50	0
Silver (Ag)	1/2	2.00	2.00	18.0	NA	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Table 10.23.4.4
AOCs 538 and 539
Inorganic Detections for First Quarter Groundwater (µg/L)
Deep Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Calcium (Ca)	2/2	77,400 - 83,400	80,400	NA	NA	NA	NA
Iron (Fe)	2/2	1,860 - 3,860	2,860	1,100	NA	NA	2
Magnesium (Mg)	2/2	9,810 - 9,830	9,820	NA	NA	NA	NA
Manganese (Mn)	2/2	110 - 189	149.5	84.0	869	NA	0
Mercury	1/2	0.27	0.27	1.1	0.2	2	0
Silver (Ag)	1/2	2.1	2.1	18.0	NA	NA	0

Notes:
µg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established

Volatile Organic Compounds in Groundwater

Shallow Groundwater

One VOC was detected in shallow groundwater samples collected at AOCs 538 and 539. Carbon disulfide was detected in one of two samples below its respective tap-water RBC.

Deep Groundwater

One VOC was detected in deep groundwater samples collected at AOCs 538 and 539. The VOC — 1,2-dichloroethene (total) — exceeded its respective tap-water RBC.

1,2-dichloroethene (total) was detected in two of two samples with a range of 3.0 to 12.0 μg/L and a mean of 7.50 μg/L. One sample in well 539GW01D01 (12.0 μg/L), exceeded the 1,2-dichloroethene tap-water RBC of 5.50 μg/L.

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

Two SVOCs were detected in shallow groundwater samples collected at AOCs 538 and 539. Both SVOCs were detected below their respective tap-water RBC.

Inorganic Elements in Groundwater

Shallow Groundwater

Eight metals were detected in shallow groundwater samples collected at AOCs 538 and 539. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and background shallow groundwater RC (where available).

Arsenic was detected in one of two samples in well NBCE538001 (60.1 μg/L), exceeding both its tap-water RBC of 0.0450 μg/L and shallow groundwater RC of 18.7 μg/L. The detection also exceeded the arsenic MCL of 50.0 μg/L.

Iron was detected in two of two samples with a range of 498 to 8,960 μg/L and a mean of 4,729 μg/L. One sample from well NBCE538001 (8,960μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No MCL or shallow groundwater RC has been established for iron.

Deep Groundwater

Six metals were detected in deep groundwater samples collected at AOCs 538 and 539. One metal — iron — exceeded it respective tap-water RBC.

Iron was detected in two of two samples with a range of 1,860 to 3,860 μg/L and a mean of 2,860 μg/L. Two samples from wells NBCE53801D (1,860 μg/L) and NBCE53901D (3,860 μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

10.23.5 Sediment Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting one sediment sample at AOCs 538 and 539 from the location shown in Figure 10.23.3. One sediment sample was collected and submitted for analysis at DQO Level III for VOCs, SVOCs and metals. No samples were selected as duplicates at this site. Table 10.23.5.1 summarizes sediment sampling and analysis at AOCs 538 and 539.

Table 10.23.5.1
AOCs 538 and 539
Sediment Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviation
1	1	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	None

Note:
a = Standard suite includes VOCs, SVOCs, metals, cyanide, pesticides, and PCBs

10.23.6 Nature of Contamination in Sediment

The analytical results for constituents found in AOC 538 and 539 sediments are presented in Tables 10.23.6.1 and 10.23.6.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.23.6.1
AOCs 538 and 539
Organic Compounds Detected in Sediment (μg/kg)

Compound	Freq. of Detection	Range of Detected Conc. (μg/kg)	Mean of Detected Conc. (μg/kg)	Industrial Soil RBC (μg/kg)	Number of Samples Exceeding RBC
VOCs					
Benzene	1/1	3.00	3.00	200	0
Chloromethane	1/1	5.00	5.00	440	0
Tetrachloroethene	1/1	5.00	5.00	110	0
Xylene (Total)	1/1	4.00	4.00	100,000	0
SVOCs					
Anthracene	1/1	700	700	61,000,000	0
Benzo(a)anthracene	1/1	2,200	2,200	7,800	0
Benzo(a)pyrene	1/1	1,300	1,300	780	1
Benzo(g,h,i)perylene	1/1	1,100	1,100	8,200,000	0
Chrysene	1/1	2,500	2,500	780,000	0
Di-n-butylphthalate	1/1	180	180	NA	NA
Di-n-octyl phthalate	1/1	15,000	15,000	4,100,000	0
Dibenz(a,h)anthracene	1/1	490	490	780	0
Dibenzofuran	1/1	190	190	820,000	0
Fluoranthene	1/1	8,000	8,000	8,200,000	0
Phenanthrene	1/1	4,600	4,600	8,200,000	0
Pyrene	1/1	5,500	5,500	6,100,000	0

Table 10.23.6.1
AOCs 538 and 539
Organic Compounds Detected in Sediment (μg/kg)

Compound	Freq. of Detection	Range of Detected Conc. (μg/kg)	Mean of Detected Conc. (μg/kg)	Industrial Soil RBC (μg/kg)	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents)					
B(a)P Equiv.	1/1	2,280	2,280	780	1
Benzo(b)fluoranthene	1/1	1,600	1,600	7,800	0
Benzo(k)fluoranthene	1/1	1,400	1,400	78,000	0
Indeno(1,2,3-cd)pyrene	1/1	980	980	7,800	0
Pesticides					
Dieldrin	1/1	370	370	360	1
Endosulfan II	1/1	160	160	1,200	0
Endrin	1/1	170	170	61,000	0
Endrin aldehyde	1/1	490	490	61,000	0

Notes:
μg/kg = Micrograms per kilogram
RBC = Industrial soil RBC
NA = No industrial soil RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS SSVs.

Table 10.23.6.2
AOCs 538 and 539
Inorganic Detections in Sediment (mg/kg)

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Aluminum (Al)	1/1	15,900	15,900	100,000	0
Antimony (Sb)	1/1	15.3	15.3	82	0
Arsenic (As)	1/1	6.60	6.60	3.8	1
Barium (Ba)	1/1	99.8	99.8	14,000	0
Beryllium (Be)	1/1	0.120	0.120	1.3	0

Table 10.23.6.2
AOCs 538 and 539
Inorganic Detections in Sediment (mg/kg)

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Cadmium (Cd)	1/1	10.7	10.7	100	0
Calcium (Ca)	1/1	42,200	42,200	NA	NA
Chromium (Cr)	1/1	107	107	1,000	0
Cobalt (Co)	1/1	21.1	21.1	12,000	0
Copper (Cu)	1/1	134,000	134,000	8,200	1
Iron (Fe)	1/1	25,100	25,100	61,000	0
Lead (Pb)	1/1	364	364	1,300	0
Magnesium (Mg)	1/1	1,170	1,170	NA	NA
Manganese (Mn)	1/1	3,150	3,150	4,700	0
Nickel (Ni)	1/1	6,480	6,480	4,100	1
Potassium (K)	1/1	433	433	NA	NA
Silver (Ag)	1/1	26.5	26.5	1,000	0
Sodium (Na)	1/1	3,370	3,370	NA	NA
Tin (Sn)	1/1	336	336	100,000	0
Vanadium (V)	1/1	15.9	15.9	1,400	0
Zinc (Zn)	1/1	17,100	17,100	61,000	0

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
NA = No industrial soil RBC established
* = For the purposes of this investigation, sediment collected from storm and floor drain catch basins are treated as soil and compared to industrial RBCs instead of RAGS SSVs.

Volatile Organic Compounds in Sediment

Four VOCs were detected in the sediment sample collected at AOCs 538 and 539. No VOCs were detected above their respective industrial RBC.

Semivolatile Organic Compounds in Sediment

Fifteen SVOCs were detected in the sediment sample collected at AOCs 538 and 539. One SVOC, benzo(a)pyrene, was detected at 1,300 μg/kg exceeding its industrial RBC of 780 μg/kg (539M0001).

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOCs 538 and 539. The BEQ was calculated for one sample at 2,280 μg/kg exceeding the benzo(a)pyrene industrial RBC of 780 μg/kg (539M0001).

Pesticides and PCBs in Sediment

Four pesticides were detected in the sediment sample collected at AOCs 538 and 539. One pesticide exceeded its industrial RBC. Dieldrin was detected at 370 μg/kg exceeding its industrial RBC of 360 μg/kg (539M0001).

No PCBs were detected in the sediment sample submitted for laboratory analysis at AOCs 538 and 539.

Other Organic Compounds in Sediment

Based on the COPCs associated with AOCs 538 and 539, no sediment samples were submitted for laboratory analysis for other organic compounds.

Inorganic Elements in Sediment

Twenty-one metals were detected in the sediment sample collected at AOCs 538 and 539. Three metals exceeded their respective industrial RBC.

Arsenic was detected at 6.60 mg/kg exceeding its industrial RBC of 3.8 mg/kg; copper was detected at 134,000 mg/kg exceeding its industrial RBC of 8,200 mg/kg; and nickel was detected

6,480 mg/kg exceeding its industrial RBC of 4,100 mg/kg. All exceedances were detected in sample 539M0001.

10.23.7 Wipe Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed the collection of sixteen wipe samples at AOCs 538 and 539. All the proposed wipe samples were collected plus 6 additional wipe samples and analyzed for metals only. Sample locations were determined in the field and are shown on Figure 10.23.4. Table 10.23.7.1 summarizes wipe sampling activity for AOCs 538 and 539.

Table 10.23.7.1
AOCs 538 and 539
Wipe Sampling Summary

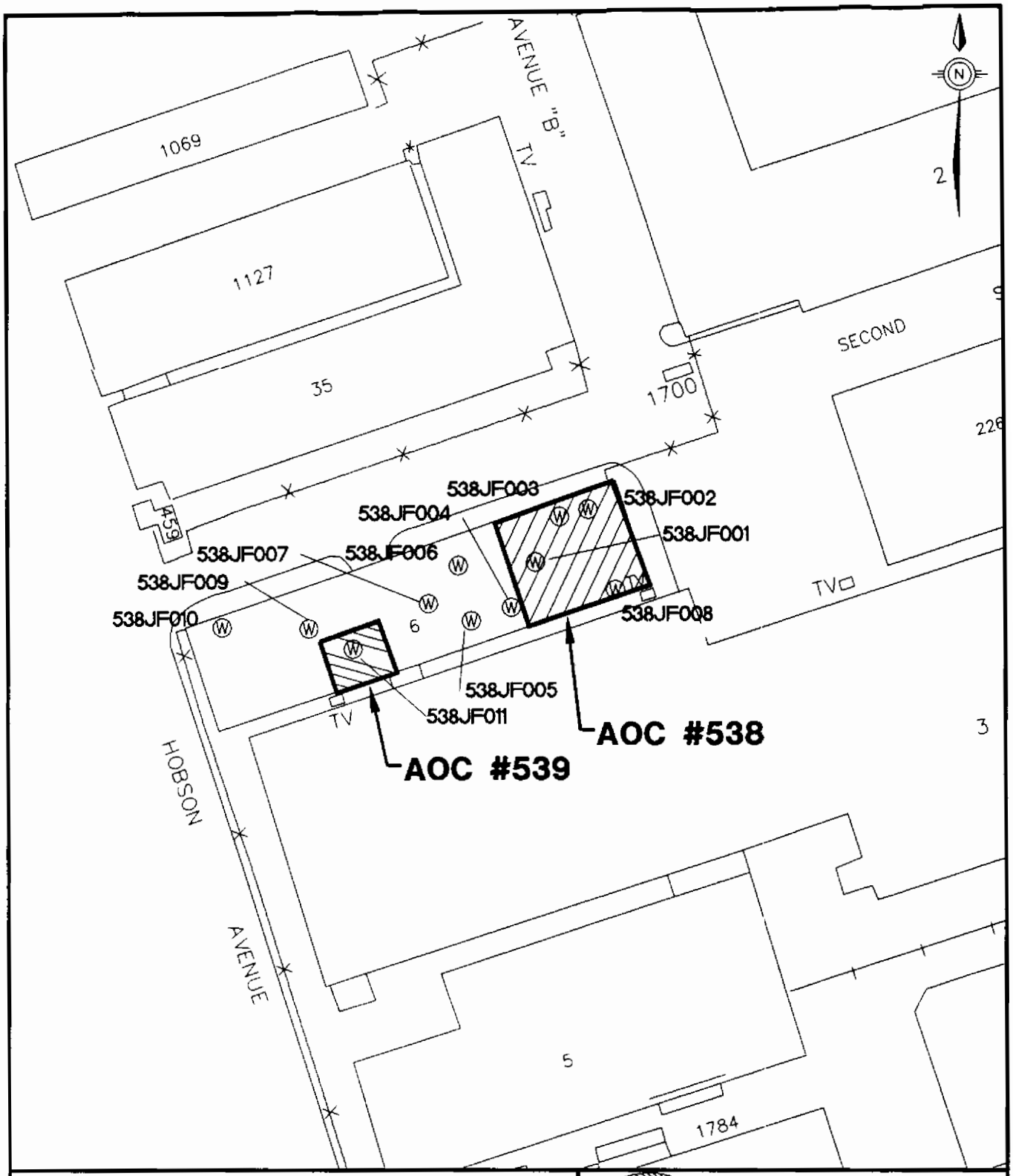
Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
16	22	Metals, SW-846	Metals, SW-846	Six additional samples were collected

10.23.8 Nature of Contamination in Dust

Table 10.23.8.1 summarizes the wipe sample analytical results for AOC 538. Sample locations were determined in the field and were biased in an attempt to identify worst case situations. Appendix H contains the complete data report for all samples collected in Zone E.

Metals Detected on Surfaces

Metals were detected in nearly all wipe samples. No residential or industrial RBCs exist for comparison to the wipe sample results.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.23.4
WIPE SAMPLE LOCATIONS
AOC #538, BLDG 6, FORGE SHOP
AOC #539
BUILDING 6, PROPELLER SHOP

DWG DATE: 09/02/97 | DWG NAME: 10-23-4

Table 10.23.8.1
AOCs 538 and 539
Wipe Sampling Analytical Results

Element	Frequency of Detection	Range of Detections (mg/wipe)
Aluminum	22/22	292 - 13,700
Antimony	10/22	0.88 - 18.5
Arsenic	20/22	1.4 - 16.6
Barium	22/22	12.4 - 5,530
Beryllium	1/22	0.40
Cadmium	22/22	1.6 - 20.2
Calcium	22/22	1,570 - 42,100
Chromium	22/22	12.0 - 330
Cobalt	22/22	0.98 - 27.2
Copper	22/22	281 - 160,000
Iron	22/22	1,640 - 40,000
Lead	22/22	38.5 - 1,100
Magnesium	22/22	128 - 5,510
Manganese	22/22	21.4 - 7,700
Mercury	4/22	0.08 - 0.30
Nickel	22/22	57 - 6,710
Potassium	18/22	328 - 9,120
Selenium	1/22	1.1
Silver	18/22	0.50 - 23.3
Sodium	6/22	189 - 8,350
Tin	8/22	19.9 - 323
Vanadium	22/22	1.5 - 46.8
Zinc	22/22	466 - 16,700

Note:
μg/wipe = micrograms per 100 square centimeters

10.23.9 Air Sampling and Analysis

The *Final Zone E RFI Work Plan* proposed collecting air samples at AOCs 538 and 539. Both the number and location of samples were to be determined in the field. A total of 17 air samples were collected. Table 10.23.9.1 summarizes air sampling activity for AOCs 538 and 539.

Table 10.23.9.1
AOCs 538 and 539
Air Sampling Summary

Samples Proposed	Samples Collected	Analyses Proposed	Analyses Performed	Deviations
TBD	17	EPA Metals	EPA Metals	No deviation from proposed strategy

10.23.10 Nature of Contamination in Air

Table 10.23.10.1 summarizes the analytical results of air samples collected at AOCs 538 and 539. Sample locations were determined in the field and were biased in an attempt to identify worst case situations.

Table 10.23.10.1
AOCs 539 and 539
Air Sampling Results

Element	Frequency of Detection	Range of Detections ($\mu g/m^3$)
Aluminum	17/17	0.0195 - 61.7
Antimony	1/17	1.64
Barium	17/17	0.0016 - 2.24
Beryllium	7/17	0.0001 - 0.0184
Cadmium	9/17	0.0001 - 0.151
Calcium	15/17	0.026 - 0.097

Table 10.23.10.1
AOCs 539 and 539
Air Sampling Results

Element	Frequency of Detection	Range of Detections ($\mu g/m^3$)
Chromium	17/17	0.0006 - 2.24
Cobalt	13/17	0.0001 - 0.26
Copper	17/17	0.013 - 4.0
Iron	16/17	0.011 - 15.7
Lead	14/17	0.0010 - 1.53
Magnesium	15/17	0.0055 - 0.045
Manganese	17/17	0.0007 - 0.644
Mercury	17/17	0.0001 - 0.0067
Nickel	16/17	0.0013 - 2.08
Potassium	17/17	0.046 - 30.4
Selenium	2/17	0.0016 - 0.0017
Sodium	17/17	0.11 - 117
Vanadium	15/17	0.0009 - 0.0062
Zinc	17/17	0.0062 - 6.61
Alkalinity		
Total Alkalinity	15/17	5.64 - 37,800

Note:
$\mu g/m^3$ = Micrograms per cubic meter

Metals Detected in Air

Metals were detected in nearly all air samples. No residential or industrial RBCs exist for comparison to the air sampling results.

10.23.11 Fate and Transport Assessment for Combined AOC 538

AOC 538 is a forge shop located in the eastern portion of Building 6. AOC 539 is a propeller shop located in the western extension of the same building. Both AOCs are located in areas which have concrete floors and which are surrounded by concrete and/or asphalt surfaces. Environmental media sampled as part of the combined AOC 538 RFI include surface soil, subsurface soil, shallow and deep groundwater, sediment, air, and wipe samples. Potential constituent migration pathways investigated for combined AOC 538 include soil to groundwater, groundwater to surface water, surface soil to sediment, and emission of volatiles from surface soil to air.

10.23.11.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.23.11.1 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 reference 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 10:1, with no attenuation of constituents in soil (DAF=10).

No organic constituents were detected in combined AOC 538 soil above groundwater protection SSLs. Zyglo (99% 1,1,1-trichloroethane), the primary constituent of concern at AOC 539, was not detected. No inorganics were detected in combined AOC 538 soil above their respective generic SSLs or background reference values.

10.23.11.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.23.11.1 also compares maximum detected organic constituent concentrations in shallow and deep 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 reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic compounds were detected in combined AOC 538 first-quarter groundwater samples (shallow or deep) above tap water RBCs or saltwater surface water screening levels. Three inorganics were detected in first-quarter groundwater samples above screening values. Arsenic was detected in one shallow groundwater sample from well NBCE538001 at a concentration exceeding its background reference value and its saltwater surface water chronic screening level. Mercury was detected at a concentration equal to its saltwater surface water chronic screening level in one shallow groundwater sample from well NBCE539001 and at a concentration marginally exceeding its surface water standard in one deep groundwater sample from well NBCE53901D. Silver was detected exceeding its saltwater surface water chronic screening level in one shallow groundwater sample from well NBCE538001 and in one sample from deep well NBCE53801D.

10.23.11.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.23.11.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water

quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined AOC 538 is 35,400:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.23.11.4 Surface Soil-to-Sediment Cross-Media Transport

One sediment sample was collected from a catch basin below Building 6. Tables 10.23.6.1 and 10.23.6.2 summarize the organic and inorganic constituent concentrations detected in the sediment sample collected at combined AOC 538. Although many of the constituents detected in the sediment sample were also detected in surface soil samples, it is unlikely that constituents detected in surface soil are a source of contamination in catch-basin sediment since the ground surface is entirely paved. Constituents detected in sediment the sediment sample collected at combined AOC 538 are more numerous than those in soil samples and were generally detected at higher concentrations. Detected catch- basin sediment constituents are consistent with past metal-working processes that were conducted at combined AOC 538. Fate and transport for constituents detected in sediment from catch basins will be examined in the Zone L RFI report.

10.23.11.5 Soil-to-Air Cross-Media Transport

Table 10.23.11.3 lists the VOCs detected in surface soil samples collected at combined AOC 538 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at combined AOC 538. In addition, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at combined AOC 538.

10.23.11.6 Fate and Transport Summary

No detected soil constituents exceeded their groundwater protection SSLs in the first-tier screen. Three inorganics — arsenic, mercury, and silver — were detected in first-quarter groundwater samples at concentrations exceeding their corresponding saltwater surface water chronic screening levels. Mercury and silver exceeded these screening levels in samples collected from both deep and shallow wells, while arsenic exceeded its standard in only the shallow aquifer. Arsenic also exceeded its background reference concentration in the shallow aquifer.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.23.11.1
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: Tier One
NAVBASE-Charleston, Zone E: AOCs 538 and 539
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	120	37	ND	ND	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	ND	2	ND	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
1,2-Dichloroethene (total)	ND	ND	ND	12	200	55	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	2	4	ND	ND	10	4.1	2560	UG/KG	UG/L	NO	NO	NO
Xylene (total)	2	2	ND	ND	71000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	160	ND	ND	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	140	ND	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	400	44	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	480	57	ND	ND	800	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	450	73	ND	ND	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	62	150	ND	ND	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	740	190	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	540	150	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	320	37	ND	ND	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	160	ND	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	190	150	ND	ND	1800000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	690	140	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	140	95	1	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	450	220	17	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	470	260	ND	ND	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	830	190	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	650	200	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	ND	1.83	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	7400	4100	ND	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	0.63	ND	ND	ND	2.5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	5.3	2.3	60.1	ND	23.9	18.7	36	MG/KG	UG/L	NO	YES	YES
Barium	27.5	18.8	ND	ND	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.2	0.22	ND	ND	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	3.7	1.8	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	45.4	5.4	ND	ND	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	4.7	1.2	ND	ND	19	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	108	51.9	ND	ND	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	116	53.7	ND	ND	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	105	24.7	74.5	189	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.18	0.38	0.2	0.27	2.6	11	0.2	MG/KG	UG/L	NO	NO	YES
Nickel	65.6	3.2	ND	ND	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	ND	0.53	5.9	ND	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	ND	0.21	2	2.1	17	180	0.23	MG/KG	UG/L	NO	NO	YES
Thallium	ND	0.53	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	5.9	3	ND	ND	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	29.2	10.6	ND	ND	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	1100	457	ND	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.23.11.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOCs 538 and 539
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Inorganic Compounds																
Arsenic	5.3	2.3	60.1	ND	14.6	0.045	36	0.045	1.59E+03	50	3.19E+01	4.65E+01	MG/KG	UG/L	NO	NO
Mercury	0.18	0.38	0.2	0.27	1.04	11	0.2	0.2	7.08E+03	2	3.54E+03	3.68E+02	MG/KG	UG/L	NO	NO
Silver	ND	0.21	2	2.1	17	180	0.23	0.23	8.14E+03	200	4.07E+01	6.92E+01	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 35,400: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.23.11.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOC 538 and 539
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	120	62000000	UG/KG	NO
Methylene chloride	2	7000	UG/KG	NO
Xylene (total)	2	320000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.23.12 Fixed-Point Risk Evaluation for AOC 538 and AOC 539

10.23.12.1 Site Background and Investigative Approach

AOC 538, a forge shop, and AOC 539, a propeller shop, are both located in Building 6. The following refers to these sites a combined AOC 538. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of 11 surface soil samples were considered in the combined AOC 538 FRE. Four monitoring wells were installed as part of the 1995 RFI. Two of these monitoring wells were installed into the shallow aquifer and two were installed into the deep aquifer. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 538 FRE. Sections 10.23.1 and 10.23.3 contain summaries of the sampling effort for combined AOC 538 soil and groundwater.

10.23.12.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.23.12.1 provides CPSS summaries for combined AOC 538 soil and identifies COPCs based on comparison to residential and industrial RBCs and RCs. Based on residential RBCs, BEQs were identified as COPCs for combined AOC 538. Arsenic, beryllium, and chromium were detected in combined AOC 538 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE 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 based on background concentration.

Table 10.23.12.2 summarizes the residential COPCs detected at each combined AOC 538 sample location with contribution to risk and hazard. As shown, BEQs contribute to risk for combined AOC 538 surface soil, exceeding 1E-06 at four of 11 locations. No COPCs were detected in

samples 538SB001, 538SB004, 538SB005, 538SB006, 538SB009, 538SB010, and 539SB001 that would have contributed to risk estimates. Figure 10.23.5 is a spatial presentation of residential risk estimates for combined AOC 538 surface soil. For those samples with detected concentrations of BEQs, risk estimates range from 1E-06 to 9E-06 with an arithmetic mean risk of 2E-06 (assuming a deminimus risk of 1E-07 for samples with no detectable concentrations of BEQs).

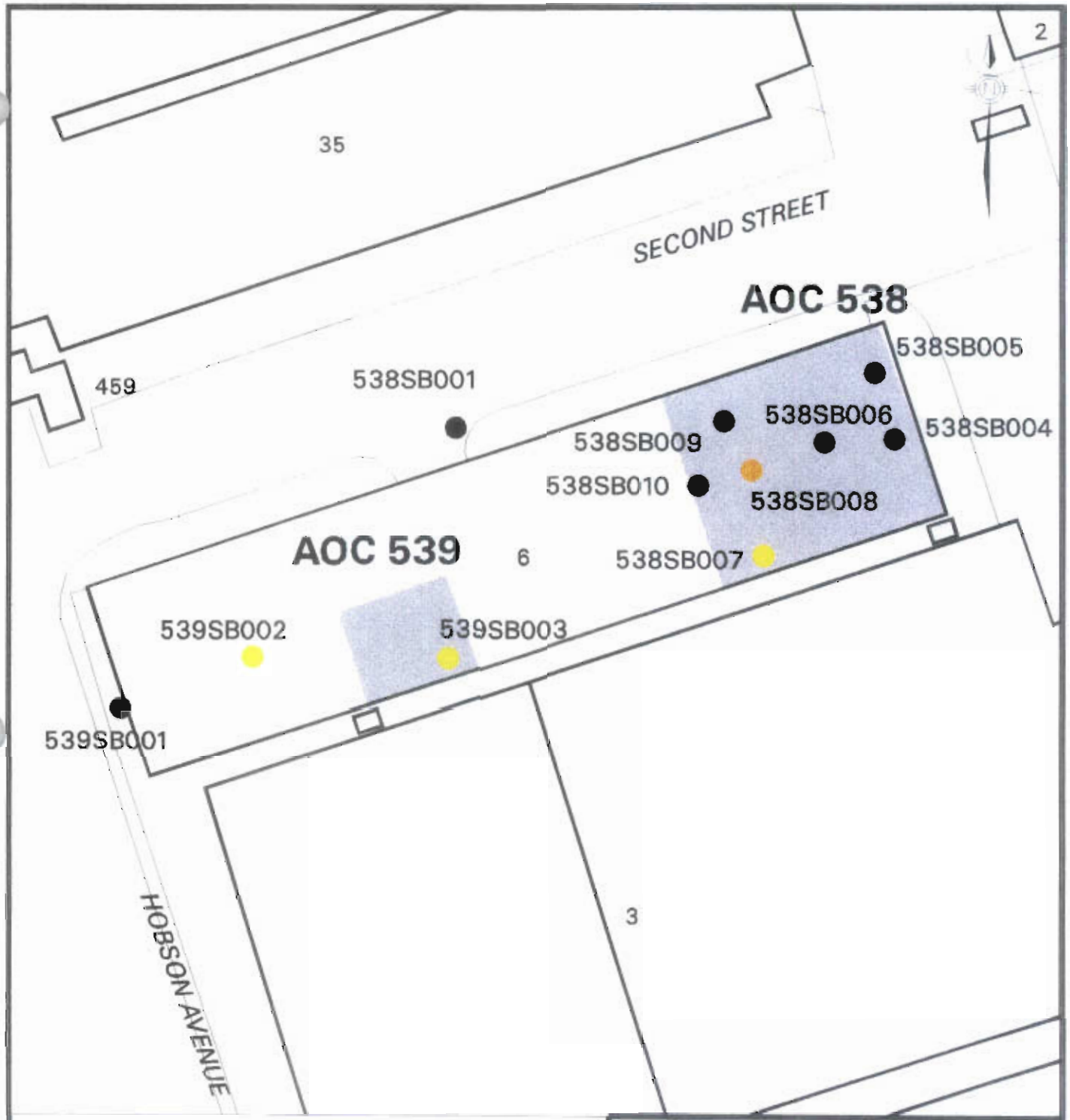
No COPCs were detected in combined AOC 538 surface soil that would have contributed to HI estimates.

Industrial Scenario

Based on industrial RBCs, no COPCs for combined AOC 538 surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on background concentration.

10.23.12.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.23.12.3 provides CPSS summaries for combined AOC 538 groundwater and identifies COPCs. 1,2-Dichloroethene (total) and trichloroethene were identified as groundwater COPCs in the deep aquifer and arsenic was identified as a COPC in the shallow aquifer. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding background concentrations for inorganics. The maximum concentration of manganese reported in the deep well samples exceeded its RBC and was eliminated from consideration in the deep groundwater FRE based on comparison to its RCs. Combined AOC 538 groundwater were not sufficient to perform Wilcoxon rank sum test analyses (less than four sample each for shallow and deep). As a result, manganese was eliminated from the deep groundwater FRE based on direct comparison of its maximum concentration to its RC.



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 100

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

FIGURE 10.23.5
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 538 & 539

Table 10.23.12.4 summarizes the COPCs identified in combined AOC 538 monitoring wells sampled during the first quarter. A risk estimate of 1E-03 was associated with the arsenic concentration in the first quarter groundwater sample collected from monitoring well NBCE538001. Neither of the first quarter groundwater samples collected from the other three wells (shallow and deep) had concentrations of COPCs associated with risk estimates above 1E-06. Figure 10.23.6 illustrates the groundwater data as a function of point-specific risk projections.

Monitoring well NBCE538001 produced first quarter results corresponding with a HI of approximately 13, due to the concentration of arsenic. No other first quarter groundwater samples were associated with hazard projections above unity. Figure 10.23.7 illustrates the groundwater data as a function of point-specific hazard projections.

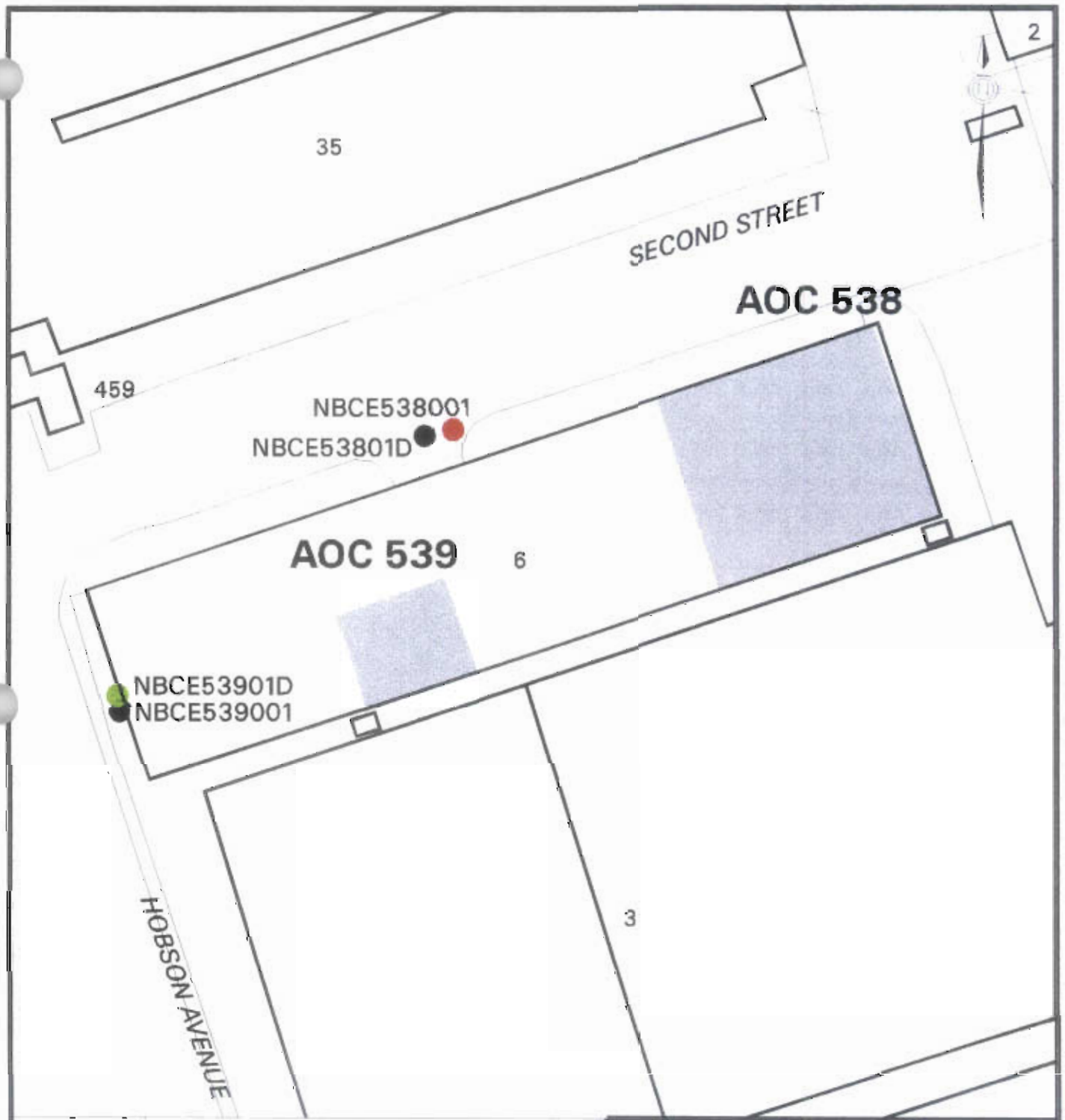
10.23.12.4 Uncertainty

AOC 538 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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.



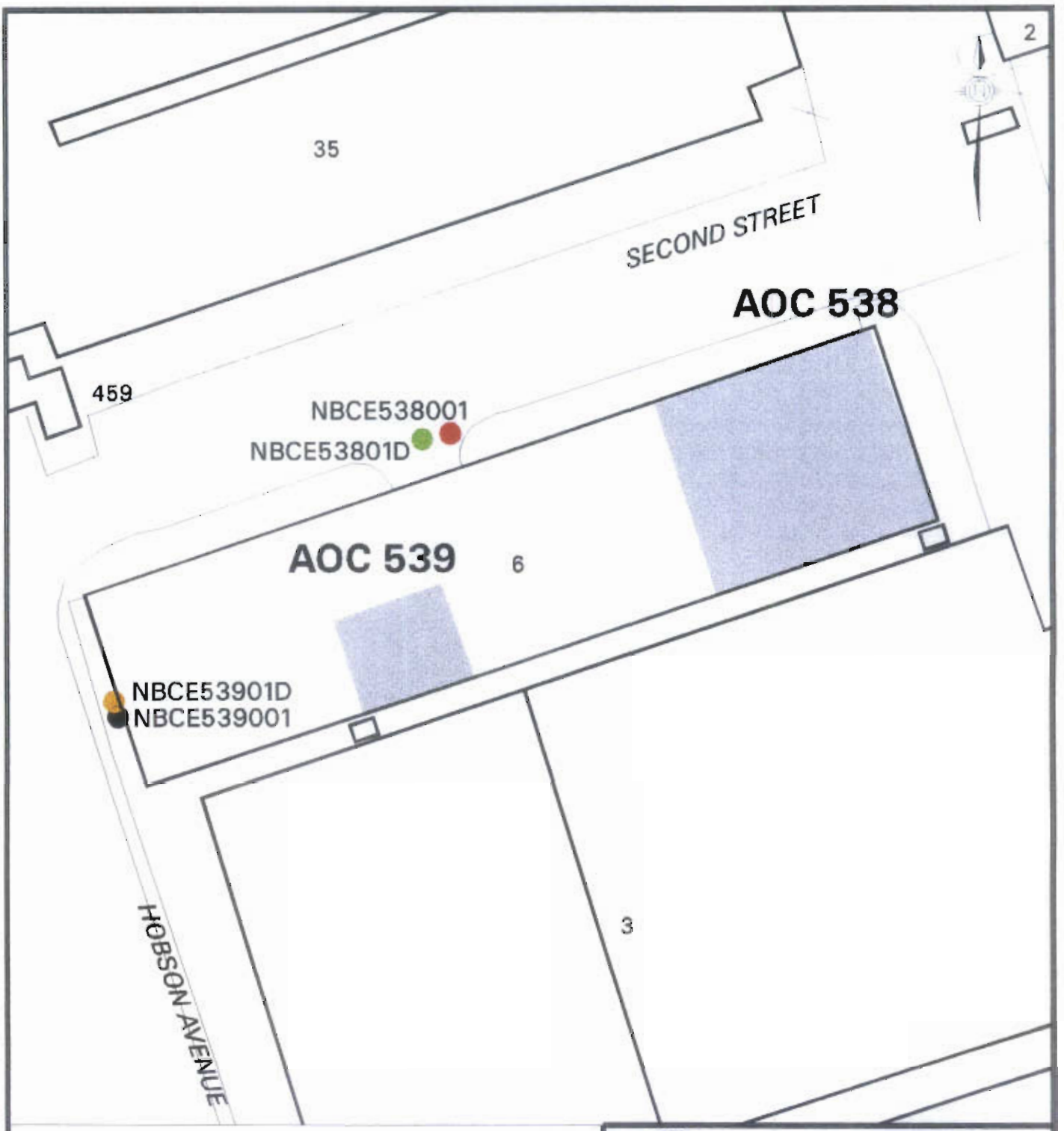
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 100

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

FIGURE 10.23.6
CUMULATIVE GROUNDWATER RISK IN WELLS
AOC 538 & 539



LEGEND - CUMULATIVE GROUNDWATER HAZARD

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

0 feet 100

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

FIGURE 10.23.7
CUMULATIVE GROUNDWATER HAZARD IN WELLS
AOC 538 & 539

Consequently, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined AOC 538, 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.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for combined AOC 538. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, only aluminum and cadmium were reported at a concentration close to their RBCs (e.g. within 10% of its RBCs). Concentrations of both of these inorganic parameters are within their respective RCs.

Arsenic, beryllium and chromium were reported in combined AOC 538 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on

comparison to their background concentration. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 concentrations close to its RBCs (e.g. within 10% of its RBCs).

Manganese was reported in combined AOC 538 deep groundwater at a maximum concentration above its RBC benchmark and was eliminated from consideration in the deep groundwater FRE based on comparison to its background concentration. As a result, its contribution to hazard has not been considered in the deep groundwater FRE.

10.23.12.5 FRE Summary

The risk and hazard posed by contaminants at combined AOC 538 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.23.12.2 and 10.23.12.4 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil -- Residential Scenario

BEQs were detected in combined AOC 538 surface soil at concentrations above their residential RGOs in only four of the 11 samples. The calculated mean risk estimate was 2E-06 which is only marginally above the 1E-06 SCDHEC risk level of concern and is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Soil -- Site Worker Scenario

No COPCs were identified for combined AOC 538 surface soil, based on industrial RBCs.

Groundwater -- Residential Scenario

Arsenic was detected in shallow groundwater at a concentration above its RGO and MCL through all four quarters of sampling. The adjacent sites AOC 530, AOC 542, and AOC 549 also reported concentrations of arsenic in the shallow groundwater, however, at concentrations below its MCL.

Thallium was detected in third quarter samples collected from monitoring wells NBCE53801D, NBCE53901D, and NBCE539001 at concentrations above its MCL. The average concentration for all monitoring wells and all four quarters of sampling, assuming one-half SQL for nondetects (2.5 μg/L), is only marginally above its MCL (2 μg/L).

Table 10.23.12.1
Chemical Present in Site Samples
AOC 538, AOC 539 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Carcinogenic PAHs													
B(a)P Equiv.	*	4	11	89.588 - 537.94	256	1594.59 - 2542.1	88	780	NA	UG/KG	4		
Benzo(a)anthracene		3	11	60 - 480	253	690 - 1100	880	7800	NA	UG/KG			
Benzo(b)fluoranthene		1	11	62 - 62	62	370 - 1100	880	7800	NA	UG/KG			
Chrysene		4	11	88 - 540	265	690 - 1100	88000	780000	NA	UG/KG			
Indeno(1,2,3-cd)pyrene		3	11	58 - 320	166	690 - 1100	880	7800	NA	UG/KG			
Benzo(k)fluoranthene		4	11	50 - 740	288	690 - 1100	8800	78000	NA	UG/KG			
Benzo(a)pyrene	*	4	11	71 - 450	220	690 - 1100	88	780	NA	UG/KG	3		
Inorganics													
Aluminum (Al)		11	11	2150 - 7400	3984	NA - NA	7800	100000	26600	MG/KG			
Antimony (Sb)		1	11	0.63 - 0.63	0.63	0.42 - 3.3	3.1	82	1.77	MG/KG			
Arsenic (As)		11	11	0.55 - 5.3	2.15	NA - NA	0.43	3.8	23.9	MG/KG	11		
Barium (Ba)		11	11	5.4 - 27.5	14.1	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		8	11	0.11 - 0.2	0.15	0.11 - 0.11	0.15	1.3	1.7	MG/KG	5		
Cadmium (Cd)		3	11	0.22 - 3.7	1.41	0.11 - 0.12	3.9	100	1.5	MG/KG			1
Calcium (Ca)	N	11	11	384 - 146000	15283	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)		11	11	3.4 - 45.4	10.3	NA - NA	39	1000	94.6	MG/KG	1		
Cobalt (Co)		11	11	0.22 - 4.7	1.79	NA - NA	470	12000	19	MG/KG			
Copper (Cu)		11	11	1.5 - 108	27.1	NA - NA	310	8200	66	MG/KG			2
Iron (Fe)	N	11	11	1080 - 17000	5045	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)		11	11	2 - 116	20.35	NA - NA	400	1300	265	MG/KG			
Magnesium (Mg)	N	11	11	134 - 1440	425	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)		11	11	5.3 - 105	33.3	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)		2	11	0.09 - 0.18	0.14	0.02 - 0.12	2.3	61	2.6	MG/KG			
Nickel (Ni)		11	11	1.3 - 65.6	9.49	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N	7	11	223 - 933	508	194 - 394	NA	NA	NA	MG/KG			
Sodium (Na)	N	7	11	29.6 - 218	127	11.3 - 76.7	NA	NA	NA	MG/KG			
Tin (Sn)		1	11	5.9 - 5.9	5.90	2.1 - 2.8	4700	6100	59.4	MG/KG			
Vanadium (V)		11	11	1.8 - 29.2	7.68	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		11	11	1.7 - 1100	122	NA - NA	2300	61000	827	MG/KG			1

Table 10.23.12.1
Chemical Present in Site Samples
AOC 538, AOC 539 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Semivolatile Organics												
Acenaphthene	1	11	160 - 160	160	380 - 1100	470000	12000000	NA	UG/KG			
Anthracene	1	11	140 - 140	140	380 - 1100	2300000	61000000	NA	UG/KG			
Benzo(g,h,i)perylene	4	11	71 - 400	183	690 - 1100	310000	8200000	NA	UG/KG			
bis(2-Ethylhexyl)phthalate	5	11	80 - 190	122	700 - 1100	46000	410000	NA	UG/KG			
Dibenzofuran	1	11	160 - 160	160	380 - 1100	31000	820000	NA	UG/KG			
Fluoranthene	3	11	93 - 690	454	690 - 1100	310000	8200000	NA	UG/KG			
Fluorene	1	11	140 - 140	140	380 - 1100	310000	8200000	NA	UG/KG			
2-Methylnaphthalene	2	11	44 - 450	247	380 - 1100	310000	8200000	NA	UG/KG			
Naphthalene	1	11	470 - 470	470	370 - 1100	310000	8200000	NA	UG/KG			
Phenanthrene	4	11	64 - 830	331	690 - 1100	310000	8200000	NA	UG/KG			
Pyrene	3	11	150 - 650	430	690 - 1100	230000	6100000	NA	UG/KG			
Volatile Organics												
Acetone	7	11	20 - 120	54.6	11 - 33	780000	20000000	NA	UG/KG			
Methylene chloride	1	11	2 - 2	2.0	2 - 51	85000	760000	NA	UG/KG			
Xylene (Total)	1	11	2 - 2	2.0	5 - 8	16000000	100000000	NA	UG/KG			

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
NA - Not applicable
UG/KG - microgram per kilogram
MG/KG - milligram per kilogram

Table 10.23.12.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 538 and 539
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
538	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
538	B004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
538	B005	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
538	B006	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
538	B007	B(a)P Equiv.	151.60	UG/KG	2.5105	100.00	NA	
		Total			2.5105		NA	
538	B008	B(a)P Equiv.	537.94	UG/KG	8.9085	100.00	NA	
		Total			8.9085		NA	
538	B009	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
538	B010	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
539	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
539	B002	B(a)P Equiv.	89.59	UG/KG	1.4836	100.00	NA	
		Total			1.4836		NA	
539	B003	B(a)P Equiv.	246.43	UG/KG	4.0810	100.00	NA	
		Total			4.0810		NA	

Table 10.23.12.3
Chemicals Present in Site Samples
AOC 538, AOC 539 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Deep Wells											
Inorganics											
Calcium (Ca)	N	2	2	77400 - 83400	80400	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	2	2	1860 - 3860	2860	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	2	2	9810 - 9830	9820	NA - NA	NA	NA	UG/L		
Manganese (Mn)		2	2	110 - 189	149.5	NA - NA	84	869	UG/L	2	
Mercury (Hg)		1	2	0.27 - 0.27	0.27	0.2 - 0.2	1.1	0.2	UG/L		
Silver (Ag)		1	2	2.1 - 2.1	2.1	2 - 2	18	NA	UG/L		
Volatile Organics											
1,2-Dichloroethene (total)	*	2	2	3 - 12	7.5	NA - NA	5.5	NA	UG/L	1	
Trichloroethene	*	1	2	2 - 2	2	5 - 5	1.6	NA	UG/L	1	
Shallow Wells											
Inorganics											
Arsenic (As)	*	1	2	60.1 - 60.1	60.1	5 - 5	0.045	18.7	UG/L	1	1
Calcium (Ca)	N	2	2	30700 - 47900	39300	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	2	2	498 - 8960	4729	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	2	2	3430 - 3970	3700	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	2	74.5 - 74.5	74.5	4.1 - 4.1	84	2560	UG/L		
Mercury (Hg)		1	2	0.2 - 0.2	0.2	0.2 - 0.2	1.1	NA	UG/L		
Selenium (Se)		1	2	5.9 - 5.9	5.9	5 - 5	18	NA	UG/L		
Silver (Ag)		1	2	2 - 2	2	2 - 2	18	NA	UG/L		
Semivolatile Organics											
Fluorene		1	2	1 - 1	1	10 - 10	150	NA	UG/L		
2-Methylnaphthalene		1	2	17 - 17	17	10 - 10	150	NA	UG/L		
Volatile Organics											
Carbon disulfide		1	2	2 - 2	2	25 - 25	100	NA	UG/L		

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

Table 10.23.12.4
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOCs 538 and 539
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
538	G01D	1,2-Dichloroethene (total)	3.00	UG/L	NA		0.0426	4.93
538	G01D	Trichloroethene	ND	UG/L	NA		NA	
		Total			NA		0.0426	
538	G001	Arsenic (As)	60.10	UG/L	1340.7828	100.00	12.8067	87.03
		Total			1340.7828		12.8067	
539	G01D	1,2-Dichloroethene (total)	12.00	UG/L	NA		0.1705	27.97
539	G01D	Trichloroethene	2.00	UG/L	0.5057	100.00	0.0426	6.99
		Total			0.5057		0.2131	
539	G001	Arsenic (As)	ND	UG/L	NA		NA	
		Total			NA		NA	

10.23.13 Corrective Measures Considerations

For AOCs 538 and 539, the upper and lower soil intervals and the shallow and deep groundwater were investigated. Based on the analytical results and the FRE, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and the shallow and deep groundwater. 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.

BEQs were identified as COCs in the soil below pavement. The calculated mean risk estimate was 2E-06, which is within USEPA's 1E-06 to 1E-04 acceptable risk range. The risk-based RGO for BEQs is 0.06 mg/kg for a 1E-06 risk. Corrective measures that prevent infiltration and percolation will be considered, along with stabilization.

Arsenic was identified as the COC in the shallow groundwater at a concentration above its risk-based remedial goal and MCL through all four quarters of sampling. The adjacent sites' AOCs 530, 542, and 549 also reported concentrations of arsenic in the shallow groundwater, but below its MCL.

Thallium was identified in the deep groundwater in third-quarter samples collected from monitoring wells NBCE53801D, NBCE53901D, and NBCE539001 at concentrations above its MCL. Thallium may be a concern.

Potential corrective measures for the impacted media and respective COCs are in Table 10.23.13.1. Corrective measures for combined AOC 538 are detailed in Section 9.

Table 10.23.13.1
Potential Corrective Measures for AOC 538 and AOC539

Medium	Compounds	Potential Corrective Measures
Soil	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	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment
Deep Groundwater	Thallium	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment

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10.24 AOC 550, Boiler House, Former Building 1111

AOC 550 is former Building 1111, a transportable boiler house for the U.S. Marine Corps from 1927 to 1941. The dimensions of this facility are unknown, but it is known that former Building 1111 is shown at two locations on historic base maps. Personnel interviews indicate that this facility was transportable. No other information was found during the RFA regarding its design features or operating practices.

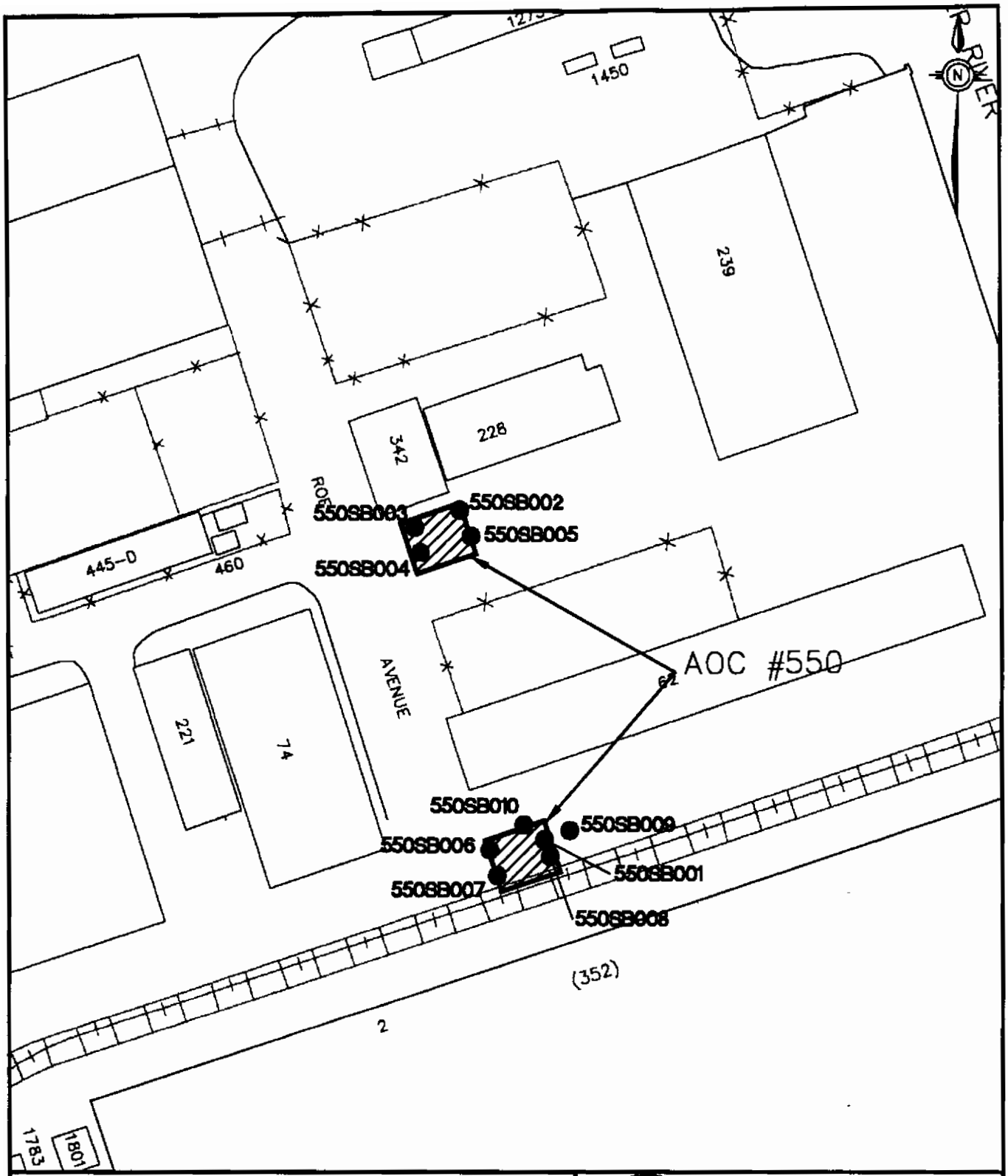
Materials of concern identified in the *Final Zone E RFI Work Plan* include petroleum hydrocarbons and heavy metals. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOC 550, soil and groundwater samples were collected in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.24.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOC 550 from the locations shown in Figure 10.24.1. The *Final Zone E RFI Work Plan*, proposed collecting six soil samples from the upper interval and six samples from the lower interval. Soil samples were also collected at both intervals for the two shallow monitoring well locations proposed at this site.

First-round Sampling — During the first-round of soil sampling, five of the eight proposed upper-interval samples and five of the eight proposed lower-interval samples were collected. The upper- and lower-interval from three sample locations could not be collected due to the extreme thickness of fill material at the site.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◓ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.24.1
SOIL BORING LOCATIONS
AOC #550
BOILER HOUSE
FORMER BUILDING 1111

DWG DATE: 09/02/97 | DWG NAME: 10-24-1

All first-round samples were submitted for analysis at DQO Level III for VOCs, SVOCs, and metals. One upper-interval sample selected as a duplicate was analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the suite of parameters proposed for the site plus a more comprehensive list of VOCs and SVOCs as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.24.1.1 summarizes first-round soil sampling at AOC 550.

Table 10.24.1.1
AOC 550
First-Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	8	5	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	Three samples were not collected due to the thickness of fill material.
Lower	8	5	VOCs, SVOCs, and metals	VOCs, SVOCs, and metals	Three samples were not collected due to the thickness of fill material.

Second-round Sampling — Second-round sampling was performed at AOC 550 after first-round analytical results were compared to the USEPA Region III RBCs and SSLs (April 1996). Parameters exceeding SSLs in the lower interval included metals and BEQs. Section 10.24.2 details specific parameters and locations which exceeded RBCs.

Two upper-interval and two lower-interval samples were proposed during second-round sampling to determine the extent of constituents detected during the initial round of soil sampling. Both upper-interval samples and both lower-interval samples were collected.

All second-round samples were submitted for analysis at DQO Level III for SVOCs and metals. No duplicate samples were collected during second-round sampling. Table 10.24.1.2 summarizes second-round soil sampling at AOC 550.

Table 10.24.1.2
AOC 550
Second-Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	2	2	SVOCs and metals	SVOCs and metals	None
Lower	2	2	SVOCs and metals	SVOCs and metals	None

10.24.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.24.2.1. Inorganic analytical results for soil are summarized in Table 10.24.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.24.2.1
AOC 550
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
2-Butanone (MEK)	Lower	1/5	10.0	10.0	NA	NA
Carbon disulfide	Lower	2/5	1.000 - 4.00	2.50	NA	NA
SVOCs (μg/kg)						
Acenaphthene	Lower	2/7	440 - 860	650	NA	NA
Acenaphthylene	Lower	1/7	60.0	60.0	NA	NA

Table 10.24.2.1
AOC 550
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (μg/kg)						
Anthracene	Lower	2/7	250 - 350	300	NA	NA
Benzo(g,h,i)perylene	Lower	4/7	50.0 - 420	197	NA	NA
Dibenzofuran	Lower	2/7	180 - 330	255	NA	NA
1,3-Dichlorobenzene	Lower	2/7	140 - 250	195	NA	NA
1,4-Dichlorobenzene	Lower	1/7	110	110	NA	NA
Fluoranthene	Upper	1/7	140	140	8,200,000	0
	Lower	5/7	100 - 1,800	756	NA	NA
Fluorene	Lower	2/7	270 - 600	435	NA	NA
2-Methylnaphthalene	Lower	2/7	71.0 - 230	151	NA	NA
Naphthalene	Lower	2/7	64.0 - 160	112	NA	NA
Phenanthrene	Lower	3/7	41.0 - 1,200	747	NA	NA
Pyrene	Upper	1/7	160	160	6,100,000	0
	Lower	5/7	96.0 - 1,800	653	NA	NA
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	1/7	26.8	26.8	780	0
	Lower	5/7	71.2 - 1,090	395	NA	NA
Benzo(a)anthracene	Upper	1/7	86.0	86.0	7,800	0
	Lower	3/7	46.0 - 730	409	NA	NA
Benzo(b)fluoranthene	Upper	1/7	180	180	7,800	0
	Lower	4/7	100 - 620	335	NA	NA
Benzo(k)fluoranthene	Lower	4/7	66.0 - 630	264	NA	NA
Benzo(a)pyrene	Lower	5/7	62.0 - 720	268	NA	NA

Table 10.24.2.1
AOC 550
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
Chrysene	Upper	1/7	150	150	780,000	0
	Lower	4/7	66.0 - 760	373	NA	NA
Dibenz(a,h)anthracene	Lower	2/7	110 - 190	150	NA	NA
Indeno(1,2,3-cd)pyrene	Lower	3/7	39.0 - 400	206	NA	NA
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	1/1	0.0426	0.0426	43	0
1234678-HpCDD	Upper	1/1	1.35	1.35	NA	NA
OCDD	Upper	1/1	25.6	25.6	NA	NA
OCDF	Upper	1/1	3.47	3.47	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.24.2.2
AOC 550
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Aluminum (Al)	Upper	7/7	2,530 - 6,290	4,270	100,000	26,600	0
	Lower	7/7	2,790 - 7,340	5,310	NA	41,100	NA
Antimony (Sb)	Lower	2/7	0.540 - 0.830	0.685	NA	1.60	NA
Arsenic (As)	Upper	7/7	0.710 - 2.10	1.05	3.80	23.9	0
	Lower	7/7	0.970 - 6.10	3.45	NA	19.9	NA

Table 10.24.2.2
AOC 550
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Barium (Ba)	Upper	7/7	10.3 - 15.6	13.1	14,000	130	0
	Lower	7/7	10.2 - 60.7	27.5	NA	94.1	NA
Beryllium (Be)	Upper	5/7	0.120 - 0.260	0.164	1.30	1.70	0
	Lower	5/7	0.160 - 0.630	0.310	NA	2.71	NA
Cadmium (Cd)	Upper	2/7	0.120 - 0.150	0.135	100	1.50	0
	Lower	3/7	0.480 - 0.680	0.557	NA	0.960	NA
Calcium (Ca)	Upper	7/7	4,140 - 37,600	14,000	NA	NA	NA
	Lower	7/7	905 - 76,100	25,600	NA	NA	NA
Chromium (Cr)	Upper	7/7	3.20 - 6.80	5.20	1,000	94.6	0
	Lower	7/7	4.60 - 22.8	12.8	NA	75.2	NA
Cobalt (Co)	Upper	7/7	0.580 - 37.9	6.79	12,000	19.0	0
	Lower	7/7	0.630 - 8.40	2.78	NA	14.9	NA
Copper (Cu)	Upper	7/7	1.10 - 10.2	3.20	8,200	66.0	0
	Lower	7/7	1.40 - 124	34.4	NA	152	NA
Iron (Fe)	Upper	7/7	1,220 - 3,560	1,900	61,000	NA	0
	Lower	7/7	1,240 - 10,800	5,810	NA	NA	NA
Lead (Pb)	Upper	7/7	1.80 - 36.0	8.16	1,300	265	0
	Lower	7/7	2.10 - 306	100	NA	173	NA
Magnesium (Mg)	Upper	7/7	264 - 548	401	NA	NA	NA
	Lower	7/7	226 - 3,020	1,340	NA	NA	NA
Manganese (Mn)	Upper	7/7	11.4 - 32.5	22.0	4,700	302	0
	Lower	7/7	9.70 - 156	50.5	NA	881	NA
Mercury (Hg)	Upper	1/7	0.0900	0.0900	61	2.60	0
	Lower	6/7	0.0800 - 0.380	0.210	NA	1.59	NA
Nickel (Ni)	Upper	7/7	1.60 - 6.10	2.69	4,100	77.1	0
	Lower	7/7	1.10 - 13.1	5.73	NA	57.0	NA

Table 10.24.2.2
AOC 550
Inorganic Detections for Soil (mg/kg)

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Potassium (K)	Upper	7/7	289 - 654	442	NA	NA	NA
	Lower	7/7	359 - 1,800	720	NA	NA	NA
Selenium (Se)	Upper	1/7	0.580	0.580	1,000	1.70	0
	Lower	4/7	0.610 - 0.970	0.773	NA	2.40	NA
Sodium (Na)	Upper	3/7	148 - 323	218	NA	NA	NA
	Lower	5/7	154 - 615	360	NA	NA	NA
Tin (Sn)	Upper	2/7	1.000 - 1.30	1.15	100,000	59.4	0
	Lower	3/7	1.40 - 21.3	10.1	NA	9.23	NA
Vanadium (V)	Upper	7/7	3.70 - 6.10	5.07	1,400	94.3	0
	Lower	7/7	4.80 - 17.8	11.5	NA	155	NA
Zinc (Zn)	Upper	7/7	4.70 - 40.7	14.1	61,000	827	0
	Lower	7/7	7.10 - 248	98.0	NA	886	NA

Notes:
mg/kg = Milligrams per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No industrial RBC or RC established

Volatile Organic Compounds in Soil

Two VOCs were detected in soil samples collected at AOC 550, with both detections occurring in the lower interval. No VOC exceeded its respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Twenty SVOCs were detected in soil samples collected at AOC 550. Five detections occurred in the upper interval and 58 in the lower interval. No SVOCs were detected above their respective industrial RBC in the upper interval. However, one SVOC — benzo(a)anthracene — exceeded its respective SSL in the lower interval.

Benzo(a)anthracene was detected in three of seven lower-interval samples with a range of 46 to 730 μg/kg and a mean of 409 μg/kg. One lower-interval sample (550SB001, 730 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOC 550. The upper-interval BEQ was calculated for one sample at 26.8 μg/kg, below the benzo(a)pyrene industrial RBC of 780 μg/kg.

Pesticides in Soil

No pesticides were detected in soil samples collected at AOC 550.

Other Organic Compounds in Soil

Three dioxins were detected in the duplicate upper-interval soil sample collected at AOC 550. No industrial RBCs have been established for dioxins. No lower-interval samples were analyzed for dioxins. In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated. The upper-interval TEQ was calculated for one sample at 0.0436 ng/kg, below the industrial RBC of 1,000 ng/kg.

Inorganic Elements in Soil

Twenty-two metals were detected in soil samples collected at AOC 550. One hundred and nineteen detections occurred in the upper-interval and 133 in the lower-interval. No metals exceeded both their respective industrial RBC and RC in the upper interval or respective SSL and RC in the lower interval.

10.24.3 Groundwater Sampling and Analysis

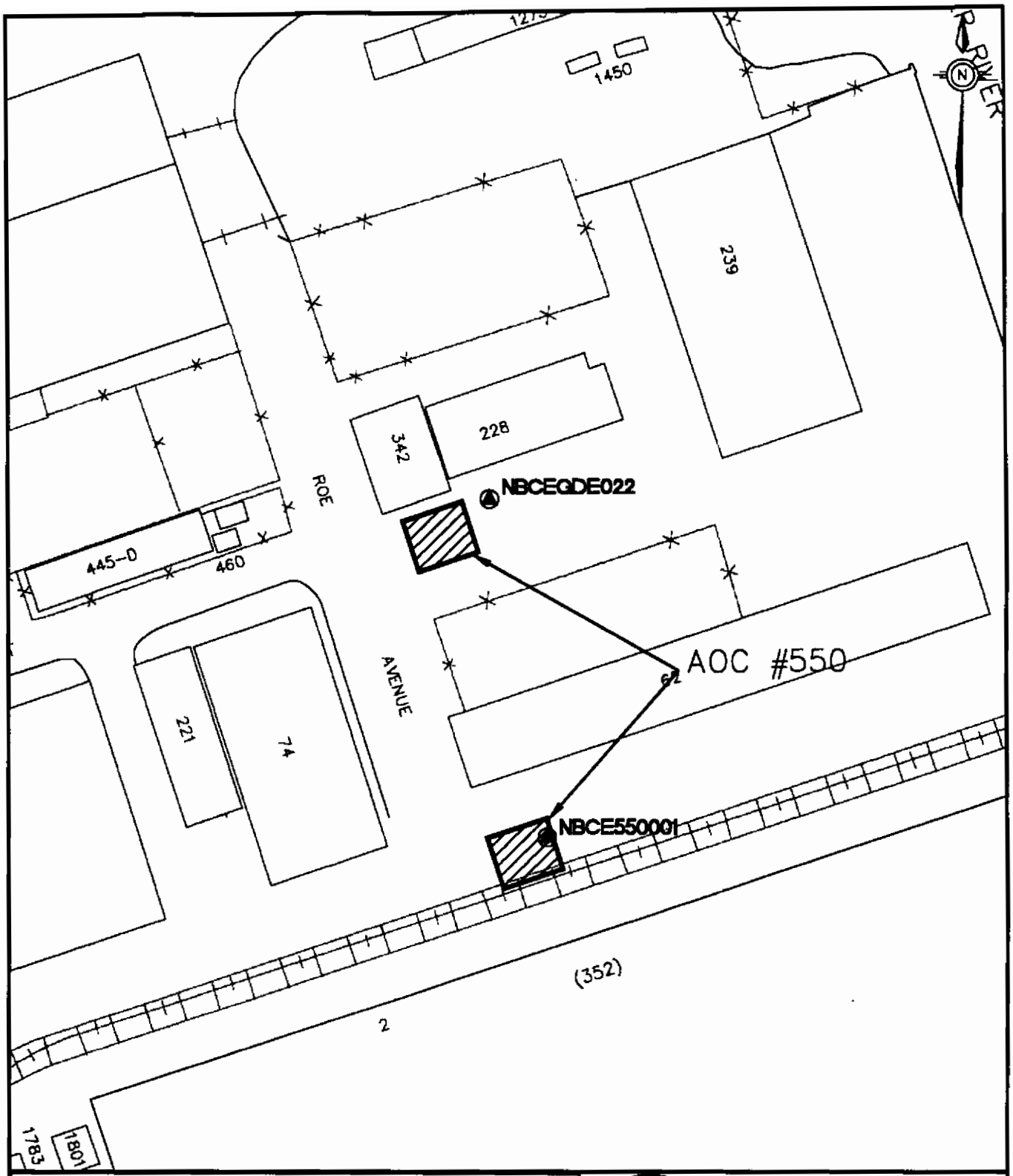
The *Final Zone E RFI Work Plan*, proposed installing two shallow monitoring wells at this site; however, due to the close proximity of the grid-based deep and shallow well pair, one well was omitted. One shallow monitoring well, NBCE550001, was installed and sampled to assess groundwater quality at AOC 550 as shown in Figure 10.24.2. Shallow grid well NBCEGDE022 was designated to help characterize AOC 550.

The grid well was sampled and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, chlorides, sulfates, and TDS at DQO Level III. The sample from well 550GW001 was submitted for analysis at DQO Level III for VOCs, SVOCs, metals, chlorides, sulfates, and TDS. No duplicate groundwater samples were collected at this site. Table 10.24.3.1 summarizes groundwater sampling and analysis at AOC 550.

Table 10.24.3.1
AOC 550
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2	1	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	VOCs, SVOCs, metals, chlorides, sulfates, and TDS	One well was omitted due to the close proximity of grid-based well NBCEGDE022

The shallow monitoring well was installed at 13.5 feet bgs in the surficial aquifer in accordance with Section 3.2.3 of this report.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.24.2
MONITORING WELL LOCATIONS
AOC #550
BOILER HOUSE
FORMER BUILDING 1111

DWG DATE: 09/02/97 | DWG NAME: 10-24-2

10.24.4 Nature of Contamination in Groundwater

Inorganic analytical results for groundwater are summarized in Table 10.24.4.1. No organic compounds were detected at this site. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.24.4.1
AOC 550
Inorganic Detections for First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Aluminum (Al)	1/1	110	110	3,700	2,810	NA	0
Arsenic (As)	1/1	18.5	18.5	0.0450	18.7	50.0	0
Barium (Ba)	1/1	60.0	60.0	260	211	2,000	0
Calcium (Ca)	1/1	127,000	127,000	NA	NA	NA	NA
Iron (Fe)	1/1	14,900	14,900	1100	NA	NA	1
Magnesium (Mg)	1/1	36,400	36,400	NA	NA	NA	NA
Manganese (Mn)	1/1	625	625	84.0	2,560	NA	0
Mercury (Hg)	1/1	0.200	0.200	1.10	NA	2.00	0
Nickel (Ni)	1/1	1.60	1.60	73.0	15.2	100	0
Potassium (K)	1/1	19,800	19,800	NA	NA	NA	NA
Sodium (Na)	1/1	512,000	512,000	NA	NA	NA	NA
Vanadium (V)	1/1	1.70	1.70	26.0	27.3	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC or RC established

Inorganic Elements in Groundwater

Shallow Groundwater

Twelve metals were detected in the one shallow groundwater sample collected at AOC 550. One metal — iron — exceeded its respective tap-water RBC.

Iron was detected in well NBCE550001 (14,900 μg/L), exceeding its tap-water RBC of 1,100 μg/L. No shallow groundwater RC or MCL has been established for iron.

10.24.5 Fate and Transport Assessment for AOC 550

AOC 550 is former Building 1111, a transportable boiler house shown at two locations on historic base maps, both located on concrete and asphalt pavement. Environmental media sampled as part of the AOC 550 CSI include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for AOC 550 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.24.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.24.5.1 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 reference 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 10:1, with no attenuation of constituents in soil (DAF=10).

No organic compounds were detected in AOC 550 soil above generic SSLs. Cobalt was detected in one surface soil sample (550SB002) above its groundwater protection SSL. Cobalt was the only inorganic soil constituent detected. Cobalt was not detected in subsurface soil above its generic SSL or its background reference value, nor was it detected in first-quarter groundwater samples,

indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer.

10.24.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.24.5.1 also compares maximum detected organic constituent concentrations in shallow and deep 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 reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No constituents were detected in AOC 550 first-round shallow groundwater samples above corresponding tap water RBCs, background reference values, or saltwater surface water chronic screening levels. As a result, the groundwater to surface water migration pathway is not expected to be a viable pathway at AOC 550. Arsenic was detected in the first-round sample from well NBCE550001 at a concentration of 18.5 μg/L below arsenic's background reference value of 18.7 μg/L. Samples from later rounds indicated elevated arsenic concentrations, including a detection of 93.2 μg/L from well NBCE5550001. Relatively high arsenic concentrations were also detected in groundwater samples at nearby SWMU 65, but were determined not to be a threat to surface water in the Cooper River.

10.24.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.24.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have

been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for AOC 550 is 165,000:1 (see Table 6.2.1).

Concentrations of cobalt, the only first-tier constituent carried over to the second tier, did not exceed the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.24.5.4 Soil-to-Air Cross-Media Transport

Table 10.24.5.3 lists the VOCs detected in surface soil samples collected at AOC 550 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at AOC 550. In addition, no VOCs detected maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at AOC 550.

10.24.5.5 Fate and Transport Summary

Cobalt, in one surface soil sample, was the only constituent detected in AOC 550 surface soil exceeding its corresponding background reference value in the first-tier screen. However, it did not exceed the adjusted screening values of the second-tier comparisons, indicating that there is no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.24.5.1
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: Tier One
NAVBASE-Charleston, Zone E: AOC 550
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
2-Butanone (MEK)	ND	10	ND	NA	4000	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	4	ND	NA	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	860	ND	NA	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	ND	60	ND	NA	150000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	ND	350	ND	NA	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	ND	420	ND	NA	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	86	730	ND	NA	800	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	ND	720	ND	NA	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	180	620	ND	NA	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	ND	630	ND	NA	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	150	760	ND	NA	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	ND	190	ND	NA	800	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	ND	400	ND	NA	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	330	ND	NA	NA	150	NA	UG/KG	UG/L	NO	NO	NO
1,3-Dichlorobenzene	ND	250	ND	NA	3000	540	28.5	UG/KG	UG/L	NO	NO	NO
1,4-Dichlorobenzene	ND	110	ND	NA	1000	0.44	19.9	UG/KG	UG/L	NO	NO	NO
Fluoranthene	140	1800	ND	NA	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	600	ND	NA	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	ND	230	ND	NA	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	ND	160	ND	NA	42000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	ND	1200	ND	NA	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	160	1800	ND	NA	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.0426	ND	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	6290	7340	110	NA	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	ND	0.83	ND	NA	2.5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	2.1	6.1	18.5	NA	23.9	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	15.6	60.7	60	NA	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.26	0.63	ND	NA	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.15	0.68	ND	NA	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	6.8	22.8	ND	NA	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	37.9	8.4	ND	NA	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	10.2	124	ND	NA	152	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	36	306	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	32.5	156	625	NA	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.09	0.38	0.2	NA	2.6	11	0.2	MG/KG	UG/L	NO	NO	NO
Nickel	6.1	13.1	1.6	NA	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.58	0.97	ND	NA	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Tin	1.3	21.3	ND	NA	59.4	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	6.1	17.8	1.7	NA	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	40.7	248	ND	NA	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.24.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, or Shallow Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOC 550
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Inorganic Compounds																
Cobalt	37.9	8.4	ND	NA	1040	2200	NA	2200	3.63E+08	2200	1.65E+05	1.00E+06	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 165,000: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

10.24.6 Fixed-Point Risk Evaluation for AOC 550

10.24.6.1 Site Background and Investigative Approach

AOC 550 was a transportable boiler house for the U.S. Marine Corp located in the former Building 1111. This site is located in a highly industrialized portion of Zone E, and as a result, the risk assessment is presented as a FRE following the framework presented in Section 7.3.

A total of seven surface soil samples were considered in the AOC 550 FRE. One monitoring well was installed into the shallow aquifer as part of the 1995 RFI. Groundwater data generated from the first quarter RFI sampling event were considered in the screening evaluation for the AOC 525 FRE. Sections 10.24.1 and 10.24.3 contain summaries of the sampling effort for AOC 550 soil and groundwater.

10.24.6.2 Fixed-Point Risk Evaluation for Soil

Table 10.24.6.1 provides CPSS summaries for AOC 550 soil and identifies COPCs based on comparison to residential and industrial RBCs, and RCs. No COPCs were identified for AOC 550 soil for either the residential or industrial scenarios. Arsenic and beryllium were detected at a concentration above their residential RBCs and were both eliminated from consideration in the AOC 550 FRE based on comparison to their RCs. Wilcoxon rank sum test did not result in the inclusion of any inorganic parameter that had been screened out based on RC.

10.24.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.24.6.2 provides CPSS summaries for AOC 550 groundwater and identifies COPCs based on comparison to residential RBCs and RCs. No COPCs were identified for AOC 525 groundwater. Manganese was detected at a concentration above its RBC, and was eliminated from consideration in the AOC 550 FRE based on comparison to its RC. Arsenic was detected in the first quarter sample collected from monitoring well NBCE550001 at a concentration of 18.5 μg/L which is above its RBC (0.045 μg/L) and close to its RC (18.7 μg/L). Subsequent quarterly

sampling reported concentrations of 19.9 μg/L (second quarter), 93.2 μg/L (third quarter), and 55.9 μg/L (fourth quarter). Consequently, second, third, and fourth quarter groundwater samples exceeded the RC and the RBC for arsenic. Additionally, third and fourth quarter samples exceeded the MCL for arsenic.

10.24.6.4 Fixed-Point Risk Evaluation Summary

Data collected for AOC 550 surface soil and first quarter groundwater were screened according to the process presented in Section 7.3.4. No COPCs were identified subsequent to this screening. Arsenic was detected in the first quarter groundwater sample collected from monitoring well NBCE550001 at a concentration close to its RC. Subsequent quarterly samples collected from monitoring well NBCE550001 reported arsenic concentrations above its MCL. SWMU 65, located adjacent to AOC 550 to the west, reported arsenic concentrations in shallow and deep groundwater above its RC, but not above its MCL.

Table 10.24.6.1
Chemicals Present in Site Samples
AOC 550 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Carcinogenic COPCs													
B(a)P Equiv.		1	7	26.75 - 26.75	26.75	855.07 - 1663.92	88	780	NA	UG/KG			
Benzo(a)anthracene		1	7	86 - 86	86	370 - 720	880	7800	NA	UG/KG			
Benzo(b)fluoranthene		1	7	180 - 180	180	370 - 720	880	7800	NA	UG/KG			
Chrysene		1	7	150 - 150	150	370 - 720	88000	780000	NA	UG/KG			
TCDD Equivalents													
Dioxin Equiv.		1	1	0.0426 - 0.0426	0.0426	NA - NA	1000	1000	NA	NG/KG			
Inorganics													
Aluminum (Al)		7	7	2530 - 6290	4265.71	NA - NA	7800	100000	26600	MG/KG			
Arsenic (As)		7	7	0.71 - 2.1	1.05	NA - NA	0.43	3.8	23.9	MG/KG	7		
Barium (Ba)		7	7	10.3 - 15.6	13.09	NA - NA	550	14000	130	MG/KG			
Beryllium (Be)		5	7	0.12 - 0.26	0.16	0.18 - 0.21	0.15	1.3	1.7	MG/KG	3		
Cadmium (Cd)		2	7	0.12 - 0.15	0.14	0.04 - 0.11	3.9	100	1.5	MG/KG			
Calcium (Ca)	N	7	7	4140 - 37600	14011.43	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)		7	7	3.2 - 6.8	5.20	NA - NA	39	1000	94.6	MG/KG			
Cobalt (Co)		7	7	0.58 - 37.9	6.79	NA - NA	470	12000	19	MG/KG			1
Copper (Cu)		7	7	1.1 - 10.2	3.20	NA - NA	310	8200	66	MG/KG			
Iron (Fe)	N	7	7	1220 - 3560	1895.71	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)		7	7	1.8 - 36	8.16	NA - NA	400	1300	265	MG/KG			
Magnesium (Mg)	N	7	7	264 - 548	401.29	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)		7	7	11.4 - 32.5	22.04	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)		1	7	0.09 - 0.09	0.09	0.04 - 0.04	2.3	61	2.6	MG/KG			
Nickel (Ni)		7	7	1.6 - 6.1	2.69	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N	7	7	289 - 654	441.86	NA - NA	NA	NA	NA	MG/KG			
Selenium (Se)		1	7	0.58 - 0.58	0.58	0.33 - 0.57	39	1000	1.7	MG/KG			
Sodium (Na)	N	3	7	148 - 323	217.67	10.8 - 11	NA	NA	NA	MG/KG			
Tin (Sn)		2	7	1 - 1.3	1.15	2.6 - 3.2	4700	100000	59.4	MG/KG			
Vanadium (V)		7	7	3.7 - 6.1	5.07	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		7	7	4.7 - 40.7	14.06	NA - NA	2300	61000	827	MG/KG			

Table 10.24.6.1
Chemicals Present in Site Samples
AOC 550 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration Residential RBC	Industrial RBC	Reference	Units	Number Exceeding Res. RBC	Ind. RB	Ref.
Semivolatile Organics												
Fluoranthene	1	7	140 - 140	140	370 - 720	310000	8200000	NA	UG/KG			
Pyrene	1	7	160 - 160	160	370 - 720	230000	6100000	NA	UG/KG			

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

Table 10.24.6.2
Chemicals Present in Site Samples
AOC 550 - Groundwater
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceedin Res.	Ref.
Shallow Wells											
Inorganics											
Aluminum (Al)		1	1	110 - 110	110	NA - NA	3700	2810	UG/L		
Arsenic (As)		1	1	18.5 - 18.5	18.5	NA - NA	0.045	18.7	UG/L	1	
Barium (Ba)		1	1	60 - 60	60	NA - NA	260	211	UG/L		
Calcium (Ca)	N	1	1	127000 - 127000	127000	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	1	1	14900 - 14900	14900	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	36400 - 36400	36400	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	1	625 - 625	625	NA - NA	84	2560	UG/L	1	
Mercury (Hg)		1	1	0.2 - 0.2	0.2	NA - NA	1.1	NA	UG/L		
Nickel (Ni)		1	1	1.6 - 1.6	1.6	NA - NA	73	15.2	UG/L		
Potassium (K)	N	1	1	19800 - 19800	19800	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	512000 - 512000	512000	NA - NA	NA	NA	UG/L		
Vanadium (V)		1	1	1.7 - 1.7	1.7	NA - NA	26	11.4	UG/L		

Notes:
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - micrograms per liter
NA - Not applicable

10.24.7 Corrective Measures Considerations

For AOC 550, the upper and lower soil intervals and the shallow groundwater were investigated. Based on the analytical results and the FRE, a COC requiring further evaluation through the CMS process was identified for the shallow groundwater. No COCs were identified for AOC 550 soil. 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.

Arsenic was identified as the COC in the shallow groundwater. Arsenic was detected in the first-quarter sample from monitoring well NBCE550001 at of 18.5 μg/L which is above its RBC (0.045 μg/L) and close to its background reference concentration (18.7 μg/L). Subsequent quarterly sampling detected concentrations of 19.9 μg/L (second quarter), 93.2 μg/L (third quarter), and 55.9 μg/L (fourth quarter). Consequently, second-, third-, and fourth-quarter groundwater samples exceeded the background reference concentration and the RBC for arsenic. Additionally, third- and fourth-quarter samples exceeded the MCL for arsenic.

Potential corrective measures for the impacted medium and respective COCs are in Table 10.24.7.1. Corrective measures for AOC 550 are detailed in Section 9.

Table 10.24.7.1
Potential Corrective Measures for AOC 550

Medium	Compounds	Potential Corrective Measures
Shallow Groundwater	Arsenic	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment

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10.25 AOC 551, Boiler House, Building 1119; and AOC 552, Former Galvanizing Shop, Building 1030

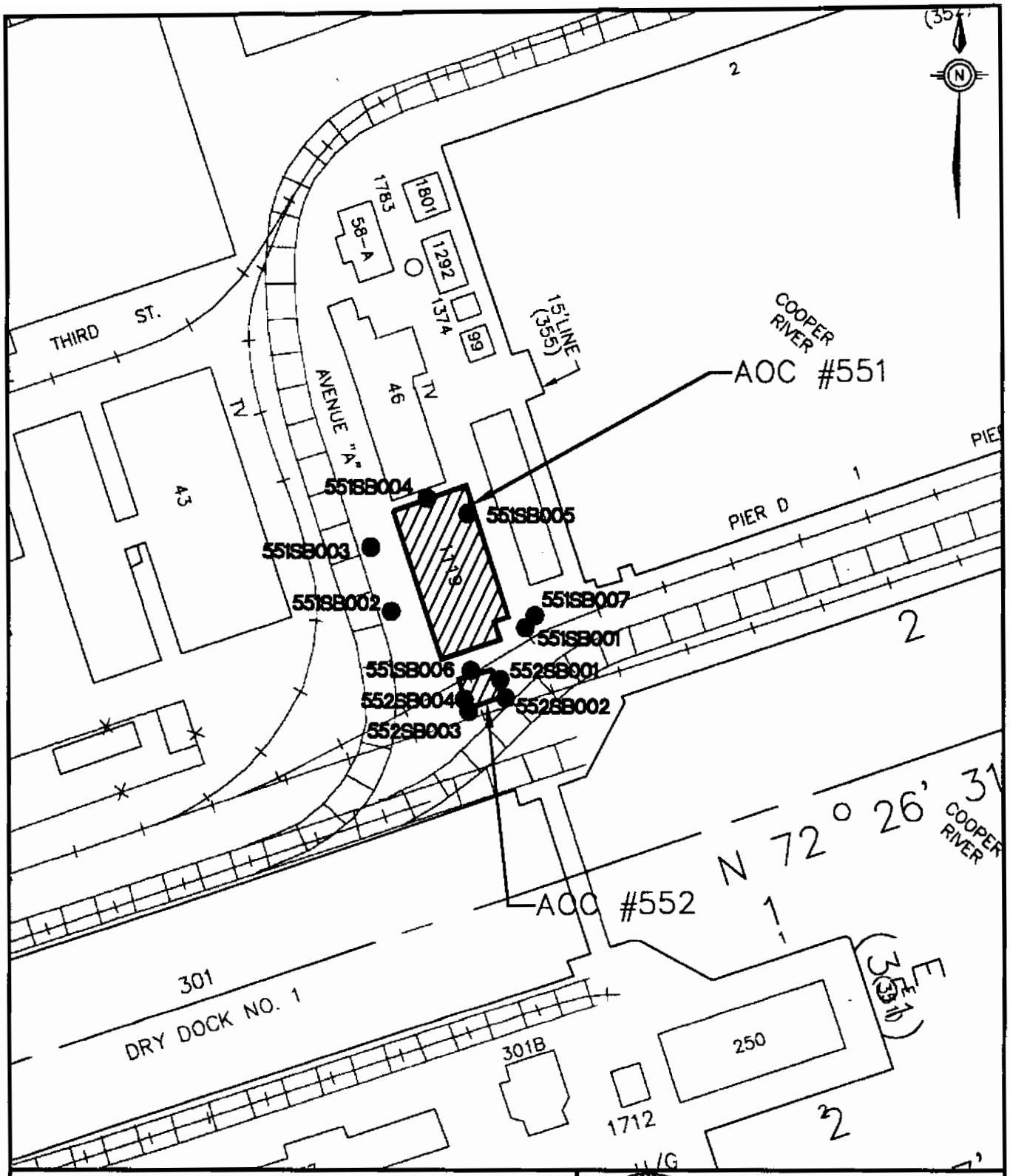
AOC 551 is Building 1119, a boiler house that operated before 1942. The building appears to have undergone drastic renovations, or it possibly may have been demolished and a new structure rebuilt on the same site. A boiler was located on site, but no information was found to indicate the type of fuel used in it. AOC 552 is a former galvanizing shop located in Building 1030, which operated from 1922 to 1926. From 1926 to 1929, the building housed a tooling shop. In 1929, the building was converted to a storage shop and was later demolished. Currently, the site is paved with asphalt and traversed by a pair of railroad tracks.

Materials of concern for AOC 551 identified in the *Final Zone E RFI Work Plan* include petroleum hydrocarbons, and heavy metals. At AOC 552, the materials of concern are inorganic acids, zinc, and heavy metals. Potential receptors that may be exposed to site contaminants include current and future building users and any site workers this area may support following base closure.

To fulfill the CSI objectives for AOCs 551 and 552, soil and groundwater samples were collected in accordance with the *Final Zone E RFI Work Plan*, and Section 3 of this report to determine whether any contamination resulted from onsite activities.

10.25.1 Soil Sampling and Analysis

Soil was sampled in two rounds at AOCs 551 and 552 from the locations shown in Figure 10.25.1. The *Final Zone E RFI Work Plan*, proposed collecting eight soil samples from the upper interval and eight samples from the lower interval. Soil samples were also collected at both intervals for the two shallow monitoring well locations proposed at this site.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.25.1
SOIL BORING LOCATIONS
AOC #551, BOILER HOUSE, BLDG 1119
AOC #552/GALVANIZING SHOP
FORMER BUILDING 1030

DWG DATE: 09/02/97 | DWG NAME: 10-25-1

First-round Sampling — During the first round of sampling, nine of the 10 proposed upper-interval and nine of the 10 proposed lower-interval samples were collected. At AOC 552, one upper- and one lower-interval sample could not be collected at 552SB003 due to large rocks encountered near the adjacent railroad tracks.

All first-round samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, and pH. Two upper-interval samples selected as duplicates were analyzed at DQO Level IV for Appendix IX analytical parameters, which includes the requested suite of parameters for the site plus a more comprehensive list of VOCs, SVOCs, as well as herbicides, hexavalent chromium, organophosphorus pesticides, and dioxins. Table 10.25.1.1 summarizes first-round soil sampling at AOCs 551 and 552.

Table 10.25.1.1
AOCs 551 and 552
First-Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	10	9	VOCs, SVOCs, metals, and pH	VOCs, SVOCs, metals, and pH	One sample could not be collected due to an obstruction
Lower	10	9	VOCs, SVOCs, metals, and pH	VOCs, SVOCs, metals, and pH	One sample could not be collected due to an obstruction

Second-round Sampling — Second-round sampling was performed at AOC 551 after first-round analytical results were compared to the USEPA Region III RBCs and SSLs (April 1996). Parameters exceeding RBCs and SSLs included metals and BEQs. Section 10.25.2 details specific parameters and locations which exceeded RBCs.

One upper-interval and one lower-interval sample were proposed during second-round sampling to determine the extent of constituents detected during the initial round of soil sampling. The upper-interval sample at 551SB007 was collected; however, the lower-interval sample could not be collected due to subsurface obstructions in the form of large rocks.

The second-round sample was submitted for analysis at DQO Level III for SVOCs, metals, and pH. No duplicate samples were collected during second-round sampling. Table 10.25.1.2 summarizes the second-round soil sampling at AOC 551.

Table 10.25.1.2
AOCs 551 and 552
Second-Round Soil Sampling Summary

Interval	Samples Proposed	Samples Collected	Analyses Proposed	Analyses Collected	Deviations
Upper	1	1	SVOCs, metals, and pH	VOCs, SVOCs, metals, and pH	None
Lower	1	0	SVOCs, metals, and pH	None	Sample could not be collected due to an obstruction

10.25.2 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.25.2.1. Inorganic analytical results for soil are summarized in Table 10.25.2.2. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.25.2.1
AOCs 551 and 552
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
VOCs (μg/kg)						
Acetone	Upper	4/9	12.0 - 110	39.5	20,000,000	0
	Lower	3/9	17.0 - 580	239	NA	NA
Carbon disulfide	Lower	1/9	2.00	2.00	NA	NA
Methylene chloride	Upper	2/9	17.0 - 23.0	20.0	760,000	0
	Lower	1/9	30.0	30.0	NA	NA
Trichlorofluoromethane	Upper	1/2	4.00	4.00	61,000,000	0
SVOCs (μg/kg)						
Acenaphthene	Lower	1/9	23.0	23.0	NA	NA
Anthracene	Upper	1/10	88.0	88.0	61,000,000	0
	Lower	3/9	62.0 - 210	122	NA	NA
Benzo(g,h,i)perylene	Upper	5/10	110 - 220	152	8,200,000	0
	Lower	4/9	140 - 420	320	NA	NA
Dibenzofuran	Upper	1/10	16.0	16.0	820,000	0
	Lower	1/9	13.0	13.0	NA	NA
Di-n-butylphthalate	Upper	1/10	77.0	77.0	20,000,000	0
Fluoranthene	Upper	5/10	120 - 280	184	8,200,000	0
	Lower	5/9	200 - 960	600	NA	NA
Fluorene	Lower	1/9	16.0	16.0	NA	NA
2-Methylnaphthalene	Upper	1/10	88.0	88.0	8,200,000	0
Phenanthrene	Upper	4/10	93.0 - 340	171	8,200,000	0
	Lower	5/9	97.0 - 970	385	NA	NA
Pyrene	Upper	7/10	81.0 - 310	198	6,100,000	0
	Lower	5/9	280 - 1,100	696	NA	NA

Table 10.25.2.1
AOCs 551 and 552
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
SVOCs (B(a)P Equivalents) (μg/kg)						
B(a)P Equiv.	Upper	6/10	8.90 - 479	223	780	0
	Lower	5/9	142 - 1,040	585	NA	NA
Benzo(a)anthracene	Upper	5/10	93.0 - 230	137	7,800	0
	Lower	5/9	110 - 800	418	NA	NA
Benzo(b)fluoranthene	Upper	4/10	89.0 - 220	137	7,800	0
	Lower	1/9	430	430	NA	NA
Benzo(k)fluoranthene	Upper	5/10	87.0 - 400	227	78,000	0
	Lower	5/9	120 - 800	514	NA	NA
Benzo(a)pyrene	Upper	5/10	140 - 270	180	780	0
	Lower	5/9	120 - 650	404	NA	NA
Chrysene	Upper	5/10	92.0 - 430	190	780,000	0
	Lower	5/9	140 - 810	450	NA	NA
Dibenz(a,h)anthracene	Upper	2/10	85.0 - 140	113	780	0
	Lower	3/9	140 - 220	167	NA	NA
Indeno(1,2,3-cd)pyrene	Upper	5/10	110 - 220	156	7,800	0
	Lower	5/9	96.0 - 380	245	NA	NA
Dioxins (ng/kg)						
Dioxin Equiv.	Upper	2/2	0.0888 - 21.9	11.0	1,000	0
123789-HxCDD	Upper	1/2	3.12	3.12	NA	NA
1234678-HpCDD	Upper	2/2	1.42 - 762	382	NA	NA
1234678-HpCDF	Upper	1/2	139	139	NA	NA
1234789-HpCDF	Upper	1/2	6.01	6.01	NA	NA
123478-HxCDD	Upper	1/2	0.712	0.712	NA	NA

Table 10.25.2.1
AOCs 551 and 552
Organic Compounds Detected in Soil

Compound	Sampling Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Number of Samples Exceeding RBC
Dioxins (ng/kg)						
123678-HxCDD	Upper	1/2	15.6	15.6	NA	NA
123478-HxCDF	Upper	1/2	0.322	0.322	NA	NA
123678-HxCDF	Upper	1/2	22.5	22.5	NA	NA
234678-HxCDF	Upper	2/2	0.209 - 0.885	0.547	NA	NA
OCDD	Upper	2/2	21.5 - 7,740	3,880	NA	NA
OCDF	Upper	1/2	804	804	NA	NA

Notes:
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram
RBC = Risk-based concentration
NA = No industrial RBC established

Table 10.25.2.2
AOCs 551 and 552
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Aluminum (Al)	Upper	10/10	1,860 - 6,500	3,980	100,000	26,600	0
	Lower	9/9	2,480 - 7,290	4,730	NA	41,100	NA
Antimony (Sb)	Upper	7/10	0.590 - 22.2	5.00	82.0	1.77	0
	Lower	7/9	0.540 - 1.70	0.923	NA	1.60	NA
Arsenic (As)	Upper	10/10	0.680 - 13.1	3.98	3.80	23.9	0
	Lower	8/9	0.840 - 12.0	4.97	NA	19.9	NA

Table 10.25.2.2
AOCs 551 and 552
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Barium (Ba)	Upper	10/10	10.5 - 179	32.0	14,000	130	0
	Lower	9/9	5.20 - 136	38.1	NA	94.1	NA
Beryllium (Be)	Upper	9/10	0.140 - 0.810	0.361	1.30	1.70	0
	Lower	8/9	0.120 - 0.530	0.328	NA	2.71	NA
Cadmium (Cd)	Upper	7/10	0.110 - 2.00	0.556	100	1.50	0
	Lower	5/9	0.120 - 2.00	0.560	NA	0.960	NA
Calcium (Ca)	Upper	10/10	1,440 - 111,000	34,000	NA	NA	NA
	Lower	9/9	755 - 44,600	15,600	NA	NA	NA
Chromium (Cr)	Upper	10/10	4.70 - 46.1	15.7	1,000	94.6	0
	Lower	9/9	2.60 - 16.5	10.7	NA	75.2	NA
Cobalt (Co)	Upper	10/10	0.790 - 69.8	9.26	12,000	19.0	0
	Lower	8/9	0.740 - 8.00	2.42	NA	14.9	NA
Copper (Cu)	Upper	10/10	5.80 - 292	50.8	8,200	66.0	0
	Lower	9/9	0.900 - 68.8	24.1	NA	152	NA
Iron (Fe)	Upper	10/10	1,750 - 10,400	4,830	61,000	NA	0
	Lower	9/9	1,160 - 15,000	6,550	NA	NA	NA
Lead (Pb)	Upper	10/10	10.5 - 934	127	1,300	265	0
	Lower	9/9	2.30 - 344	102	NA	173	NA
Magnesium (Mg)	Upper	10/10	121 - 1,850	831	NA	NA	NA
	Lower	9/9	62.1 - 1,130	671	NA	NA	NA
Manganese (Mn)	Upper	10/10	13.3 - 99.3	48.9	4,700	302	0
	Lower	9/9	5.70 - 148	51.1	NA	881	NA

Table 10.25.2.2
AOCs 551 and 552
Inorganic Detections for Soil

Element	Sample Interval	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Industrial RBC	Reference Conc.	Number of Samples Exceeding RBC and RC
Inorganic Elements (mg/kg)							
Mercury (Hg)	Upper	8/10	0.0600 - 4.10	0.588	61	2.60	0
	Lower	7/9	0.0300 - 0.720	0.304	NA	1.59	NA
Nickel (Ni)	Upper	10/10	3.00 - 38.4	8.92	4,100	77.1	0
	Lower	9/9	0.710 - 9.70	4.69	NA	57.0	NA
Potassium (K)	Upper	9/10	157 - 1,010	727	NA	NA	NA
	Lower	9/9	108 - 1,220	699	NA	NA	NA
Selenium (Se)	Upper	2/10	0.390 - 0.690	0.540	1,000	1.70	0
Silver (Ag)	Upper	2/10	0.240 - 0.270	0.255	1,000	NA	0
Sodium (Na)	Upper	9/10	78.9 - 510	201	NA	NA	NA
	Lower	6/9	138 - 245	182	NA	NA	NA
Thallium (Tl)	Lower	2/9	0.740 - 0.760	0.750	NA	NA	NA
Tin (Sn)	Upper	5/10	2.80 - 212	47.1	100,000	59.4	0
	Lower	5/9	2.60 - 5.60	4.16	NA	9.23	NA
Vanadium (V)	Upper	10/10	2.30 - 21.1	9.61	1,400	94.3	0
	Lower	9/9	1.20 - 19.0	10.9	NA	155	NA
Zinc (Zn)	Upper	10/10	16.6 - 843	144	61,000	827	0
	Lower	9/9	1.90 - 1,020	178	NA	886	NA
pH (SU)							
pH	Upper	10/10	7.81 - 9.52	8.31	NA	NA	NA
	Lower	9/9	6.76 - 8.32	7.82	NA	NA	NA

Notes:
μg/kg = Micrograms per kilogram
RBC = Risk-based concentration
RC = Reference concentration
NA = No RBC or RC established
SU = Standard units

Volatile Organic Compounds in Soil

Four VOCs were detected in soil samples collected at AOCs 551 and 552. Seven detections occurred in the upper interval and five in the lower interval. No VOC exceeded its respective industrial RBC in the upper interval or respective SSL in the lower interval.

Semivolatile Organic Compounds in Soil

Seventeen SVOCs were detected in soil samples collected at AOCs 551 and 552. Fifty-six detections occurred in the upper interval and 54 in the lower interval. No SVOC exceeded its respective industrial RBC in the upper interval. However, one SVOC — benzo(a)anthracene — exceeded its respective SSL in the lower interval.

Benzo(a)anthracene was detected in five of nine lower-interval samples with a range of 110 to 800 μg/kg and a mean of 418 μg/kg. One lower-interval sample (552SB002, 800 μg/kg) exceeded the benzo(a)anthracene SSL of 700 μg/kg.

In accordance with recent cPAH guidance, BEQs were calculated for cPAHs at AOCs 551 and 552. The upper-interval BEQ was calculated for six samples with a range of 8.90 to 479 μg/kg and a mean of 223 μg/kg. No upper-interval samples exceeded the benzo(a)pyrene industrial RBC of 780 μg/kg.

Other Organic Compounds in Soil

Eleven dioxins were detected in the two duplicate upper-interval soil samples collected at AOCs 551 and 552, with fourteen detections occurring in the upper interval. No industrial RBCs have been established for the detected dioxins.

In accordance with recent dioxin guidance, TEQs (dioxin equivalent) were calculated. The upper-interval TEQ was calculated for two samples with a range of 0.0888 to 21.9 ng/kg and a mean of 11 ng/kg. The TEQ calculation was below the industrial RBC of 1,000 ng/kg.

Inorganic Elements in Soil

Twenty-four metals were detected in soil samples collected at AOCs 551 and 552. One hundred and ninety-eight detections occurred in the upper interval and 173 occurred in the lower interval. No metal exceeded both its respective industrial RBC and RC in the upper interval. One metal — barium — exceeded both its respective SSL and RC in the lower interval.

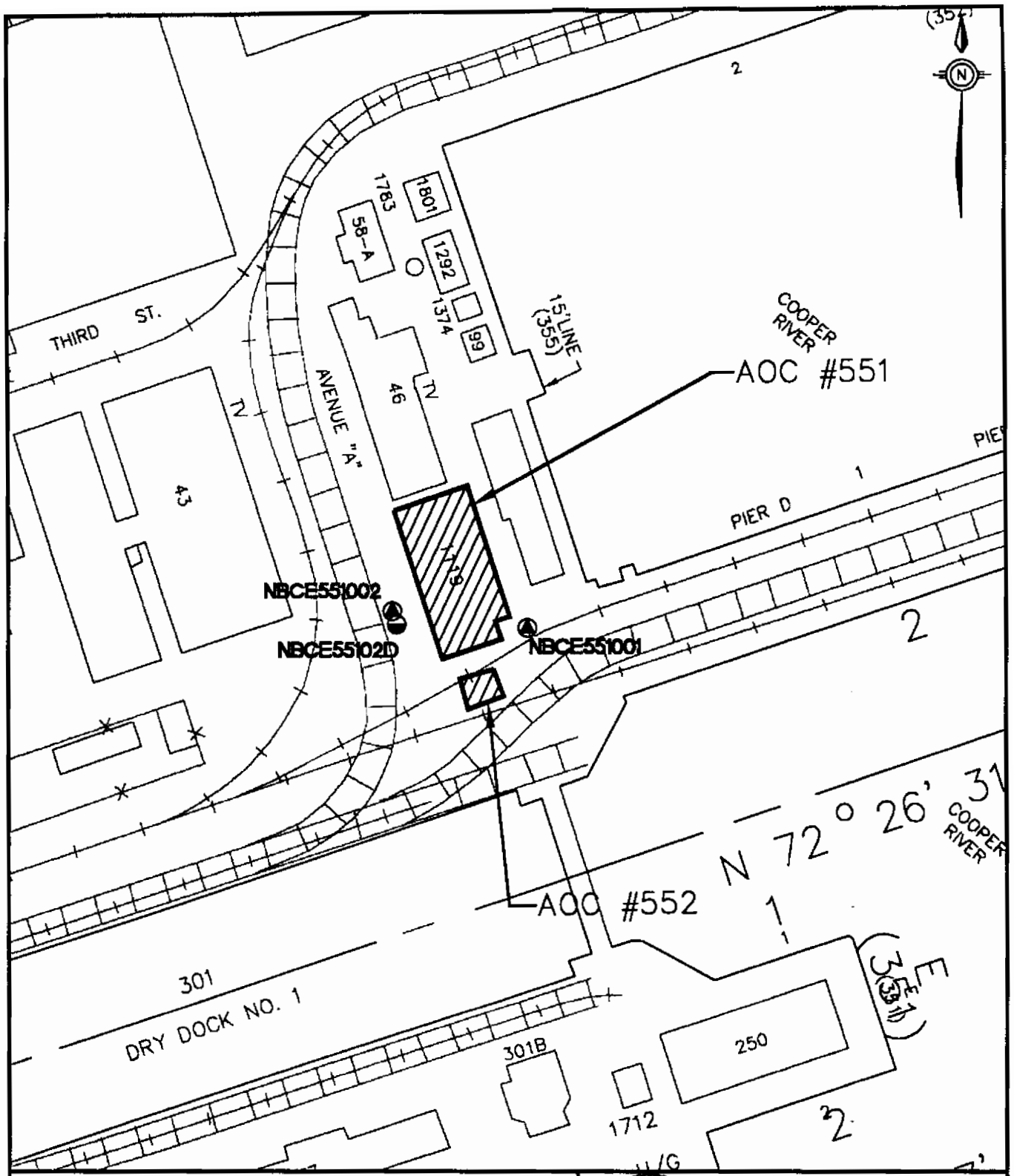
Barium was detected in nine of nine lower-interval samples with a range of 5.20 to 136 mg/kg and a mean of 38.1 mg/kg. One lower-interval sample (551SB003, 136 mg/kg) exceeded both the barium SSL of 32 mg/kg and the RC of 94.1 mg/kg.

10.25.3 Groundwater Sampling and Analysis

One deep monitoring well and two shallow monitoring wells were installed and sampled to assess groundwater quality at AOCs 551 and 552 as shown in Figure 10.25.2. The wells were installed as follows:

- Shallow Wells — NBCE551001, NBCE551002
- Deep Well — NBCE55102D

The proposed location of the deep monitoring well was originally on the southeast edge of Building 1119; however, due to subsurface obstructions, the well was moved to the southwest edge of the building.



LEGEND

- ● – SOIL BORINGS
- Ⓒ – CORE SAMPLES
- ◒ – DEEP MONITORING WELLS
- ◭ – SHALLOW MONITORING WELLS
- ▲ – SEDIMENT SAMPLES
- Ⓣ – THICKNESS SAMPLES
- Ⓦ – WIPE SAMPLES
- Ⓢ – SURFACE WATER SAMPLES

GRAPHIC SCALE 100 0 100 200

ZONE E
RFI REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.25.2
MONITORING WELL LOCATIONS
AOC #551, BOILER HOUSE, BLDG 1119
AOC #552/GALVANIZING SHOP
FORMER BUILDING 1030

DWG DATE: 09/02/97 | DWG NAME: 10-25-2

Groundwater samples were submitted for analysis at DQO Level III for VOCs, SVOCs, metals, pH, chlorides, sulfates, and TDS. No duplicate samples were collected this site. Table 10.25.3.1 summarizes groundwater sampling and analysis at AOCs 551 and 552.

Table 10.25.3.1
AOCs 551 and 552
Groundwater Sampling Summary

Depth	Wells Proposed	Wells Installed	Analyses Proposed	Analyses Collected	Deviations
Shallow	2	2	VOCs, SVOCs, metals, pH, chlorides, sulfates, and TDS	VOCs, SVOCs, metals, pH, chlorides, sulfates, and TDS	None
Deep	1	1	VOCs, SVOCs, metals, pH, chlorides, sulfates, and TDS	VOCs, SVOCs, metals, pH, chlorides, sulfates, and TDS	NBCE55102D was relocated to the southwest edge of AOC 551

The shallow monitoring wells were installed at 12.5 and 13.5 feet bgs in the surficial aquifer. The deep well was installed at 26.7 feet bgs at the base of the surficial aquifer. All wells were installed in accordance with Section 3.2.3 of this report.

10.25.4 Nature of Contamination in Groundwater

Organic compound analytical results for shallow and deep groundwater are summarized in Tables 10.25.4.1 and 10.25.4.2, respectively. Inorganic analytical results for shallow and deep groundwater are summarized in Tables 10.25.4.3 and 10.25.4.4, respectively. Appendix H contains the complete data report for all samples collected in Zone E.

Table 10.25.4.1
AOCs 551 and 552
Organic Compounds Detected in First Quarter Groundwater (μg/L)
Shallow Monitoring Wells

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
SVOCs						
Acenaphthene	1/2	2.00	2.00	220	NA	0

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
NA = No MCL established

Table 10.25.4.2
AOCs 551 and 552
Organic Compounds Detected in First Quarter Groundwater
Deep Monitoring Well

Compound	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	MCL	Number of Samples Exceeding RBC
VOCs						
Tetrachloroethene	1/1	2.00	2.00	1.1	5	1
Trichloroethene	1/1	2.00	2.00	1.60	5	1

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level

Table 10.25.4.3
AOCs 551 and 552
Inorganic Detections for First Quarter Groundwater
Shallow Monitoring Wells

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (μg/L)							
Calcium (Ca)	2/2	105,000 - 112,000	109,000	NA	NA	NA	NA
Iron (Fe)	2/2	977 - 14,600	7,790	1,100	NA	NA	1
Magnesium (Mg)	2/2	14,800 - 70,400	42,600	NA	NA	NA	NA
Manganese (Mn)	2/2	130 - 450	290	84.0	2,560	NA	0
Potassium (K)	2/2	8,600 - 37,700	23,200	NA	NA	NA	NA
Sodium (Na)	1/2	216,000	216,000	NA	NA	NA	NA
Vanadium (V)	1/2	1.10	1.10	26.0	11.4	NA	0
pH (SU)							
pH	2/2	7.10 - 7.50	7.30	NA	NA	NA	NA

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established
SU = Standard units

Table 10.25.4.4
AOCs 551 and 552
Inorganic Detections for First Quarter Groundwater
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (μg/L)							
Arsenic (As)	1/1	21.2	21.2	0.0450	16.4	50	1
Barium (Ba)	1/1	18.7	18.7	260	218	2,000	0
Calcium (Ca)	1/1	64,200	64,200	NA	NA	NA	NA
Iron (Fe)	1/1	2,570	2,570	1,100	NA	NA	1

Table 10.25.4.4
AOCs 551 and 552
Inorganic Detections for First Quarter Groundwater
Deep Monitoring Well

Element	Freq. of Detection	Range of Detected Conc.	Mean of Detected Conc.	Tap-Water RBC	Reference Conc.	MCL	Number of Samples Exceeding RBC and RC
Inorganic Elements (μg/L)							
Magnesium (Mg)	1/1	4,820	4,820	NA	NA	NA	NA
Manganese (Mn)	1/1	317	317	84.0	869	NA	0
Mercury (Hg)	1/1	0.200	0.200	1.10	0.2	2.00	0
Potassium (K)	1/1	3,790	3,790	NA	NA	NA	NA
Sodium (Na)	1/1	65,000	65,000	NA	NA	NA	NA
pH (SU)							
pH	1/1	7.03	7.03	NA	NA	NA	NA

Notes:
μg/L = Micrograms per liter
RBC = Risk-based concentration
MCL = Maximum contaminant level
RC = Reference concentration
NA = No RBC, MCL, or RC established
SU = Standard units

Volatile Organic Compounds in Groundwater

Deep Groundwater

Two VOCs — tetrachloroethene and trichloroethene — were detected in the one deep groundwater sample collected at AOC 551 (no deep wells were installed at AOC 552). Both VOCs exceeded their respective tap-water RBC.

Tetrachloroethene was detected in well NBCE55102D (2.0 μg/L), exceeding its tap-water RBC of 1.10 μg/L. The detection did not exceed the tetrachloroethene MCL of 5.00 μg/L.

Trichloroethene was detected in well NBCE55102D (2.0 μg/L), exceeding its tap-water RBC of 1.60 μg/L. The detection did not exceed the trichloroethene MCL of 5.00 μg/L.

Semivolatile Organic Compounds in Groundwater

Shallow Groundwater

One SVOC — acenaphthene — was detected in one of two shallow groundwater samples collected at AOC 551 (no shallow groundwater wells were installed at AOC 552). The SVOC did not exceed its respective tap-water RBC. No MCL has been established for acenaphthene.

Inorganic Elements in Groundwater

Shallow Groundwater

Seven metals were detected in shallow groundwater samples collected at AOC 551. One metal — iron — exceeded its respective tap-water RBC.

Iron was detected in two of two samples with a range of 977 to 14,600 μg/L and a mean of 7,790 μg/L. One sample from well NBCE551002 (14,600 μg/L) exceeded the iron tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

Deep Groundwater

Nine metals were detected in the one deep groundwater sample collected at AOC 551. Two metals — arsenic and iron — exceeded both their respective tap-water RBC and deep groundwater RC (where applicable).

Arsenic was detected in well NBCE55102D (21.2 μg/L), exceeding both its tap-water RBC of 0.0450 μg/L and deep groundwater RC of 16.4 μg/L. The detection did not exceed the arsenic MCL of 50 μg/L.

Iron was detected in well NBCE55102D (2,570 μg/L), exceeding its tap-water RBC of 1,100 μg/L. No deep groundwater RC or MCL has been established for iron.

10.25.5 Fate and Transport Assessment for Combined AOC 551

AOC 551 is Building 1119, a former boiler house. AOC 552 is a former galvanizing shop located in former Building 1030. The physical setting for both AOCs consists primarily of concrete and asphalt pavement, with the exception of a narrow strip of grass along the west side of Building 1119. Environmental media sampled as part of the combined AOC 551 CSI include surface soil, subsurface soil, and shallow and deep groundwater. Potential constituent migration pathways investigated for combined AOC 551 include soil to groundwater, groundwater to surface water, and emission of volatiles from surface soil to air.

10.25.5.1 Soil-to-Groundwater Cross-Media Transport: Tier One

Table 10.25.5.1 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 reference 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 10:1, with no attenuation of constituents in soil (DAF=10).

Methylene chloride and benzo(a)anthracene were the only organic compounds detected in combined AOC 551 soil at or above their corresponding groundwater protection SSLs. Methylene chloride exceeded its SSL in two duplicate surface soil samples (551SB002 and 551SB006) and in one subsurface soil sample (552SB001), but was not detected in first-quarter groundwater samples. Benzo(a)anthracene was reported at 800 μg/kg in subsurface soil sample 552SB002, equaling its generic SSL, but was also not detected in groundwater samples.

Six inorganics — antimony, cobalt, copper, lead, mercury, and tin — were detected in soil above their respective generic SSLs or background reference values. Antimony was detected at a concentration exceeding its generic SSL in two surface samples (551SB004 and 551SB006).

Cobalt, copper, lead, and mercury were detected at concentrations exceeding their respective generic SSLs or background reference values in the same surface soil sample (551SB006). Tin was detected at a concentration exceeding its background reference value in one surface soil sample (551SB004). None of these inorganic constituents was detected above its screening level in subsurface soil samples, nor were they detected in first-quarter groundwater samples, indicating that the current soil-groundwater equilibrium is sufficiently protective of the surficial aquifer. Slightly elevated concentrations of zinc in soil samples (maximum 843 mg/kg in surface soil and 1,020 mg/kg in subsurface soil, both from sample location 551SB006) likely reflect past site use as a galvanizing shop, but these concentrations are below the zinc generic SSL of 6,000 mg/kg.

10.25.5.2 Groundwater-to-Surface Water Cross-Media Transport: Tier One

Table 10.25.5.1 also compares maximum detected organic constituent concentrations in shallow and deep 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 reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative first-tier screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic compounds were detected in combined AOC 551 first-quarter groundwater samples (shallow or deep) at concentrations exceeding tap water RBCs or saltwater surface water chronic screening levels. No inorganics were detected in first-quarter groundwater samples from shallow wells at concentrations exceeding tap water RBCs or background reference values. Arsenic was the only inorganic detected in a first-quarter deep groundwater sample (NBCE55102D) at a concentration exceeding its respective background reference value. However, the detected

concentration of 21.2 μg/L is below the arsenic MCL of 50 μg/L and its saltwater surface water chronic screening level of 36 μg/L.

10.25.5.3 Soil and Groundwater-to-Surface Water Transport: Tier Two

Table 10.25.5.2 provides a second screening tier for all constituents detected in soil or groundwater at concentrations exceeding any of the first-tier screening levels. Constituent concentrations in groundwater are compared to combined ecological/human health RBCs that have been adjusted upward for site-specific dilution by surface water in the Cooper River, while soil constituent concentrations are compared to calculated SSLs that are based on the adjusted RBCs rather than the original target leachate concentrations. For the second-tier screen, no dilution of leachate by groundwater or attenuation of constituents in soil is assumed (DAF=1). The second screening tier identifies any constituents in soil or groundwater that pose a threat to surface water quality, after allowing for dilution of groundwater by surface water when the groundwater discharges into the river. The site-specific surface-water dilution factor calculated for combined AOC 551 is 69,600:1 (see Table 6.2.1).

None of the first-tier constituent concentrations exceeded the adjusted screening levels of the second tier, indicating that site constituents in soil and groundwater pose no threat to human health or the environment in the Cooper River.

10.25.5.4 Soil-to-Air Cross-Media Transport

Table 10.25.5.3 lists the VOCs detected in surface soil samples collected at combined AOC 551 along with corresponding soil-to-air volatilization screening levels. Minimal surface soil is exposed at combined AOC 551. In addition, no VOCs maximum concentration exceeded its respective soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not expected to be a viable pathway at combined AOC 551.

10.25.5.5 Fate and Transport Summary

In the first-tier screen, six inorganics were detected at concentrations exceeding their respective generic SSLs or background reference values in one or two surface soil samples each. Their detected concentrations in subsurface soil did not exceed groundwater protection SSLs, nor were they detected in groundwater samples. Arsenic exceeded its background reference value in the single first-quarter sample from the deep well NBCE55102D, although its concentration in this sample was less than its MCL.

None of the constituents exceeding first-tier screening values also exceeded the adjusted screening values of the second-tier comparisons, indicating no threat to surface water in the Cooper River via the evaluated migration pathways.

Table 10.25.5.1
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: Tier One
NAVBASE-Charleston, Zone E: AOCs 551 and 552
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 * Salt Wtr. Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	110	580	ND	ND	8000	3700	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	2	ND	ND	16000	1000	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	23	30	ND	ND	10	4.1	2560	UG/KG	UG/L	YES	NO	NO
Tetrachloroethene	ND	2	ND	ND	30	1.1	45	UG/KG	UG/L	NO	NO	NO
Trichloroethene	ND	2	ND	ND	30	1.6	NA	UG/KG	UG/L	NO	NO	NO
Trichlorofluoromethane	4	ND	ND	ND	13000	1300	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	23	2	ND	285000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	88	210	ND	ND	5900000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	220	420	ND	ND	2.33E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	230	800	ND	ND	800	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	270	650	ND	ND	4000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	220	430	ND	ND	2500	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	400	800	ND	ND	24500	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	430	810	ND	ND	80000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	140	220	ND	ND	800	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	220	380	ND	ND	7000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	16	13	ND	ND	NA	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	77	ND	ND	ND	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Fluoranthene	280	960	ND	ND	2150000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	16	ND	ND	280000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	88	340	ND	ND	63000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenanthrene	340	970	ND	ND	690000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	310	1100	ND	ND	2100000	1100	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	21.9	ND	NA	NA	950	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	6500	7290	ND	ND	41100	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	22.2	1.7	ND	ND	2.5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	13.1	12	ND	21.2	23.9	18.7	36	MG/KG	UG/L	NO	YES	NO
Barium	179	136	ND	18.7	820	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.81	0.53	ND	ND	32	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	2	2	ND	ND	4	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	46.1	16.5	ND	ND	94.6	37000	103	MG/KG	UG/L	NO	NO	NO
Cobalt	69.8	8	ND	ND	19	2200	NA	MG/KG	UG/L	YES	NO	NO
Copper	292	68.8	ND	ND	152	1500	2.9	MG/KG	UG/L	YES	NO	NO
Lead	934	344	ND	ND	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	99.3	148	450	317	881	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	4.1	0.72	ND	0.2	2.6	11	0.2	MG/KG	UG/L	YES	NO	NO
Nickel	38.4	9.7	ND	ND	77.1	730	42.2	MG/KG	UG/L	NO	NO	NO
Selenium	0.69	ND	ND	ND	2.5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.27	ND	ND	ND	17	180	0.23	MG/KG	UG/L	NO	NO	NO
Thallium	ND	0.76	ND	ND	2.8	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	212	5.6	ND	ND	59.4	22000	NA	MG/KG	UG/L	YES	NO	NO
Vanadium	21.1	19	1.1	ND	3000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	843	1020	ND	ND	6000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 10, adapted from 1996 EPA Soil Screening Guidance or calculated using values from Table 6.2
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November, 1995; Table 2
In each case, the value shown is the greater of the relevant screening value or the corresponding background reference value

Units: See notes for Table 10.1.5.1

Table 10.25.5.2
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, or Deep Groundwater at Concentrations Exceeding any Initial Screening Concentration
Comparison to Combined Ecological/Human Health RBCs Adjusted for Surface Water Dilution, and to SSLs Based on Adjusted Ecological/Human Health RBCs: Tier Two
NAVBASE-Charleston, Zone E: AOCs 551 and 552
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Initial Screening Concentrations *			Adjusted Screening Concentrations #					Units		Screening Results	
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Salt Wtr. Surf. Wtr. Chronic	Combined Eco/HH Surf. Wtr. RBC	Adjusted Eco/HH GW RBC	Target Leachate Conc. (DAF=1)	SSL Multi-plier	Adjusted SSL (DAF=1)	Soil Units	Water Units	Leaching Potential	Surface Water Migration Concern
Volatile Organic Compounds																
Methylene chloride	23	30	ND	ND	10	4.1	2560	4.1	2.85E+05	5	5.71E+04	5.71E+04	UG/KG	UG/L	NO	NO
Semivolatile Organic Compounds																
Benzo(a)pyrene equivalents																
Benzo(a)anthracene	230	800	ND	ND	800	0.092	NA	0.092	6.40E+03	0.1	6.40E+04	5.12E+06	UG/KG	UG/L	NO	NO
Inorganic Compounds																
Antimony	22.2	1.7	ND	ND	2.5	15	NA	15	1.04E+06	6	1.74E+05	4.35E+04	MG/KG	UG/L	NO	NO
Arsenic	13.1	12	ND	21.2	14.6	0.045	36	0.045	3.13E+03	50	6.26E+01	9.15E+01	MG/KG	UG/L	NO	NO
Cobalt	69.8	8	ND	ND	1040	2200	NA	2200	1.53E+08	2200	6.96E+04	1.00E+06	MG/KG	UG/L	NO	NO
Copper	292	68.8	ND	ND	458	1500	2.9	2.9	2.02E+05	1300	1.55E+02	7.11E+03	MG/KG	UG/L	NO	NO
Lead	934	344	ND	ND	400	15	8.5	8.5	5.92E+05	15	3.94E+04	1.00E+06	MG/KG	UG/L	NO	NO
Mercury	4.1	0.72	ND	0.2	1.04	11	0.2	0.2	1.39E+04	2	6.96E+03	7.24E+02	MG/KG	UG/L	NO	NO
Tin	212	5.6	ND	ND	55000	22000	NA	22000	1.53E+09	22000	6.96E+04	1.00E+06	MG/KG	UG/L	NO	NO

* Initial Screening Concentrations: See notes for Table 10.1.5.2
In this table, the screening values shown are not adjusted for background reference values.

\# Adjusted Screening Concentrations: See notes for Table 10.1.5.2
Adjusted Eco/HH Groundwater RBC - Combined Eco/HH Surface Water RBCs multiplied by site-specific surface water dilution factor of 69,600: GW concentrations protective of surface water

Units: See notes for Table 10.1.5.2

Table 10.25.5.3
Soil-to-Air Volatilization Screening Analysis
NAVBASE-Charleston, Zone E: AOCs 551 and 552
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	110	62000000	UG/KG	NO
Methylene chloride	23	7000	UG/KG	NO
Trichlorofluoromethane	4	790000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Region III Risk-Based Concentration Table, June 1996.

10.25.6 Fixed-Point Risk Evaluation for AOC 551 and AOC 552

10.25.6.1 Site Background and Investigative Approach

AOC 551 was a former boiler house located in Building 1119 and AOC 552 is a former galvanizing shop located in Building 1030. Building 1119 is currently used as production offices. The following refers to these sites a combined AOC 551. This site is located in a highly industrialized portion of Zone E. As a result, the risk assessment for this site is presented as a FRE following the framework presented in Section 7.3.

A total of 10 surface soil samples were considered in the combined AOC 551 FRE. Three monitoring wells were installed as part of the 1995 RFI. Two of these monitoring wells were installed into the shallow aquifer and one was installed into the deep aquifer. Groundwater data generated from the first quarter RFI sampling event are used to represent point risk/hazard for the AOC 538 FRE. Sections 10.25.1 and 10.25.3 contain summaries of the sampling effort for combined AOC 551 soil and groundwater.

10.25.6.2 Fixed-Point Risk Evaluation for Soil

Residential Scenario

Table 10.25.6.1 provides CPSS summaries for combined AOC 551 soil and identifies COPCs based on comparison to residential and industrial RBCs and RCs. Based on residential RBCs, antimony, BEQs, lead, and mercury were identified as COPCs for combined AOC 551. Arsenic, beryllium, and chromium were detected in combined AOC 551 soil at concentrations above their RBCs but were eliminated from consideration in the residential FRE based on comparison to their RCs. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on RCs.

Table 10.25.6.2 summarizes the residential COPCs detected at each combined AOC 551 sample location with contribution to risk and hazard. As shown, benzo(a)pyrene equivalent compounds

contribute to risk for combined AOC 551 surface soil, exceeding 1E-06 at five of 10 locations. No carcinogenic COPCs were detected in samples 551SB001, 551SB005, 551SB007, and 552SB001 Figure 10.25.3 is a spatial presentation of residential risk estimates for combined AOC 551 surface soil. For those samples with detected concentrations of BEQs, risk estimates range from 1E-07 to 8E-06 with an arithmetic mean risk of 2E-06 (assuming a deminimus risk of 1E-07 for samples with no detectable concentrations of benzo(a)pyrene equivalent compounds).

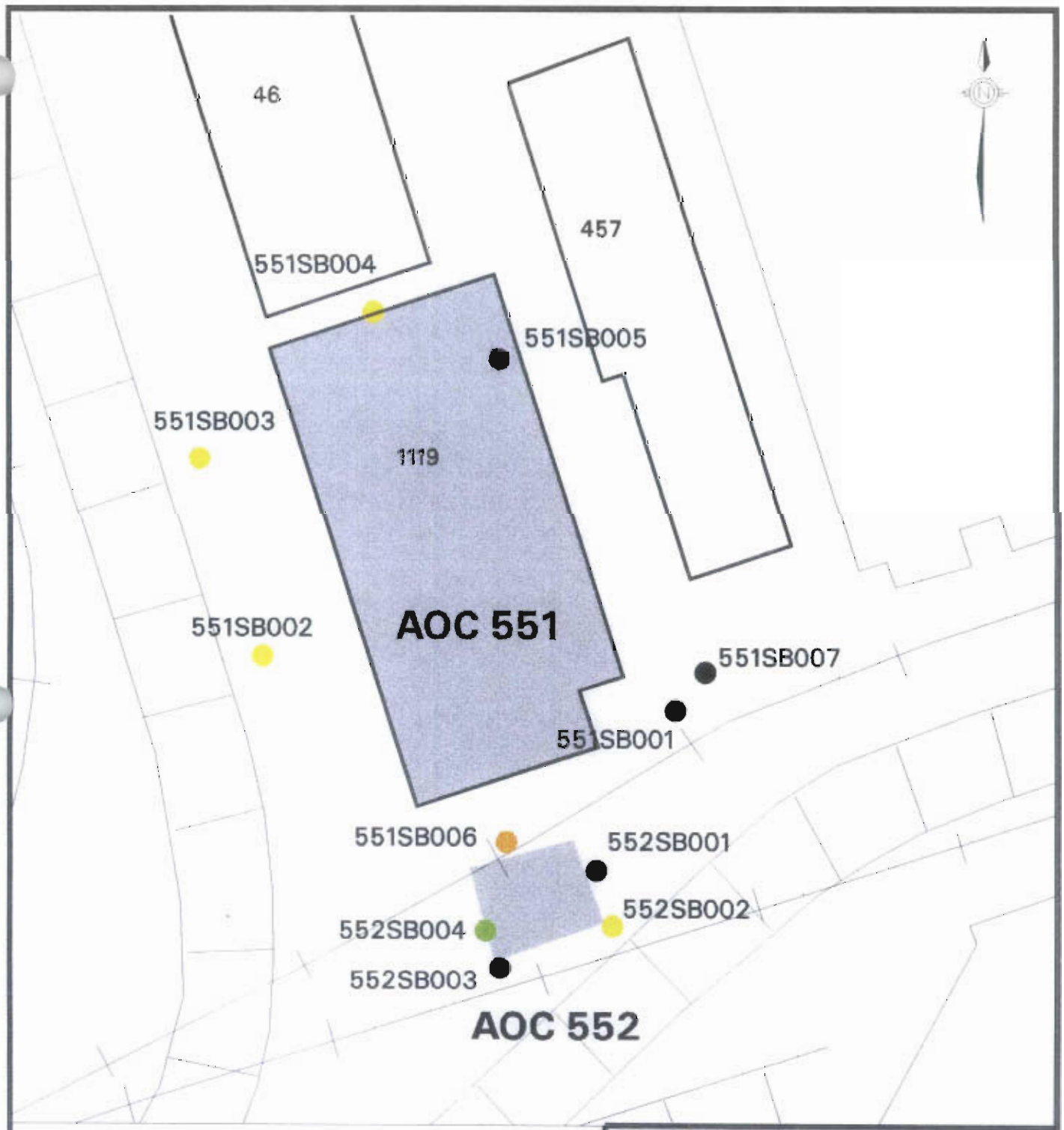
COPC surface soil concentrations were not associated with HI estimates above unity at any sample locations, based in the residential scenario. HIs ranged from 0.0027 to 0.8.

Industrial Scenario

Based on industrial RBCs, no COPCs were identified for combined AOC 551 surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out based on RC.

10.25.6.3 Fixed-Point Risk Evaluation for Groundwater

Table 10.25.6.3 provides CASS summaries for combined AOC 551 groundwater and identifies COPCs. Arsenic, tetrachloroethene and trichloroethene were identified as groundwater COPCs in the deep aquifer and no COPCs were identified in the shallow aquifer. COPC identification was based on comparison of first quarter groundwater concentrations to tap water RBCs, as well as corresponding RCs for inorganics. The maximum concentration of manganese reported in the deep well samples exceeded its RBC and was eliminated from consideration in the deep groundwater FRE based on comparison to its RCs. AOC 551 groundwater data were not sufficient to perform Wilcoxon rank sum test analyses (less than four samples each for shallow and deep).



LEGEND - CUMULATIVE SOIL RISK

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

0 feet 60

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

FIGURE 10.25.3
CUMULATIVE SOIL RISK
RESIDENTIAL SCENARIO
AOC 551, 552

As a result, manganese was eliminated from the deep groundwater FRE based on direct comparison of its maximum concentrations to its RC.

Table 10.25.6.4 summarizes the COPCs identified in combined AOC 551 monitoring wells sampled during the first quarter. The concentration of arsenic in the groundwater sample collected from NBCE55102D was the primary contributor risk estimates resulting in a risk of 5E-04. The concentration of tetrachloroethene in the groundwater sample collected from monitoring well NBCE55102D was a secondary contributor equating with a risk of 2E-06. Neither of the first quarter groundwater samples collected from the shallow water bearing zone had concentrations of COPCs. Figure 10.25.4 illustrates the groundwater data as a function of point-specific risk projections.

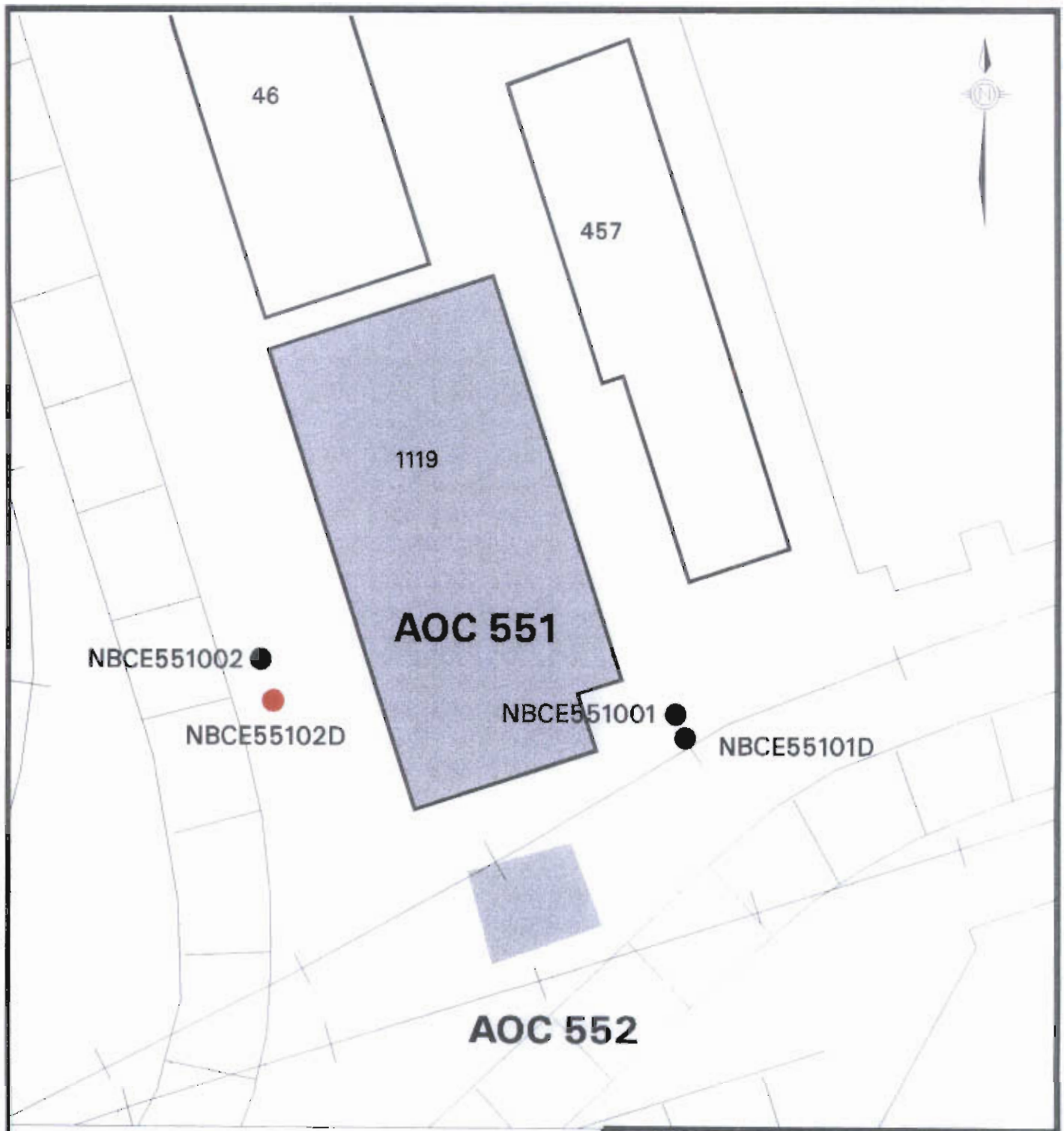
Monitoring well NBCE55102D produced first quarter results corresponding with a HI of approximately 5, due primarily to the concentration of arsenic. No other first quarter groundwater samples were associated with hazard projections above unity. Figure 10.25.5 illustrates the groundwater data as a function of point-specific hazard projections.

10.25.6.4 Uncertainty

AOC 551 uncertainty issues specific to the FRE and essential to the risk management process are presented in the following paragraphs.

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.



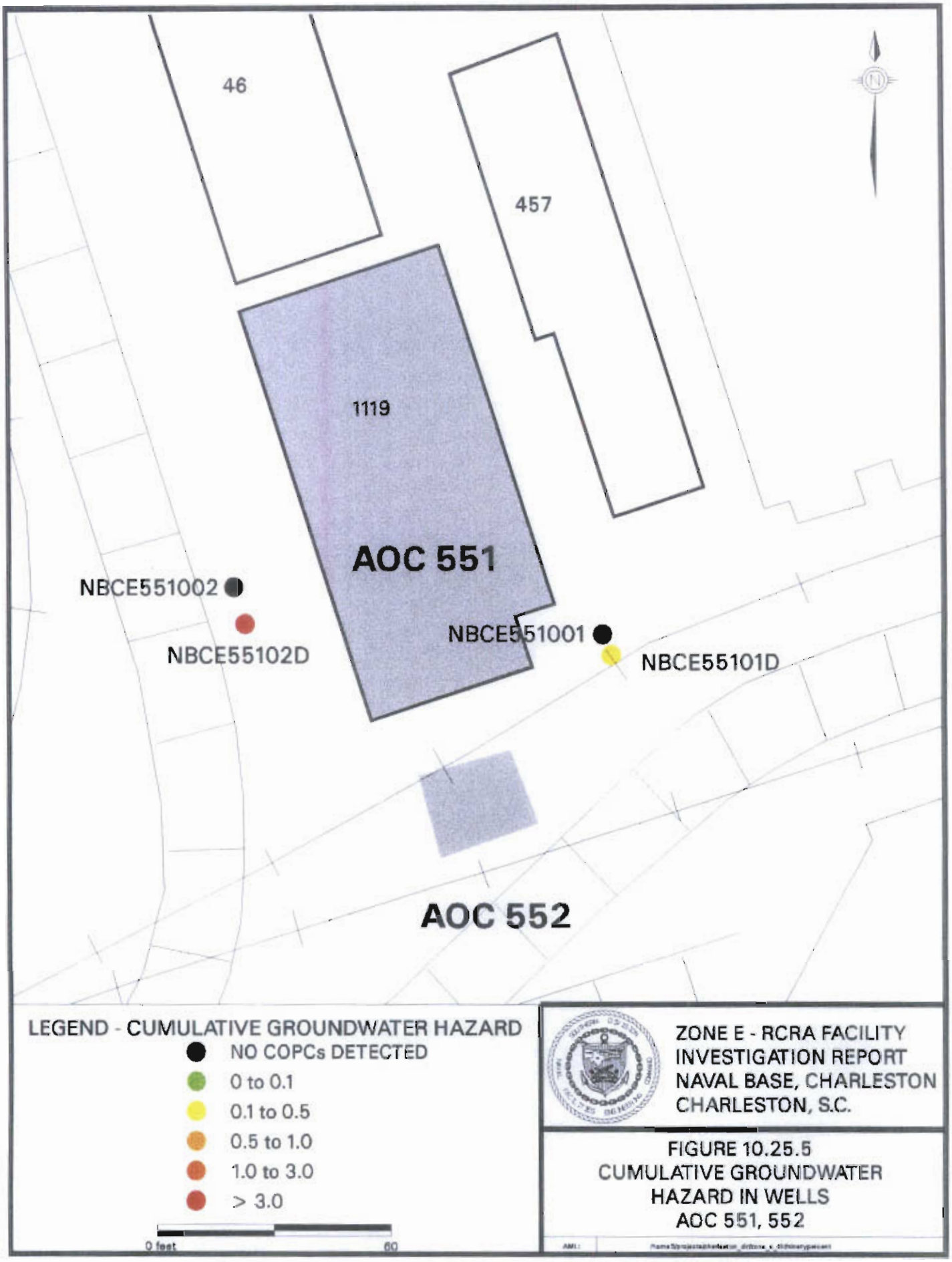
LEGEND - CUMULATIVE GROUNDWATER RISK

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

0 feet 60

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

FIGURE 10.25.4
CUMULATIVE GROUNDWATER RISK IN WELLS
AOC 551, 552


46
457
1119
AOC 551
NBCE551002
NBCE55102D
NBCE551001
NBCE55101D
AOC 552
LEGEND - CUMULATIVE GROUNDWATER HAZARD
NO COPCs DETECTED
0 to 0.1
0.1 to 0.5
0.5 to 1.0
1.0 to 3.0
> 3.0
0 feet
60
ZONE E - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.
FIGURE 10.25.5
CUMULATIVE GROUNDWATER
HAZARD IN WELLS
AOC 551, 552

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 industrial use of Zone E, specifically as a marine cargo terminal and drydocking facility. If this area were to be redeveloped, 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, chronic exposure to surface soil conditions, as represented by the samples results used in this FRE, would not be likely under any future use scenario. These factors indicate that exposure pathways assessed in this FRE would generally overestimate the risk and hazard posed to current/future site workers and future site residents.

Groundwater is not currently used as a potable water source at combined AOC 551, 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.

Quantification of Risk/Hazard

Soil

A conservative screening process was used to identify COPCs for combined AOC 551. 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 for comparison minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment based on comparison to RBCs, only copper was reported at a concentration close to its RBCs (e.g. within 10% of its RBCs).

Arsenic, beryllium and chromium were reported in combined AOC 551 soil at concentrations above their RBC benchmarks and were eliminated from consideration in the FRE based on comparison to their RC. As a result, their contribution to risk/hazard has not been considered in this FRE.

Groundwater

The same conservative screening process used for soil was also applied to groundwater. Use of conservative RBCs in combination with the use of maximum detected concentrations for comparison 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 concentrations close to its RBC (e.g. within 10% of its RBC).

Manganese was reported in combined AOC 551 shallow and deep groundwater at a maximum concentration above its RBC benchmark and was eliminated from consideration in the groundwater FRE based on comparison to its respective RCs. As a result, its contribution to hazard has not been considered in the deep groundwater FRE.

10.25.6.5 FRE Summary

The risk and hazard posed by contaminants at combined AOC 551 were assessed for the future site worker and the future site resident as sample point-specific estimates. In surface soils, the incidental ingestion and dermal contact pathways are reflected. The groundwater FRE was based on first quarter data and considers the both the ingestion and inhalation pathways. Risk and HI estimates are presented on Tables 10.25.6.2 and 10.25.6.4 such that a risk (E-06) or HI that exceeds one for any COPC at any given sample location is an indication that the concentration of that COPC exceeds its RGO (calculated at a target risk of 1E-06 and a target hazard quotient of 1). Section 7, Tables 7.3.1, 7.3.2, and 7.3.3 provide residential, industrial, and residential groundwater RGOs, respectively, for all of the COPCs identified for Zone E.

Soil — Residential Scenario

Benzo(a)pyrene equivalent compounds were detected in combined AOC 551 surface soil at concentrations above their residential RGOs in five of the 10 samples. The calculated mean risk estimate was 2E-06 which is only marginally above the 1E-06 SCDHEC risk level of concern and is within USEPA's 1E-06 to 1E-04 acceptable risk range.

Soil — Site Worker Scenario

No COPCs were identified for combined AOC 551 surface soil, based on industrial RBCs.

Groundwater — Residential Scenario

Arsenic was detected in deep groundwater at a concentration above its RGO and RC through all four quarters of sampling. However, arsenic was not detected in groundwater above its MCL through four quarters of sampling. Tetrachloroethene was detected in deep groundwater above its RGO in the sample collected in the first quarter, but was not detected in subsequent quarterly samples.

Thallium was detected in fourth quarter samples collected from monitoring wells NBCE551001 and NBCE551002 at concentrations above its MCL. The average concentration for both shallow monitoring wells and all four quarters of sampling, assuming one-half SQL for nondetects, is 2.5 μg/L, which is only marginally above its MCL (2 μg/L).

Table 10.25.6.1
Chemicals Present in Site Samples
AOC 551, AOC 552
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RB	Number Exceeding: Ref.
Carcinogenic PAHs													
B(a)P Equiv.	*	6	10	8.9 - 478.63	223.09	855.07 - 1802.58	88	780	NA	UG/KG	5		
Benzo(a)anthracene		5	10	93 - 230	136.60	370 - 780	880	7800	NA	UG/KG			
Benzo(b)fluoranthene		4	10	89 - 220	137.25	370 - 780	880	7800	NA	UG/KG			
Chrysene		5	10	92 - 430	190.40	370 - 780	88000	780000	NA	UG/KG			
Dibenz(a,h)anthracene	*	2	10	85 - 140	112.50	370 - 780	88	780	NA	UG/KG	1		
Indeno(1,2,3-cd)pyrene		5	10	110 - 220	156.00	370 - 780	880	7800	NA	UG/KG			
Benzo(k)fluoranthene		5	10	87 - 400	227.40	370 - 780	8800	78000	NA	UG/KG			
Benzo(a)pyrene	*	5	10	140 - 270	180.00	370 - 780	88	780	NA	UG/KG	5		
TCDD Equivalents													
Dioxin Equiv.		2	2	0.0888 - 21.8837	10.99	NA - NA	1000	1000	NA	NG/KG	1		
Inorganics													
Aluminum (Al)		10	10	1860 - 6500	3981.00	NA - NA	7800	100000	26600	MG/KG			
Antimony (Sb)	*	7	10	0.59 - 22.2	5.00	0.45 - 0.45	3.1	82	1.77	MG/KG	2		2
Arsenic (As)		10	10	0.68 - 13.1	3.98	NA - NA	0.43	3.8	23.9	MG/KG	10		
Barium (Ba)		10	10	10.5 - 179	32.01	NA - NA	550	14000	130	MG/KG			1
Beryllium (Be)		9	10	0.14 - 0.81	0.36	0.11 - 0.11	0.15	1.3	1.7	MG/KG	8		
Cadmium (Cd)		7	10	0.11 - 2	0.56	0.11 - 0.12	3.9	100	1.5	MG/KG			1
Calcium (Ca)	N	10	10	1440 - 111000	33967.00	NA - NA	NA	NA	NA	MG/KG			
Chromium (Cr)		10	10	4.7 - 46.1	15.65	NA - NA	39	1000	94.6	MG/KG	1		
Cobalt (Co)		10	10	0.79 - 69.8	9.26	NA - NA	470	12000	19	MG/KG			1
Copper (Cu)		10	10	5.8 - 292	50.77	NA - NA	310	8200	66	MG/KG			1
Iron (Fe)	N	10	10	1750 - 10400	4829.00	NA - NA	NA	NA	NA	MG/KG			
Lead (Pb)	*	10	10	10.5 - 934	127.43	NA - NA	400	1300	265	MG/KG	1		1
Magnesium (Mg)	N	10	10	121 - 1850	831.30	NA - NA	NA	NA	NA	MG/KG			
Manganese (Mn)		10	10	13.3 - 99.3	48.89	NA - NA	180	4700	302	MG/KG			
Mercury (Hg)	*	8	10	0.06 - 4.1	0.59	0.02 - 0.02	2.3	61	2.6	MG/KG	1		1
Nickel (Ni)		10	10	3 - 38.4	8.92	NA - NA	160	4100	77.1	MG/KG			
Potassium (K)	N	9	10	157 - 1010	727.22	224 - 224	NA	NA	NA	MG/KG			
Selenium (Se)		2	10	0.39 - 0.69	0.54	0.54 - 0.67	39	1000	1.7	MG/KG			

Table 10.25.6.1
Chemicals Present in Site Samples
AOC 551, AOC 552
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Concentration: Residential RBC	Screening Concentration: Industrial RBC	Reference	Units	Number Exceeding: Res. RBC	Number Exceeding: Ind. RB	Number Exceeding: Ref.
Silver (Ag)		2	10	0.24 - 0.27	0.26	0.21 - 0.25	39	1000	NA	MG/KG			
Sodium (Na)	N	9	10	78.9 - 510	201.36	10.7 - 10.7	NA	NA	NA	MG/KG			
Tin (Sn)		5	10	2.8 - 212	47.08	0.76 - 5.7	4700	100000	59.4	MG/KG			1
Vanadium (V)		10	10	2.3 - 21.1	9.61	NA - NA	55	1400	94.3	MG/KG			
Zinc (Zn)		10	10	16.6 - 843	143.76	NA - NA	2300	61000	827	MG/KG			1
Semivolatile Organics													
Anthracene		1	10	88 - 88	88.00	370 - 780	2300000	61000	NA	UG/KG			
Benzo(g,h,i)perylene		5	10	110 - 220	152.00	370 - 780	310000	8200000	NA	UG/KG			
Dibenzofuran		1	10	16 - 16	16.00	370 - 780	31000	820000	NA	UG/KG			
Di-n-butylphthalate		1	10	77 - 77	77.00	370 - 780	780000	20000000	NA	UG/KG			
Fluoranthene		5	10	120 - 280	184.00	370 - 780	310000	8200000	NA	UG/KG			
2-Methylnaphthalene		1	10	88 - 88	88.00	370 - 780	310000	8200000	NA	UG/KG			
Phenanthrene		4	10	93 - 340	170.75	370 - 780	310000	8200000	NA	UG/KG			
Pyrene		7	10	81 - 310	197.57	370 - 720	230000	6100000	NA	UG/KG			
Volatile Organics													
Acetone		4	9	12 - 110	39.50	6 - 12	780000	20000000	NA	UG/KG			
Methylene chloride		2	9	17 - 23	20.00	5 - 6	85000	760000	NA	UG/KG			
Trichlorofluoromethane		1	2	4 - 4	4.00	6 - 6	2300000	61000000	NA	UG/KG			

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

Table 10.25.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 551 and 552
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
551	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
551	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
551	B001	Lead (Pb)	17.90	MG/KG	NA		NA	
551	B001	Mercury (Hg)	0.06	MG/KG	0.0027	100.00	NA	
		Total			0.0027		NA	
551	B002	Antimony (Sb)	ND	MG/KG	NA		NA	
551	B002	B(a)P Equiv.	164.14	UG/KG	NA		2.7182	100.00
551	B002	Lead (Pb)	36.40	MG/KG	NA		NA	
551	B002	Mercury (Hg)	0.07	MG/KG	0.0032	100.00	NA	
		Total			0.0032		2.7182	
551	B003	Antimony (Sb)	0.97	MG/KG	0.0333	90.09	NA	
551	B003	B(a)P Equiv.	173.26	UG/KG	NA		2.8693	100.00
551	B003	Lead (Pb)	74.10	MG/KG	NA		NA	
551	B003	Mercury (Hg)	0.08	MG/KG	0.0037	9.91	NA	
		Total			0.0369		2.8693	
551	B004	Antimony (Sb)	22.20	MG/KG	0.7610	99.46	NA	
551	B004	B(a)P Equiv.	273.45	UG/KG	NA		4.5284	100.00
551	B004	Lead (Pb)	78.80	MG/KG	NA		NA	
551	B004	Mercury (Hg)	0.09	MG/KG	0.0041	0.54	NA	
		Total			0.7651		4.5284	
551	B005	Antimony (Sb)	0.83	MG/KG	0.0285	84.98	NA	
551	B005	B(a)P Equiv.	ND	UG/KG	NA		NA	
551	B005	Lead (Pb)	24.10	MG/KG	NA		NA	
551	B005	Mercury (Hg)	0.11	MG/KG	0.0050	15.02	NA	
		Total			0.0335		NA	
551	B006	Antimony (Sb)	8.50	MG/KG	0.2914	60.86	NA	
551	B006	B(a)P Equiv.	478.63	UG/KG	NA		7.9263	100.00
551	B006	Lead (Pb)	934.00	MG/KG	NA		NA	
551	B006	Mercury (Hg)	4.10	MG/KG	0.1874	39.14	NA	
		Total			0.4788		7.9263	
551	B007	Antimony (Sb)	0.59	MG/KG	0.0202	81.57	NA	
551	B007	B(a)P Equiv.	ND	UG/KG	NA		NA	
551	B007	Lead (Pb)	27.20	MG/KG	NA		NA	
551	B007	Mercury (Hg)	0.10	MG/KG	0.0046	18.43	NA	
		Total			0.0248		NA	

Table 10.25.6.2
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOCs 551 and 552
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
552	B001	Antimony (Sb)	ND	MG/KG	NA		NA	
552	B001	B(a)P Equiv.	ND	UG/KG	NA		NA	
552	B001	Lead (Pb)	10.50	MG/KG	NA		NA	
552	B001	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			NA		NA	
552	B002	Antimony (Sb)	1.00	MG/KG	0.0343	100.00	NA	
552	B002	B(a)P Equiv.	240.14	UG/KG	NA		3.9768	100.00
552	B002	Lead (Pb)	41.70	MG/KG	NA		NA	
552	B002	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			0.0343		3.9768	
552	B004	Antimony (Sb)	0.89	MG/KG	0.0305	88.12	NA	
552	B004	B(a)P Equiv.	8.90	UG/KG	NA		0.1474	100.00
552	B004	Lead (Pb)	29.60	MG/KG	NA		NA	
552	B004	Mercury (Hg)	0.09	MG/KG	0.0041	11.88	NA	
		Total			0.0346		0.1474	

Table 10.25.6.3
Chemicals Present in Site Samples
AOC 551 - Groundwater
NAVBASE - Charleston, Zone E
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection	Average Detected Concentration	Range of SQL	Screening Conc. Residential RBC	Reference	Units	Number Exceeding Res.	Ref.
Deep Wells											
Inogranics											
Arsenic (As)	*	1	1	21.2 - 21.2	21.2	NA - NA	0.045	16.4	UG/L	1	1
Barium (Ba)		1	1	18.7 - 18.7	18.7	NA - NA	260	218	UG/L		
Calcium (Ca)	N	1	1	64200 - 64200	64200	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	1	1	2570 - 2570	2570	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	1	1	4820 - 4820	4820	NA - NA	NA	NA	UG/L		
Manganese (Mn)		1	1	317 - 317	317	NA - NA	84	869	UG/L	1	
Mercury (Hg)		1	1	0.2 - 0.2	0.2	NA - NA	1.1	0.2	UG/L		1
Potassium (K)	N	1	1	3790 - 3790	3790	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	1	65000 - 65000	65000	NA - NA	NA	NA	UG/L		
Volatile Organics											
Tetrachloroethene	*	1	1	2 - 2	2	NA - NA	1.1	NA	UG/L	1	
Trichloroethene	*	1	1	2 - 2	2	NA - NA	1.6	NA	UG/L	1	
Shallow Wells											
Inorganics											
Calcium (Ca)	N	2	2	105000 - 112000	108500	NA - NA	NA	NA	UG/L		
Iron (Fe)	N	2	2	977 - 14600	7788.5	NA - NA	NA	NA	UG/L		
Magnesium (Mg)	N	2	2	14800 - 70400	42600	NA - NA	NA	NA	UG/L		
Manganese (Mn)		2	2	130 - 450	290	NA - NA	84	2560	UG/L	2	
Potassium (K)	N	2	2	8600 - 37700	23150	NA - NA	NA	NA	UG/L		
Sodium (Na)	N	1	2	216000 - 216000	216000	38200 - 38200	NA	NA	UG/L		
Vanadium (V)		1	2	1.1 - 1.1	1.1	1 - 1	26	5.3	UG/L		
Volatile Organics											
Acenaphthene		1	2	2 - 2	2	10 - 10	220	NA	UG/L		

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - micrgrams per kilograms
NA - Not applicable

Table 10.25.6.4
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOCs 551 and 552
NAVBASE-Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Risk (E-06)	% Risk	Hazard Index	% HI
551	G02D	Arsenic	21.20	UG/L	481.8182	99.56	4.5106	98.51
551	G02D	Tetrachloroethene	2.00	UG/L	1.6072	0.33	0.0256	0.56
551	G02D	Trichloroethene	2.00	UG/L	0.5057	0.10	0.0426	0.93
		Total			483.9310		4.5788	
551	G001	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	
551	G002	No COPCs	ND	UG/L	NA		NA	
		Total			NA		NA	

Table 10.25.7.1
Potential Corrective Measures for AOC 551 and AOC 552

Medium	Compounds	Potential Corrective Measures
Soil	Lead 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	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment
Deep Groundwater	Arsenic and tetrachloroethene	a) No Action b) Intrinsic Remediation and Monitoring c) Ex-situ, Chemical and Physical Treatment