N61165.AR.003666
CNC CHARLESTON
5090.3a

DRAFT CORRECTIVE MEASURES STUDY REPORT ZONE A SOLID WASTE MANAGEMENT UNITS 2 AND 38 (SWMU 2 AND 38) CNC CHARLESTON SC
6/21/1999
ENSAFE

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
CTO-029

DRAFT ZONE A, SWMU 2
CORRECTIVE MEASURES STUDY REPORT

AND

DRAFT ZONE A, SWMU 38
CORRECTIVE MEASURES STUDY REPORT

Southdiv Contract Number:
N62467-89-D-0318

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

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

June 21, 1999
Revision No.: 0

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
P.O. BOX 190010
2155 EAGLE DRIVE
NORTH CHARLESTON, S.C. 29419-9010

5090/11
Code 18710
21 June, 1999

Mr. John Litton, P.E.
Director, Division of Hazardous and Infectious Waste Management
SCDHEC-Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Subj: SUBMITTAL OF DRAFT CORRECTIVE MEASURE STUDY REPORT FOR ZONE A, SWMU 2 AND SWMU 38

Dear Mr. Litton:

The purpose of this letter is to submit the enclosed Zone A Corrective Measures Study Reports for SWMU 2 and SWMU 38 for Naval Base Charleston. The report is submitted to fulfill the requirements of condition IV.E.2 of the RCRA Part B permit issued to the Navy by the South Carolina Department of Health and Environmental Control and the U.S. Environmental Protection Agency (USEPA).

The Navy requests that the Department and the USEPA review and provide comment or approval whichever is appropriate. If you should have any questions please contact Billy Drawdy or David Dodds at (843) 743-9985 and (843) 820-5563 respectively.

Sincerely,

W. A. Drawdy FOR

H. N. SHEPPARD II, P.E.
Caretaker Site Officer
by direction

Encl:
(1) Zone A, SWMU 2 and SWMU 38 Corrective Measure Study Reports, June 15 1999

Copy to:
SCDHEC (Paul Bergstrand, Mihar Mehta)
USEPA (Dann Spariosu)
CSO Naval Base Charleston (Billy Drawdy), SOUTHNAVFACENGCOM (Tony Hunt)

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
CTO-029

DRAFT ZONE A, SWMU 2
CORRECTIVE MEASURES STUDY REPORT

AND

DRAFT ZONE A, SWMU 38
CORRECTIVE MEASURES STUDY REPORT

Southdiv Contract Number:
N62467-89-D-0318

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

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

June 21, 1999
Revision No.: 0

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
CTO-029**

DRAFT ZONE A, SWMU 2
CORRECTIVE MEASURES STUDY REPORT

**Southdiv Contract Number:
N62467-89-D-0318**

Prepared for:

**Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina**

Prepared by:

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

**June 21, 1999
Revision No.: 0**

Table of Contents

List of Figures

List of Tables

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

The following abbreviations, acronyms, and units of measurement are used in this report.

AEC	Area of Ecological Concern
BEQ	Benzo(a)pyrene Equivalent
bgs	Below ground surface
BRA	Baseline Risk Assessment
CMS	Corrective Measures Study
CNC	Charleston Naval Complex
CNSY	Charleston Naval Shipyard
COC	Chemical of Concern
CRP	Community Relations Plan
DET	Navy Environmental Detachment
DOT	Department of Transportation
DRMO	Defense Reutilization Marketing Office
E/A&H	EnSafe/Allen & Hoshall
HSWA	Hazardous and Solid Waste Amendments
ISM	Interim stabilization measures
LDR	Land disposal restriction
MCL	Maximum Contaminant Level
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
MNA	Monitored natural attenuation
OSWER	Office of Solid Waste and Emergency Response
O&M	Operations and Maintenance
PCB	Polychlorinated biphenyl
PIP	Public Involvement Plan
PPE	Personal Protective Equipment
ppm	Parts per million
RAB	Restoration Advisory Board
RBC	Risk-Based Concentration
RC	Reference Concentration

ABBREVIATIONS, ACRONYMS, AND SYMBOLS (Continued)

RCRA	Resource Conservation and Recovery Act
RDA	Redevelopment Authority
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RGO	Remedial Goal Option
RIMS	Remediation Information Management System
SCDE	Supercritical Carbon Dioxide Extraction
SCDHEC	South Carolina Department of Health and Environmental Control
SOB	Statement of Basis
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SQL	Sample Quantitation Limit
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
S/S	Solidification/stabilization
TCLP	Toxicity characteristic leaching procedure
TTAL	Treatment Technique Action Level
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WF	Weighting Factor
yd^2	Square yard
yd^3	Cubic yard
$\mu g/kg$	Microgram per kilogram
$\mu g/L$	Microgram per liter

1.0 INTRODUCTION

Combined SWMU 2 encompasses SWMUs 1 and 2 in the northeast portion of Zone A. The two units have been combined because SWMU 1 lies within the confines of SWMU 2, and because the two units will be addressed jointly during corrective measures.

The Navy has contracted Environmental Detachment Charleston to excavate, remove from the site, and properly dispose of all soils containing lead in excess of 400 mg/kg per residential cleanup standards set by the USEPA. However, this Corrective Measures Study (CMS) is provided so that the planned remedy can be compared relative to other potential alternatives capable of achieving similar remedial goals. This Corrective Measures Study (CMS) identifies, screens, develops, evaluates, and compares remedial action alternatives to mitigate hazards and threats to human health and the environment from soil and groundwater contamination at Combined SWMU 2 at the Charleston Naval Complex (CNC) Charleston, South Carolina.

The CMS is being performed under the Resource Conservation and Recovery Act of 1976 (RCRA), based on findings reported in the *Zone A RCRA Facility Investigation Report, NAVBASE Charleston, North Charleston, South Carolina* (EnSafe, 1998). As required by RCRA, the CNC Restoration Advisory Board (RAB) provides a focus for community input to the remedial decision making process. The RAB, which regularly holds open public meetings, consists of community members, regulators, and representatives of the Navy Southern Division (SOUTHDIV) and other CNC project team members.

When the CMS is complete, a Statement of Basis (SOB) that documents the CMS process and presents the preferred site alternative will be made available for public comment to ensure that decision makers are aware of public concerns. The selection of the final remedy for the site could be affected by public input. The primary CNC decision makers include SOUTHDIV, the

South Carolina Department of Health and Environmental Control (SCDHEC), the United States Environmental Protection Agency (USEPA).

This CMS report has been organized according to the format in the Office of Solid Waste and Emergency Response (OSWER) Directive 9902.3-2A, *RCRA Corrective Action Plan* (Final, May 1994):

- **Section 1, Introduction:** This section presents the purpose of this document and summarizes the project.

- **Section 2, Site Description:** This section presents Combined SWMU 2's history and background and the results of previous investigations, including the RCRA Facility Investigation (RFI), baseline risk assessment (BRA), interim stabilization measures (ISM) performed by the Navy Environmental Detachment (DET), and supplemental CMS sampling.

- **Section 3, Remedial Objectives:** This section describes the areas requiring CMS analysis and remedial action objectives. The objectives were developed using RFI characterization and assessments, and by considering applicable requirements and special requests by the CNC project team. This section also presents site remedial goals and volumes and/or areas that require remediation.

- **Section 4, Identification and Screening of Technologies:** This section outlines response actions and identifies and screens remedial technologies that may be used to achieve remedial action objectives.

- **Section 5, Development and Evaluation of Alternatives:** This section evaluates potential remedial alternatives according to the nine evaluation criteria identified in OSWER Directive 9902.3-2A, *RCRA Corrective Action Plan* (Final, May 1994), presenting strengths and weaknesses to prioritize or rank them relative to the nine evaluation criteria.

- **Section 6, Recommendations:** This section assesses the relative performance of the alternatives and presents recommendations.

- **Section 7, Public Involvement Plan:** This section summarizes the public involvement plan as it relates to the CMS.

- **Section 8, References:** This section list applicable references used for the preparation of and/or during the CMS.

- **Section 9, Signatory Requirement:** This section provides the applicable signatory requirement for the CMS.

2.0 SITE DESCRIPTION

2.1 General

Combined SWMU 2 (Figure 2.1), in the northeast corner of Zone A, includes SWMUs 1 and 2. SWMU 1 was used by the Defense Reutilization and Marketing Office (DRMO) to store military property and was confined primarily to former Building 1617. This covered storage shed was used to store hazardous materials prior to their transportation offsite for disposal or reuse. SWMU 2 encompasses SWMU 1 and includes Buildings 1606 and 1649; the area around the rail switch, north and northeast of Building 1640; the former DRMO salvage bin No. 3; and the adjacent paved ground surface. The area was used to store recovered lead from lead-acid submarine batteries from the mid-1960s until 1984. Electrodes and associated internal metallic components were removed from the battery jars in the battery electrode treatment area, SWMU 5 in Zone E, and then placed on a railcar and transferred to the DRMO area for storage and eventual sale to a salvage contractor.

The majority of Combined SWMU 2 consists of open space that is not presently in use. A movie company has a short-term lease on Building 1606. Building 1649 within Combined SWMU 2, as well as Buildings 1627 and 1640 adjacent to SWMU 2, are unoccupied. Carolina Marine Handling occupies Buildings 1604, 1605, and 1607 and the surrounding parking and open storage areas adjacent to the northwest portion of Combined SWMU 2.

According to the Charleston Naval Complex Redevelopment Authority, this area may be used for industrial or residential purposes in the future.

2.2 RFI/CMS Sampling Results

2.2.1 Soil

1986 Sampling Event

Soil samples were collected from the DRMO site in 1986. Because Hurricane Hugo struck the Charleston area in 1989 and could have altered site conditions, the 1986 data were compared to 1993 data. Data from the 1993 investigation and the 1995 RFI showed that the 1986 data no longer reflected current site conditions. Therefore, the data from this 1986 sampling event will not be considered during the CMS.

1993 Sampling Event

Twenty-four upper-interval soil samples and 22 lower-interval soil samples were collected from 25 soil borings to investigate soil contamination near this Combined SWMU. This investigation was conducted by EnSafe/Allen & Hoshall (E/A&H) and the data are of sufficient quality to be included in the CMS process.

1995-1997 Sampling Event

Zone A second round sampling included 41 upper-interval soil samples and 35 lower-interval soil samples collected from Combined SWMU 2. Sixteen soil boring samples were delayed until 1997 to accommodate Charleston Naval Shipyard (CNSY) Radiological Control Office radiological surveys in the area. Three sediment samples were also collected for metals analysis from the wetland southwest of Combined SWMU 2 during this sampling round. Because this wetland area dried out after a leaking underground water line was repaired, these samples have been reported with the soil sample results.

1998 Sampling Event

At the request of the Navy, the DET collected additional samples to further delineate lead in surface soil.

1986-1998 Soil Sampling Summary

Extensive surface soil samples collected from Combined SWMU 2 from 1986 to the present defined an extensive area of lead contamination in surface soil. Aluminum, antimony, Aroclor-1260, arsenic, BEQs, copper, and thallium were also identified as chemicals of concern (COCs) in surface soil. Table 2.1 combines and summarizes sampling results from the 1993, 1995, and 1998 sampling events for all the COCs except lead. Figures 2.2 and 2.3 illustrate lead sampling results.

Lead concentrations in surface soil from the 1993, 1995, and 1998 sampling events were combined. Figure 2.2 shows concentrations for upper-interval samples; and Figure 2.3 shows lower-interval samples. At large areas of the site, lead exceeds regulatory standards (400 milligrams/kilograms [mg/kg] for residential reuse; 1,300 mg/kg for industrial reuse) and is the primary COC at this site based on USEPA blood-level modeling.

In general, grid samples collected by the DET appear to correlate with RFI sampling results. However, lead samples collected in the southwest area of the site near the former intermittent wetland varied significantly between the 1998 DET event and previous events. Five sediment samples collected from this intermittent wetland area during the 1995 RFI contained lead from 441 to 1,500 mg/kg. Of 60 samples collected by the DET in 1998, the maximum concentration was 120 mg/kg. Only one physical change is known to have occurred in site conditions. The area was saturated during 1995 sampling due to an underground water line leak, and the area was dry during 1998 due to repairs done on the leaking line.

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (µg/kg)	Aroclor - 1260 (µg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590[a]**	**NA**	**ND**
001SB00101		10-Oct-95	2730	0.9 U	12 UJ	2 J	ND	14 U	0.88 U
002M000101	(sed)	11-Oct-95	13400	4.4	13 U	7	NS	NS	0.99 U
002M000201	(sed)	11-Oct-95	14700	7.8	16 U	45	NS	NS	1.2 U
002M000301	(sed)	29-Mar-96	11300	19.6	12 J	125	NS	NS	1.1 U
002M000401	(sed)	29-Mar-96	3000	18.3	7 J	103	91	500	1.2 J
002M000501	(sed)	29-Mar-96	27000	9.0	2 J	100	NS	NS	1.6 U
002SB00101		10-Oct-95	9190	9.9	12 U	54	NS	NS	0.98 U
002SB00101	(dup)	10-Oct-95	7260	12.7	13 UJ	80	NS	NS	0.98 U
002SB00201		10-Oct-95	5400	3.3	12 U	8	NS	NS	0.94 U
002SB00201	(dup)	10-Oct-95	6810	3.7	12 UJ	8	NS	NS	0.95 U
002SB00301		10-Oct-95	14000	8.5	13 UJ	4 J	NS	NS	1 U
002SB00401		10-Oct-95	11000	8.5	12 UJ	19	NS	NS	0.92 U

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (μg/kg)	Aroclor - 1260 (μg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590***	**NA**	**ND**
002SB00501		10-Oct-95	10200	5.8	12 UJ	9	NS	NS	0.9 U
002SB00601		10-Oct-95	17400	15.4	13 UJ	27	NS	NS	1.1 U
002SB00701	(dup)	10-Oct-95	4490	4.6	10 U	181	NS	NS	0.82 U
002SB00701		10-Oct-95	5870	3.9	10 UJ	126	NS	NS	0.82 U
002SB00801		10-Oct-95	10000	3.5	12 UJ	6 J	NS	NS	0.93 U
002SB00901		10-Oct-95	5630	9.5	18 J	108	NS	NS	0.97 U
002SB01001		10-Oct-95	9290	2.7	12 UJ	14	NS	NS	0.93 U
002SB01101		10-Oct-95	12800	9.3	12 UJ	14	NS	NS	0.93 U
002SB01201		10-Oct-95	11600	5.6	11 UJ	9	NS	NS	0.86 UJ
002SB01301	(dup)	10-Oct-95	11100	6.1	11 U	11	NS	NS	0.88 U
002SB01301		10-Oct-95	10700	5.0	11 UJ	14	NS	NS	0.86 U
002SB01401		10-Oct-95	9330	2.6	13 UJ	15	NS	NS	0.99 U

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (µg/kg)	Aroclor - 1260 (µg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590[a]**	**NA**	**ND**
002SB01501		10-Oct-95	3240	14.5	13 J	101	NS	NS	1 U
002SB01601	(dup)	30-Jan-97	6450	3.6 U	1 U	27 J	NS	NS	1.5
002SB01601		30-Jan-97	8190	6.2	3 U	90 J	NS	NS	2.8
002SB01701		30-Jan-97	2860	2.1 U	2 U	3	NS	NS	0.41 U
002SB01801		30-Jan-97	8780	7.1	1 U	2 J	NS	NS	2.3
002SB01901		10-Oct-95	10100	7.1	11 UJ	4 J	NS	NS	0.89 U
002SB02001		29-Jan-97	7380	5.6	54	120	NS	NS	0.6 J
002SB02101	(dup)	29-Jan-97	7000	4.5	7	23	NS	NS	0.39 U
002SB02101		29-Jan-97	5920	3.8	5 J	19	NS	NS	0.69 J
002SB02201		28-Jan-97	7050	3.5	8	33	NS	NS	0.38 U
002SB02301		10-Oct-95	5780	29.4	12 UJ	70	NS	NS	0.92 U
002SB02401		10-Oct-95	13300	7.7	12 UJ	7	NS	NS	0.94 U

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (μg/kg)	Aroclor - 1260 (μg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590***	**NA**	**ND**
002SB02501		10-Oct-95	7260	5.9	11 UJ	6	NS	NS	0.87 U
002SB02601		10-Oct-95	8140	11.0	12 UJ	23	NS	NS	0.92 U
002SB02701		10-Oct-95	1280	2.5	11 UJ	5 J	NS	NS	0.85 U
002SB02801		09-Oct-95	40100	21.5	56 U	174	NS	NS	4.4 U
002SB02901		09-Oct-95	12100	13.6	28 U	130	NS	NS	2.3 U
002SB03001		29-Mar-96	4360	2.4	0 UJ	6	NS	NS	0.39 U
002SB03101		30-Jan-97	8540	3.0 U	0 U	2 J	NS	NS	1.1 J
002SB03301		28-Jan-97	5830	8.3	1 J	12	NS	NS	0.49 J
002SB03401		28-Jan-97	4120	2.7	3 J	55	NS	NS	0.4 U
002SB03501		29-Jan-97	5060	0.9 J	3 J	3	NS	NS	0.41 U
002SB03601		29-Jan-97	7540	7.9	470	549	NS	NS	0.42 U
002SB03701		29-Jan-97	6270	21.5	2 J	475	NS	NS	0.5 U

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (μg/kg)	Aroclor - 1260 (μg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590[a]**	**NA**	**ND**
002SB03801	(dup)	29-Jan-97	7360	6.4	4 J	49 J	NS	NS	0.48 J
002SB03801		29-Jan-97	6320	7.5	3 J	25 J	NS	NS	0.41 U
002SB03901		28-Jan-97	10700	9.2	3 J	16	NS	NS	1.5
002SB04001		29-Jan-97	8300	3.3	0 J	1 J	NS	NS	0.4 U
002SB04101		29-Jan-97	7500	6.1	0 J	1 J	NS	NS	0.38 U
S01SB00101		06-Oct-93	2500	1.1 UJ	6 UJ	3 UJ	NS	NS	1.1 UJ
S01SB00201		27-Oct-93	7630	9.4	18 J	443 J	148	39 U	1.2 U
S02M000101	(sed)	25-Oct-93	9100	17.0 J	10 J	230	NS	NS	1.2 U
S02M000201	(sed)	25-Oct-93	4600	6.4 J	6 UJ	290	NS	NS	1.2 UJ
S02M000301	(sed)	25-Oct-93	6600	18.0 J	7 UJ	92	NS	NS	1.5 UJ
S02M000401	(sed)	25-Oct-93	1400	5.5 J	8 UJ	29	NS	NS	1.6 U
S02M000501	(sed)	25-Oct-93	2600	5.1 J	7 UJ	3 U	NS	NS	1.3 UJ

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (μg/kg)	Aroclor - 1260 (μg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590[a]**	**NA**	**ND**
S02M000601	(sed)	25-Oct-93	1000	2.0 J	7 UJ	14	NS	NS	1.4 UJ
S02M000701	(sed)	25-Oct-93	1300	1.3 UJ	6 UJ	4	NS	NS	1.3 U
S02M000801	(sed)	25-Oct-93	560	1.3 UJ	7 UJ	3	NS	NS	1.3 U
S02M000901	(sed)	25-Oct-93	620	1.2 UJ	6 UJ	6	NS	NS	1.2 U
S02M001001	(sed)	25-Oct-93	1400	2.7 UJ	7 UJ	4	NS	NS	1.4 U
S02M001101	(sed)	25-Oct-93	4600	4.7 J	13 UJ	22	NS	NS	2.5 U
S02SB00101		05-Oct-93	4300	7.6 J	6 UJ	44 J	NS	NS	1.2 UJ
S02SB00201		06-Oct-93	6100	3.2	6 UJ	10	NS	NS	5.8 UJ
S02SB00301		06-Oct-93	5600	2.8	5 UJ	7	NS	NS	1.1 UJ
S02SB00501		07-Oct-93	5400	2.1	6 UJ	20	NS	NS	1.1 UJ
S02SB00601	(dup)	06-Oct-93	5780 J	23.5 J	6 UJ	19	NS	NS	1.2 UJ
S02SB00601		06-Oct-93	8200	3.9	6 UJ	13	NS	NS	1.2 UJ

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (μg/kg)	Aroclor - 1260 (μg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590[a]**	**NA**	**ND**
S02SB00701		06-Oct-93	5700	7.1	6 UJ	75	NS	NS	1.1 UJ
S02SB00801		06-Oct-93	3000	8.4	6 UJ	12	NS	NS	5.9 UJ
S02SB00901		06-Oct-93	2700	12.0	11 J	52	NS	NS	1.1 UJ
S02SB01001		06-Oct-93	8300	12.0	6 UJ	17	NS	NS	1.2 UJ
S02SB01101		06-Oct-93	4400	20.0	40 J	140	NS	NS	1.3 UJ
S02SB01201		07-Oct-93	5400	3.6	6 UJ	34	NS	NS	1.1 UJ
S02SB01301		07-Oct-93	1800	5.2 J	6 UJ	19	NS	NS	5.5 U
S02SB01401		07-Oct-93	3700	2.2 J	6 UJ	9	NS	NS	1.2 U
S02SB01501		25-Oct-93	3800	6.9 J	9 J	180	NS	NS	1.1 UJ
S02SB01601	(dup)	26-Oct-93	3790	2.7	5 UJ	485 J	NS	NS	1.1 UJ
S02SB01601		26-Oct-93	4500	2.8 J	23 J	1500	NS	NS	1.1 UJ
S02SB01701		26-Oct-93	7500	2.3 J	6 UJ	9	NS	NS	1.8 U

Table 2.1
Surface Soil Data for COCs AT SWMU 2

Sample Number	(Type)	Date	Aluminum (mg/kg)	Arsenic (mg/kg)	Antimony (mg/kg)	Copper (mg/kg)	BEQs (μg/kg)	Aroclor - 1260 (μg/kg)	Thallium (mg/kg)
Risk Based Screening Level			**78000**	**0.43**	**31**	**3100**	**NC**	**320**	**5.5**
Background			**12800**	**9.44**	**ND**	**165**	**590[a]**	**NA**	**ND**
S02SB01801		26-Oct-93	1500	20.0 J	8 J	100	NS	NS	1.1 U
S02SB01901		26-Oct-93	6500	1.3 U	5 UJ	3	NS	NS	1.1 U
S02SB02001		26-Oct-93	3400	4.1	6 UJ	7	NS	NS	5.8 U
S02SB02101		26-Oct-93	1300	9.9	6 UJ	20	NS	NS	1.2 UJ
S02SB02201		26-Oct-93	3000	4.6	5 UJ	11	NS	NS	1.1 U
S02SB02301		26-Oct-93	2800	1.0 U	5 UJ	3 U	NS	NS	1 UJ

Notes:

NA — Not Applicable
ND — Not Detected
NC — Not Calculated
NS — Sample Not Analyzed
J — Estimated Value
U — Undetected
a — Proposed background for benzo(a)pyrene equivalents (BEQ)
sed — Sediment sample
dup — Duplicate sample

Aluminum and **copper** exceeded their background reference concentrations in only one lower-interval sample each (S02SB01602 and 002SB03702, respectively), but neither sample exceeded a regulatory risk or hazard value requiring remedial action.

Antimony exceeded its risk-based concentration (RBC) in three upper-interval sample boring locations — S02SB011, 002SB020, and 002SB036. Antimony exceeded its soil screening level (SSL) in two lower-interval soil samples — 002SB013 and 002SB036.

Arsenic was detected in 18 upper-interval and two lower-interval soil samples at concentrations exceeding its RBC (0.43 mg/kg) and its background reference concentration (9.4 mg/kg). Figure 2.4 shows all upper-interval soil data for arsenic at this site. When compared to the lead distribution figures, arsenic exceeds its background concentration in many areas outside lead contamination zones; however, most arsenic contamination appears to be concentrated in lead-contaminated areas.

Aroclor-1260 and **Benzo(a)pyrene Equivalents (BEQs)** exceeded their residential RBCs in three of five samples collected and analyzed for pesticides, polychlorinated biphenyls (PCBs), and semivolatile organic compounds (SVOCs) at Combined SWMU 2. However, the detections were estimated values less than the laboratory quantitation limit.

Mercury exceeded its SSL (1.0 mg/kg) in only four of 134 upper-and lower- interval soil samples at Combined SWMU 2. Three of these sample points (S02SB011, -021, and -020) will be removed as part of DET lead removal activities. The only point not scheduled for removal is S02SB022 (1.3 mg/kg). Because this point is isolated among many other points where mercury was either present below 1.0 mg/kg or not detected at all, and because mercury was not detected in groundwater at this site, mercury in soil does not appear to be a threat to groundwater at this site. Therefore, mercury will not be further addressed in this CMS.

Thallium (Figure 2.5) was detected only in samples collected during the 1997 sampling event. Of 16 upper-interval samples, nine contained thallium ranging from 0.5 to 2.3 mg/kg — some exceeded the minimum surface soil 0.1 residential hazard level of 0.58 mg/kg. Seven of 14 lower-interval samples, ranging from 0.4 to 3.3 mg/kg, exceeded the groundwater protection SSL of 0.35 mg/kg.

2.2.2 Groundwater

Six shallow monitoring wells were installed in 1993 to investigate groundwater contamination near the Combined SWMU. One well (002GW005) was destroyed in 1997 and replaced in 1998 (002GW007). Another well (002GW008) was installed in 1998 to assess groundwater quality east of former well 002GW005. Table 2.2 summarizes groundwater data for RFI groundwater COCs.

During RFI sampling, arsenic, lead, manganese, and silver exceeded tap-water RBCs in shallow groundwater; however, these COCs appeared inconsistently through five rounds of sampling and/or were not present site wide. In four rounds of RFI sampling beginning in 1995, arsenic never exceeded its Maximum Contaminant Level (MCL) and exceeded its reference concentration (RC) in only one well during only one sampling round. Lead has no MCL but was detected in one well (002GW005) at concentrations exceeding the USEPA Treatment Technique Action Level (TTAL) of 15 μg/L. Manganese exceeded both the RC and the RBC in one well (002GW002). Silver exceeded its MCL in one well in only one sampling event.

During 1998 CMS sampling, wells 002GW002, -003, -004, -007, and -008 were sampled to further assess trends in manganese and lead concentrations (Figures 2.6 and 2.7). Wells 002GW003, -004, -007, and -008 did not contain any metals above background, regulatory, or risk-based concentrations requiring action. Well 002GW002 contained manganese above the RBC.

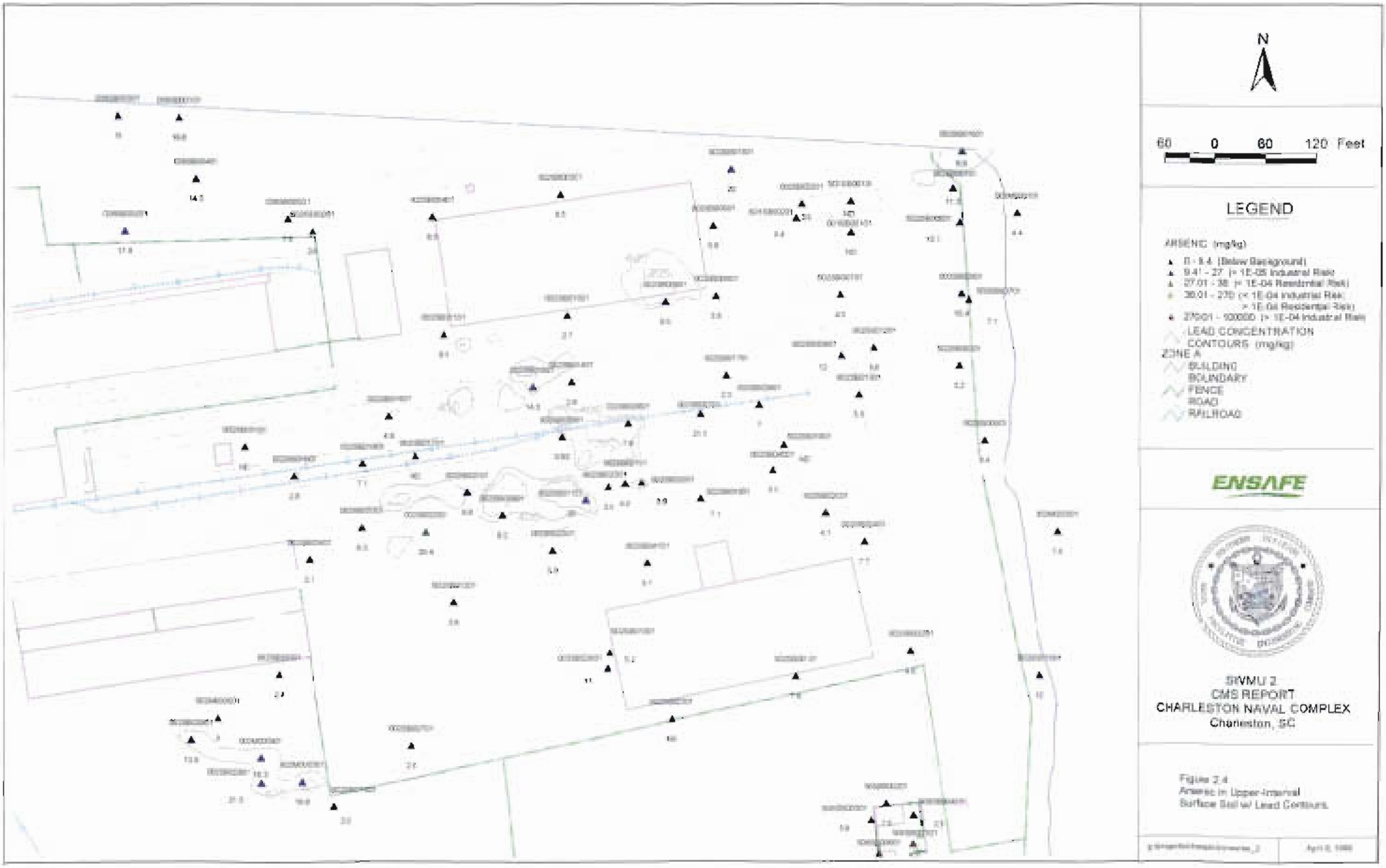


Figure 2.4
Arsenic in Upper-Interval
Surface Soil w/ Lead Contours

Table 2.2
Groundwater Data for COCs at SWMU 2

Sample Number	Date	Manganese (μg/L)	Silver (μg/L)	Arsenic (μg/L)	Lead (μg/L)
MCL		**NA**	**NA**	**50**	**15 (TTAL)**
Risk Based Screening Level		**730**	**180**	**0.045**	**NA**
Background		**577**	**ND**	**7.4**	**4.7**
002GW00101	15-Nov-93	51	10 U	10 U	5 U
002GW00102	22-Apr-96	496	7 U	2 U	2 U
002GW00103	20-Jun-96	1990	6 U	2 U	2 U
002GW00104	07-Oct-96	219	1 U	2 U	1 U
002GW00201	15-Nov-93	3370 J	10 U	10 UJ	5 UJ
002H000201	15-Nov-93	3300 J	10 U	10 UJ	5 UJ
002GW00202	23-Apr-96	3350	7 U	2 U	2 U
002GW00203	19-Jun-96	3000	6 U	2 U	3 J
002GW00204	04-Oct-96	3410	1 U	2 U	1 U
002GW002C1	15-Oct-98	2450 J	5	1 U	1 U
002GW00301	15-Nov-93	320	10 U	10 U	5 U
002GW00302	22-Apr-96	291	7 U	2 U	2 U
002GW00303	19-Jun-96	307	6 U	2 U	2 U
002GW00304	04-Oct-96	294	1 U	2 J	2 U
002GW003C1	15-Oct-98	280 J	5 U	4 J	1 U
002GW00401	15-Nov-93	150	10 U	10 U	5 U
002GW00402	23-Apr-96	119	7 U	7 U	2 U
002GW00403	19-Jun-96	168	6 U	5 J	2 U
002GW00404	04-Oct-96	241	40	10 J	1 U
002GW004C1	15-Oct-98	128 J	5 U	7 J	1 U

Table 2.2
Groundwater Data for COCs at SWMU 2

Sample Number	Date	Manganese (μg/L)	Silver (μg/L)	Arsenic (μg/L)	Lead (μg/L)
MCL		**NA**	**NA**	**50**	**15 (TTAL)**
Risk Based Screening Level		**730**	**180**	**0.045**	**NA**
Background		**577**	**ND**	**7.4**	**4.7**
002GW00501	15-Nov-93	510	10 U	89	910 J
002H000501	15-Nov-93	279 J	10 U	30	368
002GW00502	23-Apr-96	28 U	7 U	2 U	19
002GW00503	20-Jun-96	28 U	6 U	2 U	2 U
002GW00601	15-Nov-93	160	10 U	10 U	5 U
002GW00602	23-Apr-96	29 U	7 U	2 U	2 J
002GW00603	20-Jun-96	25 U	6 U	2 U	2 U
002GW00604	07-Oct-96	27	1 U	2 U	1 U
002GW007C1	19-Oct-98	130	5 U	5 J	12
002GW008C1	19-Oct-98	536	5 U	1 J	1 U

Notes:

MCL	—	Maximum Contaminant Level
NA	—	Not Applicable
ND	—	Not Detected
J	—	Estimated Value
U	—	Undetected
TTAL	—	Treatment Technique Action Level

Lead in groundwater near well 002GW005 appears to be isolated in that area and may be linked to very high lead concentrations in the surrounding soil. Concentrations decreased dramatically following well redevelopment in 1996, and 1993 levels may have been caused by previously poor well development or suspended solids in water samples induced by sampling methods. This well has since been damaged and abandoned, but it was located near the area of highest lead soil concentrations. The suspected soil source of this past groundwater contamination will be addressed with corrective measures. Lead did not exceed its Zone A background concentration (4.7 μg/L) in any of the other five Combined SWMU 2 wells.

2.2.3 Sediment

1993 Sampling Event

Eleven sediment samples, seven from the Cooper River and four from the nearby storm sewer system, were collected in 1993 to investigate sediment contamination near this Combined SWMU. These samples were submitted for metals and cyanide analyses. Lead concentrations ranged from 4.0 to 47.0 mg/kg for the Cooper River samples and from 88.0 to 1000.0 mg/kg for the storm sewer samples.

1995 Sampling Event

The *Final Zones A and B RFI Work Plan* (E/A&H 1995) proposed collection of two sediment samples from the Cooper River for metals analyses as "duplicates" of the 1993 sampling event. These samples were analyzed for metals and organotins. Lead concentrations for these two samples were 15.0 mg/kg and 26.0 mg/kg.

During Zone A second round sampling of the intermittent wetland southwest of Combined SWMU 2, three sediment samples were collected for metals analysis. This wetland area dried out after a leaking underground water line was repaired. These samples are now considered soil samples because the wetland no longer contains surface water.

2.2.4 Surface Water

No surface water concerns were identified during the RFA or subsequent investigations of this site. Therefore, surface water at Combined SWMU 2 was not sampled.

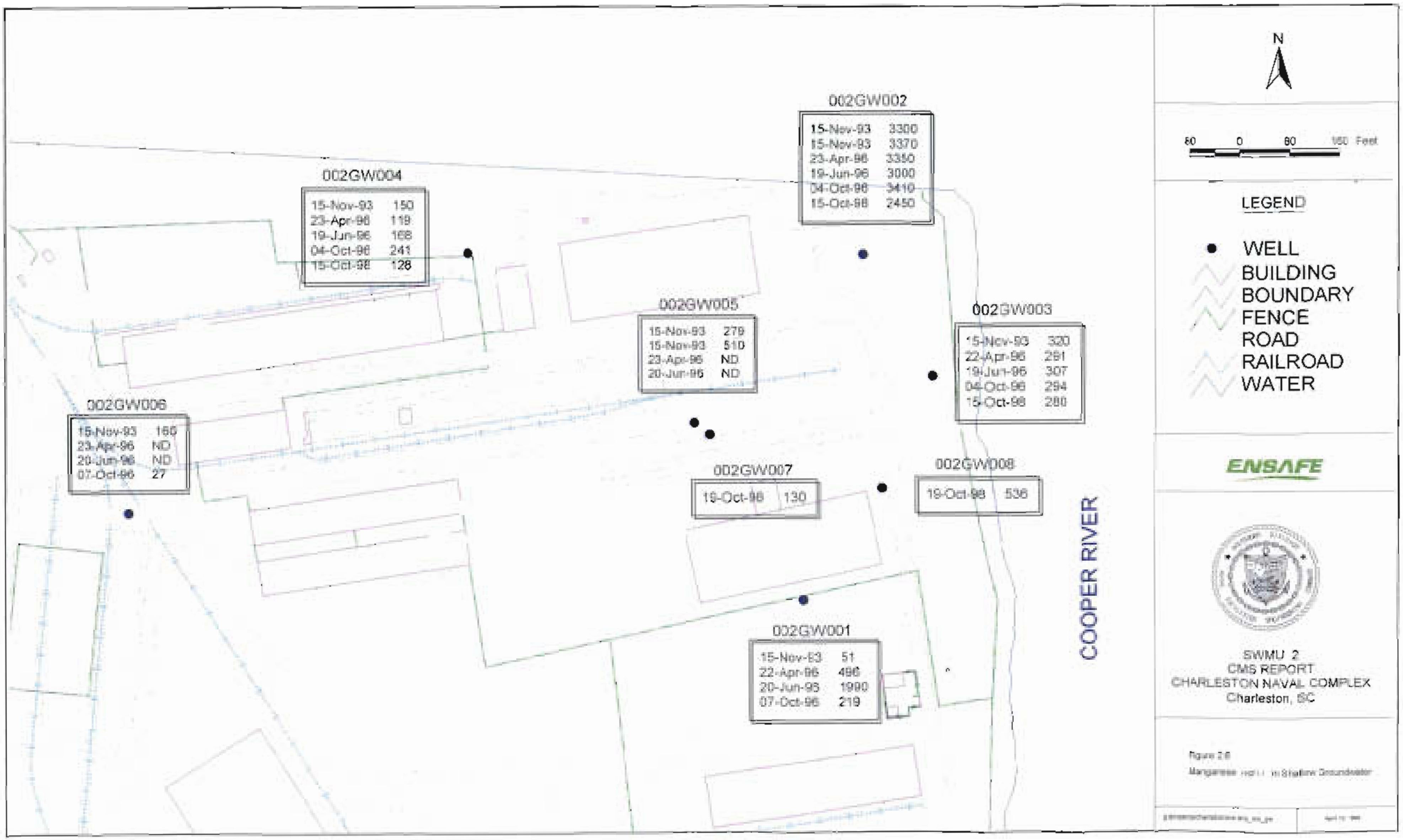
2.3 Interim Stabilization Measures

The DET collected additional soil samples in 1998 to further delineate the area of lead-contaminated soil at Combined SWMU 2 likely to require remedial action under either residential or industrial reuse (400 parts per million [ppm] or 1,300 ppm lead). No other interim measures have been taken. However, the DET is planning remove all SWMU 2 soils containing greater than 400 ppm lead.

2.4 Ecological Subzone A-1

The Zone A RFI conditional approval letter required that concerns at ecological subzone A-1 (AEC-1-1) be further addressed in the CMS. AEC-1-1 is located in the southwest corner of SWMU 2 in an area formerly kept moist by a nearby leaky water pipe. The leaks have reportedly since been repaired, and AEC-1-1 is now similar to other non-wetland, non-mowed grassy areas found at the complex. Parts of this area will also be excavated as part of DET lead cleanup activities. Therefore, this area no longer appears to be causing a potential threat to ecological receptors and will not be further addressed in this CMS.

Figure 2.5
Thallium in Lower-Interval Surface Soil



N
80 0 80 160 Feet
LEGEND
WELL
BUILDING
BOUNDARY
FENCE
ROAD
RAILROAD
WATER
002GW002
15-Nov-93 3300
15-Nov-93 3370
23-Apr-96 3350
19-Jun-96 3000
04-Oct-96 3410
15-Oct-98 2450
002GW004
15-Nov-93 150
23-Apr-96 119
19-Jun-96 168
04-Oct-96 241
15-Oct-98 128
002GW005
15-Nov-93 279
15-Nov-93 510
23-Apr-96 ND
20-Jun-96 ND
002GW003
15-Nov-93 320
22-Apr-96 291
19-Jun-96 307
04-Oct-96 294
15-Oct-98 280
002GW006
15-Nov-93 160
23-Apr-96 ND
20-Jun-96 ND
07-Oct-96 27
002GW007
19-Oct-98 130
002GW008
19-Oct-98 536
002GW001
15-Nov-93 51
22-Apr-96 496
20-Jun-96 1990
07-Oct-96 219
COOPER RIVER
ENSAFE
SWMU 2
CMS REPORT
CHARLESTON NAVAL COMPLEX
Charleston, SC

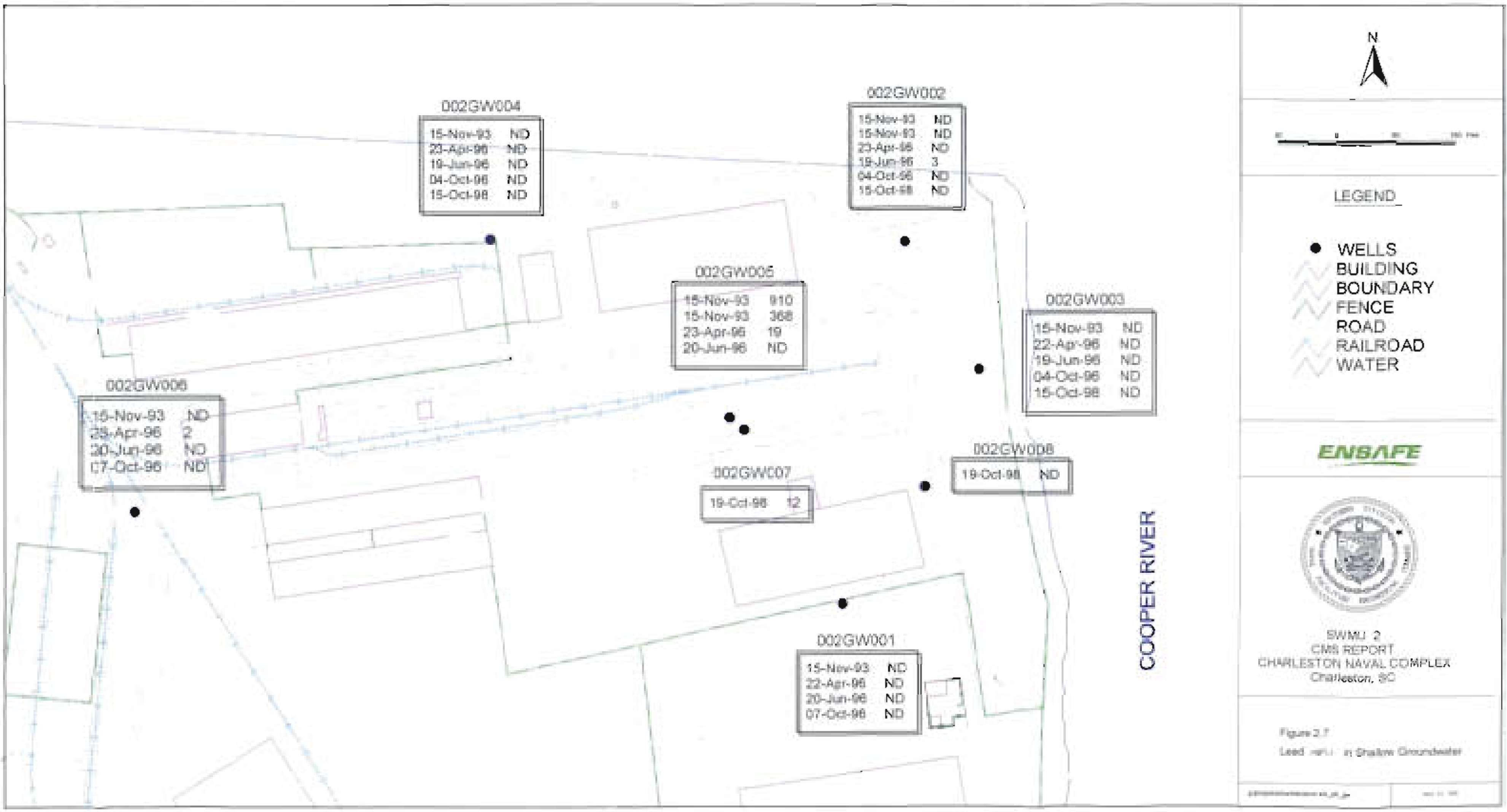


Figure 2.7
Lead in Shallow Groundwater

3.0 REMEDIAL OBJECTIVES

To improve the focus of this CMS, this section summarizes the remedial objectives for soil and groundwater contamination at this site. In some cases, remedial objectives presented in the RFI have been modified due to superceding information such as background concentrations or achievable laboratory instrument detection capabilities. In other cases, this section justifies removing COCs identified in the RFI based on a lack of significant risk or hazard.

3.1 Soil Remedial Objectives

Lead is the primary COC at this site. However, aluminum, antimony, Aroclor-1260, arsenic, BEQs, copper, and thallium also require mention in this CMS because at least one soil sample collected during the RFI exceeded a project team criteria. In some cases, these criteria were not the exceedance of a regulatory or risk-based concentration, but rather an exceedance of background concentrations or other subjective target.

Lead exceeded residential and industrial cleanup goals of 400 and 1,300 mg/kg over an extensive area of the site. These remedial objectives are based on USEPA blood-level modeling and have been accepted by the project team.

Aluminum and **copper** were originally included in the CMS process because one of 57 lower-interval soil samples contained these compounds at concentrations exceeding their background reference concentrations (RC). However, neither exceeded its lower-interval residential risk and hazard-based soil screening concentrations (RBC). Moreover, because background concentrations represent a 95% confidence interval, 5% of samples collected at random would be expected to exceed the background concentration. Therefore, remedial objectives are not needed for either compound and they will not be further addressed in this CMS.

Arsenic was detected in 18 upper-interval and two lower-interval soil samples at concentrations exceeding its RBC (0.43 mg/kg) and its background reference concentration (9.44 mg/kg). However, several factors influence arsenic remedial objectives at this site:

- Arsenic has a background reference concentration of 9.44 mg/kg. This value corresponds to a residential hazard quotient of approximately 0.4, a residential risk of 2.5E-05, an industrial hazard quotient below 0.1, and an industrial risk of 3.6E-06. This CMS will not evaluate alternatives to achieve concentrations below background.

- Arsenic remedial goal options (RGOs) presented in the RFI are more conservative under risk-based than hazard-based scenarios. Therefore, the arsenic RGOs will be evaluated only for risk-based scenarios.

- The DET is scheduled to remove much of the arsenic contaminated soils where they coincide with lead contamination in excess of 400 mg/kg. This activity will reduce site risk due to arsenic to 2.3E-05 residential which is below the calculated Zone A inorganic background risk due to arsenic (4.1E-05 residential).

Antimony exceeded its RBC in four sample boring locations — S02SB011, and 002SB-013, -020, and -036. Boring locations -011, -020 and -036 coincide with areas where lead exceeded industrial cleanup concentrations (1,300 mg/kg) and will be indirectly addressed as part of lead cleanup activities. Sample point -013 lies outside the area of lead contamination. A lower-interval sample (12.7 mg/kg) from this point exceeded the antimony residential groundwater protection SSL of 2.7 mg/kg. However, antimony will not be directly addressed as part of this CMS for the following reasons:

- All surface soil samples containing antimony contamination exceeding its surface soil 0.1 residential hazard RGO of 2.9 mg/kg are within the area where lead contamination exceeded 1,300 mg/kg. Therefore, antimony surface soil contamination in these areas will be indirectly addressed as part of the larger lead plume.

- Because antimony was not detected in any groundwater samples collected at Combined SWMU 2, site-specific data indicate that the subsurface soil groundwater protection SSL of 2.7 mg/kg may be overly conservative. This SSL was based on several conservative assumptions that support this possibility, one being large areal coverage at that specific concentration. Antimony exceeded the SSL in sample point 002SB013; however, antimony was not detected in nearby sample location 002SB026. This indicates that antimony in 002SB013 is not part of some larger mass of antimony-containing soil and therefore does not indicate a significant threat to groundwater.

Aroclor-1260 and **BEQs** exceeded their residential RBCs in three of five samples collected and analyzed for pesticides, PCBs, and SVOCs at Combined SWMU 2. Lead concentrations near the BEQ exceedance in the southeast part of the site (002M000401) sample also exceeded residential cleanup criteria; therefore, this contamination will be addressed in conjunction with lead cleanup activities. The other two BEQ hits were estimated values below the laboratory quantitation limit and do not appear to be representative of a spill or other acute BEQ release.

Thallium exceeded its groundwater protection SSL (0.35 mg/kg) in seven of 60 lower-interval soil samples (range 0.4 to 3.3 mg/kg, mean 1.2 mg/kg) and exceeded the minimum 0.1 residential hazard concentration of 0.58 mg/kg in 10 of 89 surface soil samples (range 0.5 to 2.8 mg/kg, mean 1.3 mg/kg). However, thallium will not be addressed as part of this CMS for the following reasons:

Surface Soils:

- A remedial goal of 0.58 mg/kg thallium in lower-interval soil may not be feasible due to achievable laboratory sample quantitation limits (SQLs). Thallium SQLs for lower-interval soil samples in Zone A averaged 1.0 mg/kg, with a standard deviation of ±0.8.

- Five of the ten 1997 lower-interval detections were estimated values detected below the SQL. These detections are from soil samples nested within areas that previously had no thallium detections.

- Four of the detections exceeding the mean SQL were within 2 standard deviations (the 95% Upper Tolerence Limit [UTL]) of the mean. Therefore, these detections are within the range of the Zone A SQL for thallium and are not significantly different from the SQL.

- Only one sample exceed the 95% UTL for the SQL. This detection (2.8 mg/kg) barely exceeded the 95% UTL (2.6 mg/kg). However, by statistical design, up to 5% of the samples could be expected to exceed the 95% UTL.

- The concentration and distribution of detections show no obvious interconnection or other indications that thallium is present in soils due to a release. Instead, the random distribution across the site at similar concentrations indicates that thallium may be naturally present at concentrations exceeding 0.58 mg/kg.

- The maximum surface soil detection of 2.8 mg/kg corresponds to a residential point hazard of only 0.5, which falls within the potentially acceptable range or 0.1 to 3.

Subsurface Soils:

- Thallium was not detected in any groundwater samples collected at Combined SWMU 2; therefore, site-specific data indicate that the groundwater protection SSL may be overly conservative.

- A remedial goal of 0.35 mg/kg thallium in lower-interval soil may not be feasible due to achievable laboratory SQLs. Thallium SQLs for lower-interval soil samples in Zone A averaged 1.2 mg/kg with a standard deviation of ± 1.3.

- Five of the seven 1997 lower-interval detections were estimated values detected below the SQL. These detections are from soil samples nested within areas that previously reported no thallium detections.

- Two detections exceeded the mean SQL. However, neither exceeded the SQL mean plus 2 standard deviations (the 95% UTL). Therefore, these detections are within the range of the Zone A SQL for thallium and are not significantly different from the SQL.

- The concentration and distribution of detections show no obvious interconnection or other indications that thallium is present in soils due to a release. Instead, the random distribution across the site of similar concentrations indicates that thallium may be naturally present at concentrations exceeding 0.35 mg/kg.

Table 3.1 summarizes remedial objectives for Combined SWMU 2.

Table 3.1
Combined SWMU 2 Soil Remedial Goal Objectives

	Residential		Industrial	
RFI COC	**Concentration (mg/kg)**	**Criteria**	**Concentration (mg/kg)**	**Criteria**
Lead	400	USEPA Blood Concentration Model	1,300	USEPA Blood Concentration Model
Aluminum	NA[a]		NA[a]	
Antimony	NA[a]		NA[a]	
Aroclor-1260	NA[b]		NA[b]	
Arsenic	9.44	Background	9.44	Background
BEQs	NA[b]		NA[b]	
Copper	NA[a]		NA[a]	
Thallium	NA[a]		NA[a]	

Notes:
[a] — No RGO is needed for this RFI COC for reasons outlined in the above text.
[b] — Aroclor and BEQs were found only in areas where lead exceeded its remedial objective concentrations. Therefore, these compounds will be addressed as part of lead cleanup activities.

3.2 Groundwater Remedial Objectives

Lead, silver, arsenic, and manganese were identified as groundwater COCs in the RFI. Lead did not exceed its TTAL in the most recent round of sampling, and the suspected soil source material for the previously observed groundwater contamination will be addressed during corrective actions at this site. Silver did not exceed its MCL in the most recent round of sampling for that compound, and neither did arsenic.

Of the four shallow groundwater COCs identified in the RFI for this site, only manganese consistently exceeded its screening criteria. However, manganese need not be addressed by corrective action for the following reasons:

- There were not enough sample points to parametrically determine background values for manganese in groundwater in Zone A. Therefore, the maximum observed background sample value (0.58 mg/L in shallow groundwater and 2.7 mg/L in deeper groundwater) was approved by the project team for use as the reference background concentration. Concentrations above shallow background were consistently detected in only well 002GW002, and these concentrations were comparable to deeper background. Because the shallow and deeper aquifer zones in Zone A appear to be interconnected, the high concentrations seen in well 002GW002 may likely be attributed to deeper aquifer background concentrations. The concentrations detected were also comparable to shallow background values found elsewhere at the Charleston Naval Complex (Zone C 0.6 mg/L; Zone E 2.6 mg/L; Zone F 2.0 mg/L; Zone G 2.9 mg/L; Zone H 2.4 mg/L; and Zone I 5.4 mg/L).

- This concentration of manganese, if allowed to remain in-place, would result in a residual hazard of 0.6 under an industrial re-use scenario. This is below the required action industrial hazard quotient of 3.0.

- There are no current receptors of this groundwater contaminant. The aquifer is not used as a drinking water supply, and the well point is not immediately adjacent to any surface water where ecological receptors may be of concern.

- There is not a known historic anthropogenic source for manganese at this site.

- The extent of manganese detections above Zone A background was limited to only one well.

For the reasons cited above, further assessment or corrective action of groundwater at this site is not recommended. However, a project team risk management decision will be needed to approve this recommendation.

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section describes the initial steps of remedy selection — identification and screening of applicable technologies. Remediation technologies such as containment, biological, physical/chemical, and thermal treatment technologies (both in situ and ex situ), as well as offsite disposal options were identified and reviewed based on site-specific conditions and waste constraints. Screening occurs when technologies are either eliminated from further consideration or retained for further consideration. From the technologies retained, alternatives for remedial action at Combined SWMU 2 will be developed and further evaluated.

4.1 Potential Response Actions

Remedial action alternatives can be broadly categorized into general response actions for consideration in the CMS. These general response actions are summarized below.

- **Institutional Controls:** Institutional controls often supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls should not supplant active response measures as the sole remedy unless active measures are determined to be impractical. Institutional controls typically include:

  — Site access controls
  — Public awareness, education
  — Groundwater use restrictions
  — Long-term monitoring
  — Deed restrictions
  — Warning against excavation, soil use

- **Monitored Natural Attenuation:** Natural attenuation refers to dilution, dispersion, advection, and biotic degradation of contaminants in the environment. Monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with remediation objectives and to ensure that receptors are not threatened.

- **Treatment:** Treatment can be used to reduce the toxicity, mobility, or volume of the principal threats posed by a site, where practical.

- **Containment:** This engineering control would protect human health and the environment by preventing or controlling exposure to site contaminants for waste that poses a relatively low long-term threat or where treatment is impractical.

- **Combination:** Appropriate methods can be combined to protect human health and the environment.

4.2 Technology Screening

Applicable technology descriptions, site constraints, and waste constraints are summarized in Table 4-1. Site and waste constraints were used to screen or retain the applicable technologies.

4.2.1 Results for Soil Remediation

Combined SWMU 2 soil contamination is primarily confined to the uppermost 0 to 3 feet below ground surface. This material is generally hard, tight, silty, clayey fill down to the water table. It has relatively low permeability and porosity and a variable organic content. The water table ranges from approximately 4 to 6 feet in this area, based on location, tidal influence, and time of year (e.g., seasonal precipitation influences).

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
		INSTITUTIONAL CONTROLS		
Institutional controls	Leaves contaminated soil in place. Site access would be controlled by site access controls, public awareness, education, deed restrictions, etc.	Does not remove the source — plans for future site use may be impacted.	None.	Yes
		CONTAINMENT		
Surface Cap	Capping is a containment technology that will limit human contact with soil and reduce infiltration of rainwater through contaminated soil. Capping materials include soil, asphalt, and concrete.	Plans for future site use may be impacted by capping technology.	None.	Yes
		SOIL IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES		
Bioremediation	Naturally occurring microbes are stimulated by circulating water-based solutions through contaminated soils to enhance biodegradation. Nutrients, oxygen, hydrogen peroxide and other amendments may enhance biodegradation and contaminant desorption from subsurface materials. Bioremediation may occur in aerobic and anaerobic conditions.	Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones.	In situ bioremediation most readily treats non-halogenated volatile, semivolatile, and fuel hydrocarbons. High concentrations of heavy metals, highly chlorinated organics, long-chain hydrocarbons, or inorganic salts are likely to be toxic to microorganisms.	No, waste constraint: lead.
Bioventing	Air is either extracted from or injected into the unsaturated soils to increase oxygen concentrations and stimulate biological activity. Flow rates are much lower than soil vapor extraction, minimizing volatilization and release of contaminants to the atmosphere.	Bioventing is applicable to contaminants in the vadose zone.	Bioventing is applicable for any contaminant that more readily degrades aerobically than anaerobically.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Electrokinetically Enhanced Bioremediation	The application of an electric field to electrokinetically transport nutrients and biodegrading bacteria to areas of contamination.	The effectiveness of an electric field can be reduced by the presence of buried metallic conductors, and pH and reduction-oxidation changes induced by the process electrode reactions. Permeability, degree of water saturation, and/or high water table can also impact the process effectiveness.	This technology is appropriate for treating soils contaminated with petroleum hydrocarbons and other compounds easily biodegraded under anaerobic conditions.	No, waste constraint: lead.
Landfarming	Contaminated soil is cultivated to enhance biodegradation of contaminants.	In Situ landfarming should only be performed in low-risk areas where leaching of contaminants is not a concern.	In Situ landfarming cannot support anaerobic conditions, which are required to cultivate the proper microorganisms for biodegradation of some contaminants.	No, waste constraint: lead.
Natural Attenuation	Natural attenuation is a long-term management philosophy. Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminants to acceptable concentrations.	Natural attenuation may not be a good remediation choice for locations where site conditions make it difficult to predict contaminant movement.	Some inorganics can be immobilized through natural attenuation, but they will not be degraded.	No, waste constraint: lead.
Phytoremediation	Phytoremediation is the use of plants to remove, contain, and/or degrade contaminants. Examples include: enhanced rhizosphere biodegradation, phytoaccumulation, phytodegradation, and phytostabilization.	Climatic or hydrologic conditions may restrict the rate of growth of the remediation plants, and treatment is generally limited to within 3 feet of the soil surface. Due to time required for remediation, plans for future site use may be impacted by phytoremediation.	High concentrations of hazardous materials can be toxic to plants.	No, site constraint: future site use and depth of contamination.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Chemical Oxidation	Chemical oxidation is a process in which the oxidation state of a contaminant is increased while the oxidation state of the reactant is decreased. The reactant can be another element, including the oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide or chlorine dioxide.	Iron and manganese in the soil will compete with contaminants for oxygen.	This technology is effective in treating media contaminated with low concentrations of halogenated and non-halogenated volatiles and semivolatiles, polychlorinated biphenyls (PCBs), pesticides, cyanides, and volatile and nonvolatile metals.	No, waste constraint: lead.
Electrokinetic Separation	Low intensity direct electrical current is applied across electrode pairs that have been implanted in the ground on either side of the contaminated zone. Contaminants desorbed from the soil surface are transported toward cathodes or anodes, depending on their charge.	The effectiveness of electrokinetic remediation can be reduced by the presence of buried metallic conductors, immobilization of metal ions by undesirable chemical reactions with naturally occurring and co-disposed chemicals, and pH and reduction-oxidation changes induced by the process electrode reactions. Permeability and degree of water saturation can also impact the process effectiveness.	This technology can be used for treating soil contaminated with heavy metals, radionuclides, and organic contaminants.	No, site constraint: high presence of metallic material in soil and shallow brackish water salts.
Fracturing	Cracks are developed by fracturing beneath the surface in low permeability and over-consolidated sediments to open new passageways that increase the effectiveness of many in situ processes and enhance extraction efficiencies. Fracturing must be used in conjunction with a treatment technology such as soil vapor extraction, bioremediation, vitrification, electrokinetics or pump-and-treat systems. Technologies used in fracturing include blast-enhanced fracturing, pneumatic fracturing, hydraulic fracturing, and Lasagna process.	Cemented sediments limit fracturing effectiveness and fractures will close in non-clayey soils. The technology should not be used in areas of high seismic activity. Fracturing can potentially interfere with utilities and site activities.	The potential exists for opening new pathways which could spread contaminants such as DNAPLs.	No, site constraint: non-clayey soils.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Pressure Dewatering	Air is injected into the soil at a rate that causes an increase in groundwater pressure, which results in groundwater flow away from the air injection site. This technique increases the amount of soil that can be biodegraded through bioventing.	Pressure dewatering is applicable for remediating contaminants in the vadose zone.	Pressure dewatering is applicable for any contaminant that is more readily degraded aerobically than anaerobically.	No, waste constraint: lead.
Soil Flushing	Soil flushing uses water or a solvent to leach contaminants from the soil. Groundwater extraction must be included to prevent spreading contamination in groundwater.	Low-permeability soils are difficult to treat with soil flushing. Soil flushing should only be used where flushed contaminants and flushing fluid can be contained and recaptured.	Mobilization of NAPLs in response to cosolvent flooding can worsen the extent of site contamination.	No, site constraint: recapture and containment concerns.
Soil Vapor Extraction	Soil vapor extraction (SVE) uses extraction wells and vacuum pumps to create a pressure gradient to volatilize contaminants from the soil. The off-gases from the extraction wells may require treatment prior to release into the atmosphere.	This technology can be used at sites where areas of contamination are large and deep and/or underneath a structure. Soils should be fairly homogeneous and have high permeability, porosity, and uniform particle size distributions.	SVE is applicable to soils contaminated with VOCs and some SVOCs. The presence of NAPL in subsurface soil may affect the efficiency of SVE on organic compounds	No, waste constraint: lead.
Solidification/ Stabilization	In Situ solidification/stabilization immobilizes contaminants by mixing site soil with portland cement, lime, or a chemical reagent to reduce the mobility of the contaminant. Large augering equipment is used to mix soils in place with the reagent.	Solidification will likely leave a solid mass, similar to concrete, but stabilization causes certain contaminants to bind (physically and/or chemically) to soil particles, which will likely leave a tillable soil.	This technology works well for inorganics including radionuclides. Although organic contaminated soils may be treated with solidification/stabilization, some organics can delay or inhibit reactions necessary for solidification.	Yes
SOIL IN SITU THERMAL TREATMENT TECHNOLOGIES				
Aquathermolysis	Water is heated to 200° to 450°C under pressure and injected into a contaminated area. At these temperatures water acts as a catalyst, reactant and solvent.	Shallow groundwater will limit the effectiveness this technology. Aquathermolysis can impact utilities and water/sewer transport systems.	Aquathermolysis may be effective in aiding the remediation of waste oils, chromium and volatile organic compounds.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU THERMAL TREATMENT TECHNOLOGIES				
Thermally Enhanced Soil Vapor Extraction	Site soils are electrically heated to 700°F or higher to degrade and volatilize contaminants. A vacuum system covering the entire treatment area collects all offgases and vaporizes them with heating elements. Residual gases are passed through activated carbon. Different heating systems that are used for this technology include: electrical heating blankets, radio frequency/electromagnetic heating, and hot air injection.	This technology typically requires at least 5 feet between groundwater and the bottom of the treatment zone. Heating the soil to high temperatures can impact utilities and water/sewer transport systems.	This technology has been proven to remove some VOCs, SVOCs, pesticides, herbicides, and PCBs from soil. It can remove some volatile forms of metals from soil, although elemental forms will not be removed	No, site constraint: Groundwater is less than 5 feet below the treatment zone.
Vitrification	Electrical heating is used to melt contaminated soils, producing a glass-like matrix with very low leaching characteristics.	Shallow groundwater tends to interfere with this process. The technology will create a vitreous mass that may impact future use of the site.	Some organic and inorganic contaminants may volatilize in the process.	No, site constraint: Groundwater is less than 5 feet below the treatment zone.
SOIL EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Biopiles	Excavated soils are mixed with amendments, nutrients, and fillers and placed in aboveground enclosures. In an aerated static pile, excavated soils are formed into piles and aerated with blowers or vacuum pumps. Compost piles and static piles are examples of biopiles.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for biopiles.	Biopile treatment has been used to treat nonhalogenated VOCs and fuel hydrocarbons. Halogenated VOCs, SVOCs, and pesticides also can be treated, but the process effectiveness will vary and may apply only to some compounds within these contaminant groups. Heavy metals cannot be degraded by biopiles and can be toxic to the microorganisms.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
		SOIL EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES		
Biosorption	Biosorption is the sorptive removal of toxic metals from solution by a specially prepared biomass.	Existing structures and utilities may impede or restrict excavation. This technology may not be effective for clayey soil.	Biosorption removes toxic metals from solution. Not proven effective at concentrations above 30 ppm.	No, waste constraint: lead concentration >30 ppm.
		SOIL EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES		
Fungal Biodegradation	Fungal biodegradation refers to the degradation of a wide variety of organopollutants by using the lignin-degrading or wood-rotting enzyme system of white rot fungus.	Existing structures and utilities may impede or restrict excavation.	White rot fungus can degrade and mineralize a number of organopollutants, including the predominant conventional explosives TNT, RDX, and HMX. In addition, white rot fungus has the potential to degrade and mineralize other recalcitrant materials such as DDT, PAHs, and PCBs.	No, waste constraint: lead.
Landfarming	Contaminated soil is excavated, applied into lined beds, and periodically turned over or tilled to aerate and enhance biodegradation of contaminants.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for landfarming.	Inorganic contaminants will not be biodegraded and volatile contaminants must be pretreated to prevent polluting the air.	No, waste constraint: lead.
Slurry Phase Biological Treatment	An aqueous slurry is created by combining soil with water and other additives. The slurry is mixed continuously to keep solids suspended and microorganisms in contact with the soil contaminants. Upon completion of the process, the slurry is dewatered and the treated soil is disposed of.	Existing structures and utilities may impede or restrict excavation. Nonhomogeneous soils and clayey soils can create material handling problems.	Slurry-phase bioreactors are used primarily to treat nonhalogenated SVOCs and VOCs in excavated soils or dredged sediments. Slurry-phase bioreactors containing co-metabolites and specially adapted microorganisms can be used to treat halogenated VOCs and SVOCs, pesticides, and PCBs.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
		SOIL EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES		
Chemical Extraction	Excavated soil is washed with aqueous-based solutions to separate contaminants sorbed onto fine particles from the rest of the soil matrix. The fractions of soil to be treated are processed in a slurry with specific leachant mixtures to ionize target metals. The treated mixture is further treated to develop an enriched leaching solution, which is then treated to remove the target metals.	Existing structures and utilities may impede or restrict excavation. Soils with higher clay content may reduce extraction efficiency and require longer contact times.	Acid extraction is suitable for treating soils contaminated by heavy metals. Solvent extraction has been shown to be effective in treating soils containing primarily organic contaminants, but is generally least effective on very high molecular weight organic and very hydrophilic substances.	Yes
Chemical Oxidation	Chemical oxidation is a process in which the oxidation state of a contaminant is increased while the oxidation state of the reactant is decreased. The reactant can be another element, including the oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide or chlorine dioxide.	Existing structures and utilities may impede or restrict excavation. Iron and manganese in the soil will compete with contaminants for oxygen.	This technology is effective in treating media contaminated with low concentrations of halogenated and non-halogenated volatiles and semivolatiles, PCBs, pesticides, cyanides, and volatile and nonvolatile metals.	No, waste constraint: lead.
Dehalogenation	Reagents are added to soils contaminated with halogenated organics. The dehalogenation process is achieved by either replacing the halogen molecules or decomposing and partially volatilizing the contaminants. Examples of dehalogenation include base-catalyzed decomposition and glycolate/alkaline polyethylene glycol (A/PEG).	Existing structures and utilities may impede or restrict excavation. High clay and moisture content will increase treatment costs. Capture and treatment of residuals from the process will be especially difficult for soils containing high levels of fines and moisture.	The target contaminant groups for dehalogenation treatment are halogenated SVOCs and pesticides. The technology can be used but may be less effective against selected halogenated VOCs.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Separation	Separation techniques concentrate contaminated solids through physical and chemical means. These processes seek to detach contaminants from their medium (e.g., soil, sand, or other binding material). Gravity separation, magnetic separation, and sieving/physical separation are examples of this technology.	Existing structures and utilities may impede or restrict excavation. Specific gravity of particles will affect settling rates and process efficiency.	The target contaminant groups are SVOCs, fuels, and inorganics (including radionuclides). The technologies can be used on selected VOCs and pesticides. Magnetic separation is specifically used on heavy metals, radionuclides, and magnetic radioactive particles, such as uranium and plutonium compounds.	No, waste constraint: not applicable to low concentration non-particulate lead.
Soil Washing	Excavated soil is washed with aqueous-based solutions to separate contaminants sorbed onto fine particles from the rest of the soil matrix. This technology only separates the contaminants and does not destroy them. Further treatment or disposal of the process water is required.	Existing structures and utilities may impede or restrict excavation. High humic content in soil may require pretreatment. It may be difficult to remove organics adsorbed to clay-size particles.	This technology is effective at removing SVOCs and inorganics. It is less effective at treating VOCs.	Yes
Soil Vapor Extraction	A vacuum is applied to a network of aboveground piping to encourage volatilization of organics from the excavated soil. The process includes a system for handling offgases.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for this technology. High moisture content, high humic content, or compact soils will inhibit volatilization.	SVE is applicable to soils contaminated with VOCs and some SVOCs.	No, waste constraint: lead.
Solar Detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight.	Existing structures and utilities may impede or restrict excavation. Site must have adequate sunlight.	The target contaminant groups for solar detoxification are VOCs, SVOCs, solvents, pesticides, and dyes. The process may also remove some heavy metals from water.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Solidification/Stabilization	Contaminants are physically bound or encased within a stabilized mass, or chemical reactions are induced with stabilizing agents. The contaminants are not removed or destroyed, but their mobility is reduced. Examples of S/S technologies include: bituminization, emulsified asphalt, modified sulfur cement, polyethylene extrusion, pozzolan/portland cement, radioactive waste solidification, sludge stabilization, and soluble phosphates.	Existing structures and utilities may impede or restrict excavation.	This technology works well for inorganics including radionuclides. Although organic-contaminated soils may be treated with solidification/stabilization, some organics can delay or inhibit reactions necessary for solidification.	Yes
Supercritical Carbon Dioxide Extraction (SCDE)	This process employs supercritical carbon dioxide as a solvent to remove normally insoluble organic compounds. It does not destroy target contaminants.	Existing structures and utilities may impede or restrict excavation. Elevated water content can have a negative impact on SCDE performance.	This technology can remove normally insoluble organics from soil.	No, site constraint: lead.
SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES				
Aquathermolysis	Water is heated to 200° to 450°C under pressure and is injected into a contaminated area. At these temperatures water acts as a catalyst, reactant and solvent.	Existing structures and utilities may impede or restrict excavation.	Aquathermolysis may be effective in aiding the remediation of waste oils, chromium and volatile organic compounds.	No, waste constraint: lead.
Distillation	Hydrocarbons and water are volatilized from contaminated media using either heat or vacuum.	Existing structures and utilities may impede or restrict excavation.	This technology is limited to the removal of organic contaminant from wastes.	No, waste constraint: lead.
High-Pressure Oxidation	Wet air oxidation and supercritical water oxidation belong to this technology category. Both processes use high pressure and temperature to treat organic contaminants.	Existing structures and utilities may impede or restrict excavation.	Wet air oxidation can treat hydrocarbons and other organic compounds. Supercritical water oxidation is applicable for PCBs and other stable compounds.	No, waste constraint: lead.

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES				
Hot Gas Decontamination	This process involves raising the temperature of the contaminated material for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants.	Existing structures and utilities may impede or restrict excavation.	This process is applicable for demilitarizing explosive items, such as mines and shells (after removal of explosives), or scrap material contaminated with explosives.	No, waste constraint: lead.
Incineration/Pyrolysis	Incineration burns contaminated sediment at high temperatures (1,600° - 2,200°F) to volatilize and combust organic contaminants. A combustion gas treatment system must be included with the incinerator. The circulating bed combustor, fluidized bed reactor, infrared combustor, and rotary kiln are examples of incinerators. Pyrolysis is a thermal process that chemically changes contaminated sediment by heating it in the absence of air. Pyrolysis can be achieved by limiting oxygen to rotary kilns and fluidized bed reactors. Molten salt destruction is another example of pyrolysis.	Existing structures and utilities may impede or restrict excavation. Highly abrasive feed can damage the processor unit. The technology requires drying the soil to achieve less than 1% moisture content.	Incineration may be effective in treating organic- contaminated soil, but not for soil with metals as the primary contaminants. The target contaminant groups for pyrolysis are SVOCs and pesticides. Pyrolysis is not effective in either destroying or physically separating inorganics from the contaminated medium. Volatile metals may be removed by the higher temperatures, but are not destroyed.	No, waste constraint: lead.
Open Burn/Open Detonation	In open burn operations, explosives or munitions are destroyed by self-sustained combustion, which is ignited by an external source, such as flame, heat, or a detonatable wave. Open detonation destroys detonatable explosives and munitions by detonating with an energetic charge.	Existing structures and utilities may impede or restrict excavation. For safety purposes, substantial space is required for open processes. Open burn/open detonation requires a RCRA Subpart X permit.	Open burn/open detonation can be used to destroy excess, obsolete, or unserviceable munitions, components, and energetic materials, as well as media contaminated with energetics.	No, waste constraint: lead.
Thermal Desorption	Soil is generally heated between 200° and 1,000°F to separate VOCs, water, and some SVOCs from the solids into a gas stream. The organics in the gas stream must be treated or captured. Thermal desorption may be used at high or low temperatures depending on the volatility of the contaminants.	Existing structures and utilities may impede or restrict excavation. Highly abrasive feed can damage the processor unit. Clay and silty soils and soil with high humic content increase reaction time due to binding of contaminants.	Inorganic contaminants or metals that are not particularly volatile will not be effectively removed by thermal desorption.	No, waste constraint: lead

Table 4.1
Soil Technology Screening for SWMU 2

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES				
Vitrification	Electrical heating is used to melt contaminated soils, producing a glass-like matrix with very low leaching characteristics.	Existing structures and utilities may impede or restrict excavation.	This technology is primarily used for radioactive contaminants.	No, waste constraint: lead.
OTHER SOIL TREATMENT TECHNOLOGIES				
Excavation and Offsite Disposal	Contaminated soil is excavated and disposed of offsite at a licensed waste disposal facility.	Existing structures and utilities may impede or restrict excavation. Transportation of the soil through populated areas may affect community acceptance.	TCLP results may impact disposal options.	Yes

Evaluation of potential remedial technologies was based on these general site characteristics and the contaminants discussed in Section 2. The following technologies were all screened from further consideration.

- The following biological treatment technologies were screened from further consideration because these technologies do not effectively treat inorganics: **bioremediation**, **bioventing**, **electrokinetically enhanced bioremediation**, **landfarming**, **biopiles**, **fungal biodegradation**, and **slurry phase biological treatment**.

- **Monitored natural attenuation (MNA)** was screened from further consideration because it does not effectively treat inorganics since these compounds are often immobilized during MNA, but not destroyed. Immobilization may involve adsorption, coprecipitation, precipitation, and diffusion into the soil matrix, and may either be reversible or slowly reversible.

- **Phytoremediation** was screened from further consideration because of the depth of contamination at one hot spot, the time required for remediation, and plans for future site use.

- **In situ and ex situ chemical oxidation** were screened from further consideration because they treat VOCs and SVOCs more effectively than inorganics. Moreover, chemical oxidation is typically used to treat soils containing contaminants too concentrated or too toxic for bioremediation to be effective. For in situ oxidation, soils must be sufficiently permeable for the oxidant solution to reach the contamination and for reaction products to move away from the area. Furthermore, background metal concentrations would likely interfere with the process by competing for the chemical oxidants.

- **Electrokinetic separation** was screened from further consideration because the metallic material in soil and shallow brackish water salts would interfere with the technology.

- **Fracturing** was screened from further consideration because it is not applicable to current site conditions.

- **Pressure dewatering** was screened from further consideration because this technique is used to increase the amount of soil that can be biodegraded through bioventing. Lead is not biodegradable.

- **Soil flushing** was screened from further consideration because groundwater contamination is independent of soil contamination. Soil flushing could contaminate groundwater.

- **In situ soil vapor extraction (SVE), ex situ SVE** and **thermally enhanced SVE** were screened from further consideration because they effectively treat VOCs and SVOCs rather than inorganics. **In situ SVE** and **thermally enhanced SVE** would also be screened from further consideration because vadose zone technologies are not being considered for this site. The shallow water table limits the technology's effectiveness because of the difficulty of moving gases and vapor through the subsurface. The vadose zone should extend at least 10 feet below the ground surface to provide a sufficient volume of soil for SVE to effectively treat soil contaminants. Furthermore, soil-vapor transport can be severely limited in a soil with a high bulk density, low porosity, and low permeability.

- **In situ and ex situ aquathermolysis** were screened from further consideration because they do not effectively treat inorganics.

- **In situ vitrification** was screened from further consideration because shallow groundwater interferes with the process. The technology was also screened from further consideration because of its impact on future site use. Ex situ vitrification was screened from further consideration because it is primarily used to treat radioactive contaminants.

- **Biosorption** was screened from further consideration because it treats dissolved species more effectively than soil-sorbed constituents. This technology has not been proven effective at treating metal concentrations above 30 ppm.

- **Dehalogenation** was screened from further consideration because it does not effectively treat inorganics. Dehalogenation is limited to halogenated contaminants.

- **Physical separation** was screened from further consideration because it is does not apply to low concentration nonparticulate lead.

- **Solar detoxification** was screened from further consideration because it primarily targets VOCs, SVOCs, and solvents rather than inorganics.

- **Supercritical carbon dioxide extraction (SCDE)** was screened from further consideration because it does not effectively treat inorganics.

- **Distillation** was screened from further consideration because it is limited to the removal of organic contamination.

- **High-pressure oxidation** was screened from further consideration because it does not effectively treat inorganics.

- **Hot gas decontamination** was screened from further consideration because it is primarily used for demilitarizing explosives.

- **Incineration and pyrolysis** were screened from further consideration because they do not effectively treat inorganics.

- **Open burn and detonation** were screened from further consideration because they are used primarily to treat munitions rather than inorganics.

- **Thermal desorption** was screened from further consideration because it does not effectively treat inorganic compounds.

Table 4.1, Soil Technology Screening for Combined SWMU 2, summarizes the information used to screen technologies and shows the retained status for each technology.

Soil technologies retained for further consideration are listed below:

- Institutional controls (only with other technologies)
- Surface cap (soil and concrete cap)
- In situ solidification/stabilization
- Excavation and offsite disposal
- Chemical extraction (excavation and treatment by)
- Soil washing (excavation and treatment by)
- Ex situ solidification/stabilization

5.0 DEVELOPMENT AND EVALUATION OF ALTERNATIVES

The purpose of the detailed analysis of alternatives is to provide decision makers with adequate information to select an appropriate site remedy. During the detailed analysis, each alternative is assessed against the evaluation criteria described in the OSWER Directive Number 9902.3-2A. Assessment results are then arrayed to compare the alternatives and identify key tradeoffs among them.

5.1 Evaluation Process

The evaluation process is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for a site, and satisfy RCRA requirements for selecting the remedial action.

Primary Criteria

Four evaluation criteria have been developed to address the RCRA requirements and considerations and their additional technical and policy considerations. The evaluation criteria with the associated statutory considerations that must be met are:

- Primary Criteria 1 — Protection of human health and the environment
- Primary Criteria 2 — Attainment of cleanup standards
- Primary Criteria 3 — Source control
- Primary Criteria 4 — Compliance with applicable waste management standards

Secondary Criteria

The alternatives are scored on their abilities to meet the four primary criteria as well as five secondary criteria. These secondary criteria can help rank remedial alternatives that have met all four of the primary criteria described above.

- Secondary Criteria 1 — Long-term reliability and effectiveness
- Secondary Criteria 2 — Reduction in waste toxicity, mobility, or volume
- Secondary Criteria 3 — Short-term effectiveness
- Secondary Criteria 4 — Implementability
- Secondary Criteria 5 — Cost

Each remedial alternative is evaluated with respect to the above criteria, as described in the following sections.

5.1.1 Protection of Human Health and the Environment

Corrective action remedies must be protective of human health and the environment. Each alternative must satisfy this criteria to be eligible for selection. Evaluation of this criteria should provide a final measure to assess whether each alternative adequately protects human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term reliability and effectiveness, short-term effectiveness, and compliance with applicable waste management standards.

Evaluation of the overall protectiveness of an alternative should focus on whether an alternative achieves adequate protection by eliminating, reducing, or controlling the risks posed through each pathway through treatment, engineering, or institutional controls. This evaluation considers whether an alternative poses any unacceptable short-term or cross-media impacts.

5.1.2 Attainment of Cleanup Standards

Remedies will be required to attain media cleanup standards set by the implementing agency, which may be derived from existing state or federal regulations or other standards. The media cleanup standards for a remedy will often play a large role in determining the extent of the remedy and technical approaches to it. In some cases, certain technical aspects of the remedy, such as the practical capabilities of remedial technologies, may influence to some degree the media cleanup standards that are established.

In addition, this CMS will evaluate whether the potential remedial alternatives will achieve the preliminary remediation objective as identified by the implementing agency as well as other, alternative remediation objectives proposed in the CMS. The time frame for each alternative to meet these standards will be estimated and included in this discussion.

5.1.3 Source Control

A critical objective of any remedy must be to stop further environmental degradation by controlling or eliminating further releases that may threaten human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, continue indefinitely. Therefore, an effective source control program is essential to ensure the long-term reliability and effectiveness of the corrective action program.

The source control standard is not intended to mandate a specific remedy or class of remedies. Instead, the CMS will examine a wide range of options. This standard should not be interpreted to preclude the equal consideration of using other protective remedies to control the source, such as partial waste removal, capping, slurry walls, in situ treatment or stabilization and consolidation.

This CMS report will also address whether source control measures are necessary, and if so, the type of actions that would be appropriate. For any source control measure proposed, its estimated effectiveness based on site conditions and the history of the specific technology will be discussed.

5.1.4 Compliance with Applicable Waste Management Standards

Corrective action remedies must comply with applicable waste management standards. To be eligible for selection, each alternative must satisfy this criteria, which is used to evaluate whether each alternative will meet all the federal and state waste management standards identified in the remedial process. The detailed analysis should identify which requirements are applicable or relevant and appropriate to an alternative. The lead agency (the Navy) determines which requirements are applicable or relevant and appropriate, in consultation with the support agencies (USEPA and SCDHEC). Each alternative's compliance with the following waste management standards should be addressed during the detailed analysis:

- Chemical-specific regulations
- Location-specific regulations
- Action-specific regulations

5.1.5 Long-Term Reliability and Effectiveness

The evaluation of alternatives under this secondary criterion addresses the results of a remedial action in terms of the risk remaining at the site after response objectives have been met. This evaluation primarily focuses on the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The following should be addressed for each alternative:

- **Magnitude of Residual Risk:** This factor assesses the residual risk from untreated waste or treatment residuals when remedial activities are complete. This risk may be measured by numerical standards such as cancer risk levels or the volume or concentration of constituents in waste, media, or treatment residuals remaining onsite.

- **Adequacy and Reliability of Controls:** This factor assesses the adequacy and suitability of any controls used to manage treatment residuals or untreated wastes remaining onsite. It may include an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.

5.1.6 Reduction of Toxicity, Mobility, or Volume

This criterion gives preference to remedial actions employing treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances. The evaluation should consider the following specific factors:

- The treatment processes, the remedies they will employ, and the materials they will treat.

- The amount of hazardous materials that will be destroyed or treated, including how principal threat(s) will be addressed.

- The degree of expected reduction in toxicity, mobility, or volume, measured as a percentage of reduction (or order of magnitude) when possible.

- The degree to which the treatment will be irreversible.

- The type and quantity of treatment residuals that will remain following treatment.

5.1.7 Short-Term Effectiveness

The short-term effectiveness of a remedial alternative is evaluated relative to its effect on human health and the environment during implementation. Short-term effectiveness is based on four key factors:

- Risks to the community during implementation of the remedial action.
- Risks to workers during implementation of the remedial action.
- Potential for adverse environmental impact as a result of implementation.
- Time until remedial response objectives are achieved.

5.1.8 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. It involves analysis of the following factors:

Technical Feasibility

- Technical difficulties and unknowns associated with construction and operation.

- Potential technical problems during implementation that may lead to schedule delays.

- Ease of remedial action and potential future activities based on technology performance.

- Ability and ease of remedy effectiveness monitoring, including an evaluation of the risks of exposure should monitoring be insufficient to detect a system failure.

Administrative Feasibility

- Activities needed to coordinate with other offices and agencies.

Availability of Services and Materials

- Availability of adequate offsite treatment, storage capacity, and disposal services.

- Availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources.

- Availability of services and materials, plus the potential to obtain competitive bids, which may be particularly important for innovative technologies.

- Availability of prospective technologies.

5.1.9 Cost

Cost estimates for each remedial alternative are based on engineering analyses, published estimates of necessary technology and costs for similar actions (such as excavation) at other remediation sites. The cost estimate for a remedial alternative consists of three principal elements: capital cost, operations and maintenance (O&M) costs, and present-worth analysis. Costs are expressed in 1999 dollars.

Capital Costs

- *Direct costs* for equipment, labor, and materials used to develop, construct, and implement a remedial action.

- *Indirect costs* for engineering, financial, and other services that are not actually part of construction, but are required to implement a remedial alternative. The percentage applied to the direct cost varies with the degree of difficulty associated with construction and/or implementation of the alternative. In this CMS, the indirect costs include health and safety items, permitting and legal fees, bid and scope contingencies, engineering design and services, and miscellaneous supplies or costs.

Annual O&M Costs: O&M costs refer to post-construction costs necessary to ensure the continued effectiveness of a remedial action. They typically refer to long-term power and material costs (such as the operational cost of a water treatment facility), equipment replacement costs, and long-term monitoring costs.

Present-Worth Analysis: This analysis makes it possible to compare remedial alternatives on the basis of a single cost representing an amount that would be sufficient to cover all costs associated with the remedial action during its planned life, if invested in the base year and disbursed as needed. A performance period appropriate to each alternative is assumed for present-worth analyses. Discount rates of 6% are assumed for base calculations. An increase in the discount rate decreases the alternative's present worth.

The cost elements for each remedial alternative are summarized in the cost analysis section. The study estimate costs provided for the alternatives are intended to reflect actual costs with an accuracy of minus 30% to plus 50%, in accordance with USEPA guidelines.

5.2 Evaluation of Soil Alternatives

The alternatives include containment, in situ and ex situ treatment, and excavation and disposal. Depending on remedial objectives, each alternative may include institutional controls and monitoring. The following alternatives have been developed from the technologies retained from the screening described in Section 4:

Alternative 1: Low-Permeability Surface Cap
Alternative 2: In Situ Solidification/Stabilization
Alternative 3: Excavation and Offsite Disposal at Landfill
Alternative 4: Excavation and Treatment by Chemical Extraction
Alternative 5: Excavation and Treatment by Soil Washing
Alternative 6: Ex Situ Solidification/Stabilization

5.2.1 Alternative 1: Low-Permeability Surface Cap

This alternative uses a physical barrier to cover contaminated soil to eliminate dermal and gastrointestinal contact. Land use would be restricted to industrial purposes using institutional controls to minimize uncontrolled exposure.

Cover construction assumes: (1) concrete, asphalt and rail line excavation and removal before placing a 24-inch thick low permeability soil layer with a vegetative cover or (2) placing a 8-inch thick concrete cover over existing site surfaces.

5.2.1.1 Low-Permeability Surface Cap: Primary Criteria

Overall Protection of Human Health and the Environment

The cover would eliminate the threat of dermal and gastrointestinal contact for current and future site workers. Contaminated soil would be left onsite indefinitely; however, the cover would be maintained to ensure adequate protection. This alternative would protect human health and the environment by physically eliminating receptor pathways and controlling access through institutional controls. Cover construction and maintenance would be easily implemented and current site controls (site security, access control, and fencing) and the institutional controls would be adequate to ensure minimal disturbance of the cover. Short-term risks from inhalation and dermal contact during implementation would be minimal, and could be controlled using common engineering techniques and the use of PPE.

Attainment of Cleanup Standards

Surface capping would attain media cleanup standards as established by the Project Team by eliminating dermal and gastrointestinal contact. This alternative would thus minimize the threat to human health and the environment by eliminating potential migratory pathways.

Source Control

This alternative would provide effective source control by reducing rainwater infiltration, thereby effectively reducing mobility of contaminants that may threaten human health and the environment. Furthermore, institutional controls would drastically reduce the likelihood of additional risks to future site workers.

Compliance with Waste Management Standards

The cover would isolate or eliminate contaminants exceeding remedial objectives in environmental media, but not manage solid or hazardous waste. The potential for contact with soil in which contaminants exceed remedial objectives is eliminated by removing the primary pathways. Site grading would need to comply with federal, state, and local air emissions and storm water control regulations. This alternative would not trigger any location-specific regulations.

5.2.1.2 Low-Permeability Surface Cap: Secondary Criteria

Long-term Reliability and Effectiveness

A cover would effectively reduce site worker contact with the contaminated soil. However, institutional controls and routine O&M would be required to ensure that any exposure to human and environmental receptors is within protective levels. By managing Combined SWMU 2 as an industrial site and restricting land use, residual site risk would be eliminated.

Soil and concrete covers are generally reliable containment controls. If the cover failed, site workers could be exposed; however, repairs could be made to re-establish the cover's integrity. Future liability may be incurred because the waste is not destroyed.

Reduction of Toxicity, Mobility, or Volume

Capping does not remove, treat, or remediate the contaminated soil; it provides containment only. The soil and concrete covers are considered reversible — since the contaminants exceeding remedial objectives remain onsite, they may be exposed if the cover fails due to poor maintenance. This alternative would not reduce toxicity, mobility, or volume.

Short-Term Effectiveness

Adverse impacts to the surrounding environment are not anticipated during cover construction; engineering controls would be applied to manage storm water runoff. Once design plans are approved, actual cover construction would be expected to take a relatively short time. During construction of covers, there would be a risk of dermal or gastrointestinal contact to construction workers and exposure to particulate emissions; however, this risk would be reduced by proper material handling practices and appropriate use of personal protective equipment (PPE). Temporary fencing would be installed around the work zone to control site access to remediation workers only.

It is anticipated that the time frame until remedial objectives are satisfied would be one to three months. Consequently, worker exposure to the contaminants would be minimal.

Implementability

A soil or concrete cover with institutional controls is technically and administratively feasible. This alternative could be readily applied at the site given that the proposed areas to be covered are easily accessible to site workers. The potential technical problems that might slow remediation activities are concrete, asphalt, and rail line removal for the soil cover alternative; approximately 60% of the contaminated soil is beneath reinforced concrete and/or asphalt and/or rail lines. Implementation of this alternative would also involve placement of the cover, implementation of the institutional controls, and establishment of maintenance requirements. Future monitoring and maintenance would involve visually inspecting the cover periodically and repairing any damage or degradation (if required). However, repairs would be easily implemented. Soil covering would not require any extraordinary services or materials. The cover location and material selection is not intended to interfere with future site use.

Currently access to Combined SWMU 2 is through property leased to Carolina Marine Handling. This tenant's traffic, parking, and material storage practices may slow the implementation of this alternative.

Cost

Costs associated with surface capping areas where lead contamination exceeds 1,300 ppm (industrial reuse scenario) are presented in Tables 5.1 (soil) and 5.2 (concrete). The remediation costs for industrial reuse including institutional controls would be $214,600 for a soil cover and $236,710 for a concrete cover. Costs associated with surface capping areas where lead contamination exceeds 400 ppm (residential reuse scenario) are presented in Tables 5.3 (soil) and 5.4 (concrete). The remediation costs for residential reuse would be $381,155 for a soil cover and $320,425 for a concrete cover. Institutional controls would be required for the industrial reuse scenario because impacted soil exceeding the residential cleanup level would still represent an exposure threat.

Table 5.1
Soil Cover with Institutional Controls
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Soil Cover			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	5,500 ft^2	$4.00/ft^2	$22,000
Hauling to Landfill	21 hrs	$80/hr	$1,680
Disposal	140 yd^3	$20/yd^3	$2,800
Site Preparation	670 yd^3	$1.50/yd^3	$1,000
24-inch Soil Cover	1,000 yd^3	$8.00/yd^3	$8,000

Table 5.1
Soil Cover with Institutional Controls
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Soil Cover			
Vegetative Cover	14,000 ft^2	$0.04/$ft^2$	$560
Institutional Controls	LS	$50,000	$50,000
Engineering/Oversight	LS	20%	$18,200
Contingency/Miscellaneous	LS	25%	$22,760
Subtotal			**$132,000**
Operation and Maintenance Cost			
Maintain cover (30 years)	LS	$5,000	$5,000
Inspection	LS	$1,000	$1,000
Subtotal			**$6,000**
Present Value at 6% discount rate over 30 years			**$82,600**
Total			**$214,600**

Table 5.2
Concrete Cover with Institutional Controls
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Concrete Cover			
Mobilization/Demobilization	LS	$5,000	$5,000
Site Preparation	670 yd^3	$1.50/$yd^3$	$1,000
Drainage System	LS	$25,000	$25,000
Concrete Surface (8 inches)	950 yd^2	$16.60/$yd^2$	$15,770
Institutional Controls	LS	$50,000	$50,000
Capital Costs for Soil Cover			
Engineering/Oversight	LS	20%	$19,350
Contingency/Miscellaneous	LS	25%	$24,190
Subtotal			**$140,310**
Operation and Maintenance Cost			
Maintain drainage and cover (30 years)	LS	$6,000	$6,000

Table 5.2
Concrete Cover with Institutional Controls
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Inspection	LS	$1,000	$1,000
Subtotal			**$7,000**
Present Value at 6% discount rate over 30 years			**$96,400**
Total			**$236,710**

Table 5.3
Soil Cover with Institutional Controls
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Soil Cover			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	24,000 ft²	$4.00/ft²	$96,000
Hauling to Landfill	90 hrs	$80/hr	$7,200
Disposal	600 yd³	$20/yd³	$12,000
Site Preparation	1,000 yd³	$1.50/yd³	$1,500
24-inch Soil Cover	4,000 yd³	$8.00/yd³	$32,000
Vegetative Cover	55,000 ft²	$0.04/ft²	$2,200
Institutional Controls	LS	$50,000	$50,000
Engineering/Oversight	LS	20%	$41,180
Contingency/Miscellaneous	LS	25%	$51,475
Subtotal			**$298,555**
Operation and Maintenance Cost			
Maintain cover (30 years)	LS	$5,000	$5,000
Inspection	LS	$1,000	$1,000
Subtotal			**$6,000**
Present Value at 6% discount rate over 30 years			**$82,600**
Total			**$381,155**

Table 5.4
Concrete Cover with Institutional Controls
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Concrete Cover			
Mobilization/Demobilization	LS	$5,000	$5,000
Grading/Site Preparation	1,000 yd^3	$1.50/yd^3	$1,500
Drainage System	LS	$25,000	$25,000
Concrete Surface (8 inches)	4,400 yd^2	$16.60/yd^2	$73,000
Institutional Controls	LS	$50,000	$50,000
Engineering/Oversight	LS	20%	$30,900
Contingency/Miscellaneous	LS	25%	$38,625
Subtotal			**$224,025**
Operation and Maintenance Cost			
Maintain drainage and cover (30 years)	LS	$6,000	$6,000
Inspection	LS	$1,000	$1,000
Subtotal			**$7,000**
Present Value at 6% discount rate over 30 years			**$96,400**
Total			**$320,425**

5.2.2 Alternative 2: In Situ Solidification/Stabilization

Solidification/stabilization (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. The basic S/S procedure involves three steps: (1) mixing of a reagent with the soil, (2) curing the mixed product, and (3) storage or landfilling the treated soil. The soil and reagent can be mixed in situ by using a backhoe to apply and mix additives, or by using more sophisticated auger/caisson or injector-head systems. Leachability testing is performed to measure contaminant immobilization.

5.2.2.1 In Situ Solidification/Stabilization: Primary Criteria

Overall Protection of Human Health and the Environment

In situ S/S would eliminate the threat of dermal and gastrointestinal contact for future site workers. Contaminated soil would be left onsite indefinitely; however, the S/S process binds the contaminants and reduces mobility to ensure adequate protection. This alternative would protect human health and the environment by physically eliminating receptor pathways and controlling access through institutional controls. Short-term risks from inhalation and dermal contact during implementation would be controlled using common engineering techniques and the use of PPE.

Attainment of Cleanup Standards

In situ S/S would attain media cleanup standards as established by the Project Team by binding the contaminants, eliminating dermal and gastrointestinal contact. This alternative would thus minimize the threat to human health and the environment by eliminating potential migratory pathways.

Source Control

This alternative would provide effective source control by binding the contaminants and reducing their mobility thereby eliminating further releases that may threaten human health and the environment.

Compliance with Waste Management Standards

In situ S/S would physically bind contaminants in the soil. The potential for contact with contaminated soil is eliminated by removing the primary pathways. Implementation would need to comply with federal, state, and local air emissions and storm water control regulations. This alternative would not trigger any location-specific regulations.

5.2.2.2 In Situ Solidification/Stabilization: Secondary Criteria

Long-term Reliability and Effectiveness

In situ S/S would effectively reduce site worker contact with the contaminated soil. However, institutional controls might be required to ensure that the S/S soil remains in place. By managing Combined SWMU 2 as an industrial site and restricting land use, residual site risk would be eliminated.

S/S would achieve reliable containment controls. However, future liability might be incurred because the waste would not be destroyed.

Reduction of Toxicity, Mobility, or Volume

In situ S/S does not remove the contaminated soil; it binds the contaminants and eliminates exposure pathways. This alternative would reduce mobility, but it could also almost double the volume of material.

Short-Term Effectiveness

Adverse impacts to the surrounding environment are not anticipated during implementation; engineering controls would be applied to manage storm water runoff. Implementation would be expected to take from one to three months. During implementation, there would be a risk of dermal or gastrointestinal contact to construction workers and exposure to particulate emissions; however, this risk would be reduced by proper material handling practices and appropriate use of PPE. Temporary fencing would be installed around the work zone to control site access to remediation workers only.

Implementability

In situ S/S is technically and administratively feasible. However, concrete, asphalt, and part of the railroad would have to be removed before this alternative could be applied at the site, and the residual material might interfere with future site use.

Currently access to Combined SWMU 2 is through property leased to Carolina Marine Handling. This tenant's traffic, parking, and material storage practices may slow the implementation of this alternative.

Cost

Costs associated with in situ solidification/stabilization are presented in Tables 5.5 and 5.6. The total cost for areas where lead contamination exceeds 1,300 ppm (industrial reuse scenario) would be $375,095. The total cost for areas where lead contamination exceeds 400 ppm (residential reuse scenario) would be $944,540. No O&M costs are associated with this alternative.

Table 5.5
In Situ Solidification/Stabilization
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Excavation			
Mobilization/Demobilization	LS	$1,000	$1,000
Existing Surface Cover Excavation	5,500 ft^2	$4.00/$ft^2$	$22,000
Hauling to Landfill	21 hrs	$80/hr	$1,680
Disposal	140 yd^3	$20/$yd^3$	$2,800
Site Preparation	1,000 yd^3	$1.50/$yd^3$	$1,500
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$78,980**

Table 5.5
In Situ Solidification/Stabilization
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
In Situ Solidification/Stabilization			
Mobilization/Demobilization	LS	$29,890	$29,890
Equipment Cost	1 month	$84,940/month	$84,940
Operational Labor	173 hours	$375/hr	$64,875
Engineering/Oversight	LS	20%	$51,740
Contingency/Miscellaneous	LS	25%	$64,670
Subtotal			**$296,115**
Total			**$375,095**

Table 5.6
In Situ Solidification/Stabilization
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Excavation			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	24,000 ft^2	$4.00/ft^2	$96,000
Hauling to Landfill	90 hrs	$80/hr	$7,200
Disposal	600 yd^3	$20/yd^3	$12,000
Site Preparation	1,000 yd^3	$1.50/yd^3	$1,500
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$171,700**
In Situ Solidification/Stabilization			
Mobilization/Demobilization	LS	$29,890	$29,890
Equipment Cost	3 month	$84,940/month	$254,820
Operational Labor	520	$375/hr	$195,000
Engineering/Oversight	LS	20%	$130,280
Contingency/Miscellaneous	LS	25%	$162,850
Subtotal			**$772,840**
Total			**$944,540**

5.2.3 Alternative 3: Excavation and Offsite Disposal at Landfill

All contaminated soil exceeding concentrations calculated using the USEPA Blood Concentration Model would be excavated and disposed in an offsite landfill. Institutional controls would be required to minimize uncontrolled exposure for the industrial scenario.

To achieve the residential scenario remedial objective (<400 mg/kg lead), approximately 670 yd^3 of soil would require removal/disposal. To achieve the industrial scenario remedial objective (<1,300 mg/kg lead), approximately 2,950 yd^3 of soil would require removal/disposal.

The areas identified for remediation are delineated in Figures 2.2 and 2.3. The excavated soil would be stockpiled onsite and sampled for waste characterization by TCLP. Soil characterized as hazardous waste would be disposed of in a Subtitle C landfill. Soil characterized as nonhazardous would be disposed of in Subtitle D landfill.

5.2.3.1 Excavation and Offsite Disposal at Landfill: Primary Criteria

Overall Protection of Human Health and the Environment

Excavation and offsite disposal protects human health and the environment by removing contaminated soil where risk exceeds calculated levels. This alternative, coupled with appropriate institutional controls for industrial reuse scenario, would eliminate risk to human health and the environment due to dermal and gastrointestinal contact.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE use. This alternative would comply with applicable waste management standards and chemical-specific regulations.

Attainment of Cleanup Standards

Excavation would attain media cleanup standards as established by the Project Team. Contaminated soil would be excavated at select locations until confirmation samples satisfy remedial objectives. Excavation is one of the most aggressive remedial technologies and would likely require the least time to attain cleanup standards.

Source Control

This alternative would eliminate the most contaminated media. If remediation for industrial reuse is chosen, institutional controls would further reduce the likelihood of additional risks by eliminating potential exposure pathways to residual contamination.

Compliance with Waste Management Standards

Excavation and offsite disposal meets chemical-specific regulations for the associated site-wide remedial objectives protective of future industrial site workers. Excavation activities onsite may require compliance with federal, state, and local air emissions and storm water control regulations. Transportation offsite would trigger U.S. Department of Transportation (DOT) regulations. Land disposal restrictions (LDRs) would be triggered if the contaminated soil were determined to be a hazardous waste. It is anticipated that some loads of Combined SWMU 2 excavated soil would be hazardous and some non-hazardous; toxicity characteristic leaching procedure (TCLP) analysis would be performed for verification. No location-specific regulations would be triggered by this alternative.

5.2.3.2 Excavation and Offsite Disposal at Landfill: Secondary Criteria

Long-term Reliability and Effectiveness

This alternative would reduce the quantity of soil in which contaminant concentrations exceed concentrations calculated using the USEPA Blood Concentration Model. For the industrial reuse scenario, minor institutional controls would be required to ensure that any exposure to human and environmental receptors is within protective levels.

Removal to a landfill is a reliable and well established option because onsite risks are eliminated. However, since the excavated soil would be transferred to a landfill, future liability might be incurred because the waste would not be destroyed.

Reduction of Toxicity, Mobility, or Volume

Excavation would eliminate the source area and therefore eliminate contaminants exceeding remedial objectives. This alternative includes the removal of the most contaminated soil from the site and disposal in a secure Subtitle C or D landfill (based on TCLP analysis of the waste). Because the source would no longer remain onsite after this technology is employed, excavation is considered to be irreversible. However, the waste's overall mobility, toxicity, and volume would not be reduced with this alternative.

Short-Term Effectiveness

The excavation operation would be sufficiently removed from the public to reduce health and safety concerns associated with soil removal. Temporary fencing would be installed around the work zone to control site access to remediation workers only. Excavation workers would be exposed to increased particulate emissions and might also have more dermal contact with hazardous constituents. However, worker risks can be reduced by implementing dust control technologies and a site-specific health and safety plan which specifies PPE, respiratory protection, etc. It is anticipated that remedial objectives would be satisfied within one to three months. Consequently, worker exposure to the contaminants would be minimal.

Implementability

Excavation with offsite disposal is technically and administratively feasible at this site. Removal and offsite disposal are common remedial alternatives that have been applied at previous sites. The potential technical problems that might slow remediation activities are concrete, asphalt, and rail line removal to access contaminated soil, materials handling and disposal (standby time between confirmatory sampling and disposal), and potential foundation support measures (if required). The soil volumes are moderately small (approximately 2,950 yd^3), but approximately 60% of the contaminated soil is beneath reinforced concrete and/or asphalt and/or rail lines. No future remedial actions would be required after this alternative is completed.

Excavation with offsite disposal would not require any extraordinary services or materials. The Bee's Ferry Road Landfill in Charleston, SC is a Subtitle D facility which has accepted nonhazardous soil from interim removal actions on the base. The Safety-Kleen (Pinewood) Inc. Landfill is a Subtitle C facility in Pinewood, SC, that will accept hazardous waste.

Currently access to Combined SWMU 2 is through property leased to Carolina Marine Handling. This tenant's traffic, parking, and material storage practices may slow the implementation of this alternative.

Costs

Costs associated with excavation and offsite disposal are presented in Tables 5.7 and 5.8. The remediation costs for industrial reuse including institutional controls would be $199,970 for excavation and disposal to a nonhazardous, Subtitle D landfill and $318,970 for excavation and disposal to a hazardous, Subtitle C landfill. If the excavated soil were distributed between the nonhazardous and hazardous landfills based on TCLP characterization, the actual total cost would fall between these two extremes. The remediation costs for residential reuse would be $519,460 for excavation and disposal to a nonhazardous, Subtitle D landfill and $1,159,350 for excavation and disposal to a hazardous, Subtitle C landfill. As in the industrial scenario, the actual total cost would fall between these two extremes. No O&M costs are associated with this alternative.

Table 5.7
Excavation and Offsite Disposal
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Removal Action			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	5,500 ft^2	$4.00/ft^2	$22,000
Transportation to Landfill	21 hrs	$80/hr	$1,680
Disposal	140 yd^3	$20/yd^3	$2,800
Excavation	670 yd^3	$20/yd^3	$13,400
Confirmation/TCLP Samples	35 samples	$100/sample	$3,500
Backfill	670 yd^3	$15/yd^3	$10,050
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$108,430**
Subtitle D Disposal Facility			
Transportation	670 yd^3	$8/yd^3	$5,360
Soil Disposal	670 yd^3	$36/yd^3	$24,120
Engineering/Oversight	LS	20% cost	$27,580
Contingency/Miscellaneous	LS	25% cost	$34,480
Subtotal			**$91,540**
Total (Subtitle D)			**$199,970**
Subtitle C Disposal Facility			
Transportation	670 yd^3	$8/yd^3	$5,360
Soil Disposal	900 tons	$150/ton	$135,000
Engineering/Oversight	LS	20% cost	$28,072
Contingency/Miscellaneous	LS	25% cost	$42,180
Subtotal			**$210,540**
Total (Subtitle C)			**$318,970**

Table 5.8
Excavation and Offsite Disposal
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Removal Action			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	24,000 ft^2	$4.00/ft^2	$96,000
Transportation to Landfill	90 hrs	$80/hr	$7,200
Disposal	600 yd^3	$20/yd^3	$12,000
Excavation	2,950 yd^3	$20/yd^3	$59,000
Confirmation/TCLP Samples	150 samples	$100/sample	$15,000
Backfill	2950 yd^3	$15/yd^3	$44,250
Subtotal			**$228,450**
Subtitle D Disposal Facility			
Transportation	2,950 yd^3	$8/yd^3	$23,600
Soil Disposal	2,950 yd^3	$36/yd^3	$106,200
Engineering/Oversight	LS	20% cost	$71,650
Contingency/Miscellaneous	LS	25% cost	$89,560
Subtotal			**$291,010**
Total (Subtitle D)			**$519,460**
Subtitle C Disposal Facility			
Transportation	2,950 yd^3	$8/yd^3	$23,600
Soil Disposal	3,980 tons	$150/ton	$597,000
Engineering/Oversight	LS	20% cost	$124,120
Contingency/Miscellaneous	LS	25% cost	$186,180
Subtotal			**$930,900**
Total (Subtitle C)			**$1,159,350**

5.2.4 Alternative 4: Excavation and Treatment by Chemical Extraction

This process uses an acid, such as hydrochloric acid, to extract heavy metal contaminants from soils. In this process, all contaminated soil exceeding concentrations calculated using the USEPA Blood Concentration Model would be excavated and treated or disposed of. The excavated soil would be stockpiled onsite and sampled for waste characterization by TCLP. Soil characterized as nonhazardous would be disposed of in Subtitle D landfill. Soil characterized as hazardous waste would be screened to remove coarse solids, then mixed with hydrochloric acid in an extraction unit. The residence time in the extraction unit depends on the soil type, contaminants, and contaminant concentrations, but generally ranges from 10 to 40 minutes. The soil-extractant mixture is pumped out of the mixing tank, and the soil and extractant are separated using hydrocyclones. The cleaned soil fraction can be returned to the site for continued use.

To achieve the residential scenario remedial objective (<400 mg/kg lead), approximately 670 yd^3 of soil would require excavation/treatment. To achieve the industrial scenario remedial objective (<1,300 mg/kg lead), approximately 2,950 yd^3 of soil would require excavation/treatment. Institutional controls would be required to minimize uncontrolled exposure for the industrial scenario.

5.2.4.1 Excavation and Treatment by Chemical Extraction: Primary Criteria

Overall Protection of Human Health and the Environment

Excavation and treatment by chemical extraction protects human health and the environment by removing contaminants exceeding concentrations calculated using the USEPA Blood Concentration Model. This alternative, coupled with appropriate institutional controls for industrial reuse scenario, would eliminate risk to human health and the environment due to dermal and gastrointestinal contact.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and chemical-specific regulations.

Attainment of Cleanup Standards

Excavation and treatment by chemical extraction would attain media cleanup standards as established by the Project Team. Contaminated soil would be excavated at select locations until confirmation samples satisfy remedial objectives. The contaminated soil would be treated to remove contaminants, then backfilled to the site. The duration of chemical extraction is typically one to two months for this volume of soil.

Source Control

This alternative would provide effective source control by removing contaminants from the most contaminated soil. If remediation for industrial reuse is chosen, institutional controls would further reduce the likelihood of additional risks by eliminating potential exposure pathways to residual contamination.

Compliance with Waste Management Standards

Excavation and treatment by chemical extraction meets chemical-specific regulations for the associated site-wide remedial objectives protective of future industrial site workers under the industrial reuse scenario and future site residents under the residential reuse scenario. Excavation and treatment activities onsite may require compliance with federal, state, and local air emissions and storm water control regulations. Treated soil would be analyzed to determine residual lead concentrations. No location-specific regulations would be triggered by this alternative.

5.2.4.2 Excavation and Treatment by Chemical Extraction: Secondary Criteria

Long-term Reliability and Effectiveness

This alternative would reduce the quantity of soil in which contaminant concentrations exceed concentrations calculated using the USEPA Blood Concentration Model. Minor institutional controls may be required for the industrial reuse scenario to ensure that any exposure to human and environmental receptors is within protective levels.

Chemical extraction does not destroy contaminants — instead the contaminants are separated from the soil, thereby reducing the hazardous waste volume. Because the contaminants are transferred from the soil to the extractant, the extractant requires further treatment.

Reduction of Toxicity, Mobility, or Volume

Chemical extraction reduces site contamination by removing contaminants from the soil. With this alternative, site toxicity, contaminant mobility, and hazardous waste volume would be reduced. Residual contamination would remain onsite at concentrations below remedial objectives.

Short-Term Effectiveness

The excavation and treatment operation would be sufficiently removed from the public to reduce health and safety concerns associated with soil removal. Temporary fencing would be installed around the work zone to control site access to remediation workers only. Remediation workers would be exposed to increased particulate emissions and might also have more dermal contact with hazardous constituents. However, worker risks can be reduced by implementing dust control technologies and a site-specific health and safety plan specifying PPE, respiratory protection, etc. It is anticipated that remedial objectives would be achieved in approximately one month for the industrial scenario and two months for the residential scenario. Consequently, worker exposure to contaminants would be minimal.

Implementability

Chemical extraction is technically and administratively feasible at Combined SWMU 2. Commercial-scale units for chemical extraction are in operation. The potential technical problems that might slow remediation activities are concrete, asphalt, and rail line removal to access contaminated soil, materials handling and backfill to the site (standby time between confirmatory sampling and backfill), and potential foundation support measures (if required). The soil volumes are moderately small (approximately 2,950 yd^3), but approximately 60% of the contaminated soil is beneath reinforced concrete and/or asphalt and/or rail lines. No future remedial actions would be required after this alternative is completed.

Currently access to Combined SWMU 2 is through property leased to Carolina Marine Handling. This tenant's traffic, parking, and material storage practices may slow the implementation of this alternative.

Costs

Costs associated with excavation and treatment by chemical extraction are presented in Tables 5.9 and 5.10. The total cost for excavation and treatment by chemical extraction for an industrial-use scenario including application of institutional controls, would be $1,159,940. Alternatively, the total cost for excavation and treatment by chemical extraction for a residential-use scenario would be $1,657,420. These costs were calculated based on the worst case, which is all excavated soil is characterized as hazardous waste. If the excavated soil were distributed between the nonhazardous and hazardous based on TCLP characterization, the actual total cost would be less. No O&M costs are associated with this alternative.

Table 5.9
Excavation and Treatment by Chemical Extraction
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Excavation			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	5,500 ft^2	$4.00/$ft^2$	$22,000
Hauling to Landfill	21 hrs	$80/hr	$1,680
Disposal	140 yd^3	$20/$yd^3$	$2,800
Site Preparation	670 yd^3	$1.50/$yd^3$	$1,000
Soil Excavation	670 yd^3	$20/$yd^3$	$13,400
Confirmation/TCLP Samples	35 samples	$100/sample	$3,500
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$99,380**
Chemical Extraction			
Site Preparation	LS	$125,000	$125,000
Mobilize and Assemble	LS	$166,500	$166,500
Pretreatment Unit	LS	$55,500	$55,500
Start-up Charge	LS	$33,800	$33,800
Decontaminate/Demobilize	LS	$75,300	$75,300
Process Equipment Rental	1 month	$164,000/m	$164,000
Process Labor	1 month	$57,700/m	$57,700
Consumables	670 yd^3	$34/$yd^3$	$22,780
Engineering/Oversight	LS	20% cost	$159,990
Contingency/Miscellaneous	LS	25% cost	$199,990
Subtotal			**$1,060,560**
Total			**$1,159,940**

Table 5.10
Excavation and Treatment by Chemical Extraction
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Removal Action			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	24,000 ft^2	$4.00/ft^2	$96,000
Hauling to Landfill	90 hrs	$80/hr	$7,200
Disposal	600 yd^3	$20/yd^3	$12,000
Site Preparation	1,000 yd^3	$1.50/yd^3	$1,500
Soil Excavation	2,950 yd^3	$20/yd^3	$59,000
Confirmation/TCLP Samples	150 samples	$100/sample	$15,000
Subtotal			**$195,700**
Chemical Extraction			
Site Preparation	LS	$125,000	$125,000
Mobilize and Assemble	LS	$166,500	$166,500
Pretreatment Unit	LS	$55,500	$55,500
Start-up Charge	LS	$33,800	$33,800
Decontaminate/Demobilize	LS	$75,300	$75,300
Process Equipment Rental	2 month	$164,000/m	$328,000
Process Labor	2 month	$57,700/m	$115,400
Consumables	2,950 yd^3	$34/yd^3	$100,300
Engineering/Oversight	LS	20% cost	$228,610
Contingency/Miscellaneous	LS	25% cost	$285,760
Subtotal			**$1,514,170**
Total			**$1,657,420**

5.2.5 Alternative 5: Excavation and Treatment by Soil Washing

Soil washing separates contaminants sorbed onto fine soil particles from bulk soil in an aqueous-based system based on particle size. In this process, all contaminated soil exceeding concentrations calculated using the USEPA Blood Concentration Model would be excavated and treated or disposed of. The excavated soil would be stockpiled onsite and sampled for waste characterization by TCLP. Soil characterized as nonhazardous would be disposed of in Subtitle D landfill. Soil characterized as hazardous waste would be washed with water augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove contaminants. The cleaned soil fraction can be returned to the site for continued use.

Soil washing removes contaminants from soils by either:

- Dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH).

- Concentrating them into a smaller volume of soil through particle-size separation, gravity separation, and attrition scrubbing.

Soil washing is a media transfer technology. The contaminated water generated from soil washing must be treated for lead.

To achieve the residential scenario remedial objective (<400 mg/kg lead), approximately 670 yd^3 of soil would require excavation/treatment. To achieve the industrial scenario remedial objective (<1,300 mg/kg lead), approximately 2,950 yd^3 of soil would require excavation/treatment. Institutional controls would be required to minimize uncontrolled exposure for the industrial scenario.

5.2.5.1 Excavation and Treatment by Soil Washing: Primary Criteria

Overall Protection of Human Health and the Environment

Excavation and treatment by soil washing protects human health and the environment by removing soil contaminants exceeding concentrations calculated using the USEPA Blood Concentration

Model. This alternative would eliminate risk to human health and the environment due to dermal and gastrointestinal contact. Appropriate institutional controls are required for the industrial reuse remediation option.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and chemical-specific regulations.

Attainment of Cleanup Standards

Excavation and treatment by soil washing would attain media cleanup standards as established by the Project Team. Contaminated soil would be excavated at select locations until confirmation samples satisfy remedial objectives. The contaminated soil would be treated to remove contaminants then backfilled to the site. Soil washing typically takes one to two months for this volume of soil.

Source Control

This alternative would provide effective source control by removing contaminants from the most contaminated soil. Institutional controls for the industrial reuse scenario would further reduce the likelihood of additional risks by eliminating potential exposure pathways to residual contamination.

Compliance with Waste Management Standards

Excavation and treatment by soil washing meets chemical-specific regulations for the site-wide remedial objectives protective of future industrial site workers under the industrial reuse scenario and future site residents under the residential reuse scenario. Excavation and treatment activities onsite may require compliance with federal, state, and local air emissions and storm water control regulations. Treated soil would be analyzed to determine residual lead concentrations. No location-specific regulations would be triggered by this alternative.

5.2.5.2 Excavation and Treatment by Soil Washing: Secondary Criteria

Long-term Reliability and Effectiveness

This alternative would reduce the quantity of soil in which contaminant concentrations exceed concentrations calculated using the USEPA Blood Concentration Model. Minor institutional controls may be required for the industrial reuse scenario to ensure that any exposure to human and environmental receptors would be within protective levels.

Soil washing does not destroy contaminants — instead the contaminants are separated from the soil, thereby reducing the hazardous waste volume. Because the contaminants are transferred from the soil to the wash water, this wastewater requires further treatment.

Reduction of Toxicity, Mobility, or Volume

Soil washing reduces site contamination by removing contaminants from the soil. With this alternative, site toxicity, contaminant mobility, and hazardous waste volume would be reduced. Residual contamination would remain onsite at concentrations below remedial objectives.

Short-Term Effectiveness

The excavation and treatment operation would be sufficiently removed from the public to reduce health and safety concerns associated with soil removal. Temporary fencing would be installed around the work zone to control site access to remediation workers only. Remediation workers would be exposed to increased particulate emissions and might also have more dermal contact with hazardous constituents. However, worker risks can be reduced by implementing dust control technologies and a site-specific health and safety plan specifying PPE, respiratory protection, etc. Remedial objectives can probably be met in approximately one month. Consequently, worker exposure to the contaminants would be minimal.

Implementability

Soil washing is technically and administratively feasible at Combined SWMU 2. Commercial-scale units for soil washing are available. The potential technical problems that might slow remediation activities are concrete, asphalt, and rail line removal to access contaminated soil, materials handling, backfilling to the site (standby time between confirmatory sampling and backfill), and potential foundation support measures (if required). The soil volumes are moderately small (approximately 2,950 yd^3), but approximately 60% of the contaminated soil is beneath reinforced concrete and/or asphalt and/or rail lines. No future remedial actions would be required after this alternative is completed.

Currently access to Combined SMWU 2 is through property leased to Carolina Marine Handling. This tenant's traffic, parking, and material storage practices may slow the implementation of this alternative.

Cost

Costs associated with excavation and treatment by soil washing are presented in Tables 5.11 and 5.12. The total cost for excavation and treatment by soil washing for an industrial use scenario, including application of institutional controls, would be $619,310. Alternatively, the total cost for excavation and treatment by soil washing for a residential-use scenario would be $914,520. These costs were calculated based on the worst case, which is all excavated soil is characterized as hazardous waste. If the excavated soil were distributed between the nonhazardous and hazardous based on TCLP characterization, the actual total cost would be less. No O&M costs are associated with this alternative.

Table 5.11
Excavation and Treatment by Soil Washing
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Excavation			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	5,500 ft^2	$4.00/$ft^2$	$22,000
Hauling to Landfill	21 hrs	$80/hr	$1,680
Disposal	140 yd^3	$20/$yd^3$	$2,800
Site Preparation	670 yd^3	$1.50/$yd^3$	$1,000
Soil Excavation	670 yd^3	$20/$yd^3$	$13,400
Confirmation/TCLP Samples	35 samples	$100/sample	$3,500
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$99,380**
Soil Washing			
Site Preparation	LS	$125,000	$125,000
Mobilize/Demobilize	LS	$15,000	$15,000
Pretreatment Unit	LS	$55,500	$55,500
Startup/Shakedown	LS	$17,000	$17,000
Decontaminate	LS	$250	$250
Process Equipment Rental	1 month	$81,000/m	$81,000
Process Labor	36 hours	$255/hr	$9,180
Maintenance/Spare Parts	900 tons	$2.24/ton	$2,020
Consumables	670 yd^3	$34/$yd^3$	$22,780
Engineering/Oversight	LS	20% cost	$85,420
Contingency/Miscellaneous	LS	25% cost	$106,780
Subtotal			**$519,930**
Total			**$619,310**

Table 5.12
Excavation and Treatment by Soil Washing
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Removal Action			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	24,000 ft^2	$4.00/$ft^2$	$96,000
Hauling to Landfill	90 hrs	$80/hr	$7,200
Disposal	600 yd^3	$20/$yd^3$	$12,000
Site Preparation	1,000 yd^3	$1.50/$yd^3$	$1,500
Soil Excavation	2,950 yd^3	$20/$yd^3$	$59,000
Confirmation/TCLP Samples	150 samples	$100/sample	$15,000
Subtotal			**$195,700**
Soil Washing			
Site Preparation	LS	$125,000	$125,000
Mobilize/Demobilize	LS	$15,000	$15,000
Pretreatment Unit	LS	$55,500	$55,500
Startup/Shakedown	LS	$17,000	$17,000
Decontaminate	LS	$250	$250
Process Equipment Rental	1 month	$95,000/m	$95,000
Process Labor	80 hours	$340/hr	$27,200
Consumables	2,950 yd^3	$34/$yd^3$	$100,300
Engineering/Oversight	LS	20% cost	$126,190
Contingency/Miscellaneous	LS	25% cost	$157,380
Subtotal			**$718,820**
Total			**$914,520**

5.2.6 Alternative 6: Ex Situ Solidification/Stabilization

1 Solidification/stabilization (S/S) reduces the mobility of hazardous substances and contaminants in the environment physically and chemically. Ex situ S/S offers greater control of the mixing

process than in situ S/S. With ex situ S/S the soil is excavated, stockpiled onsite, and sampled for waste characterization by TCLP. Soil characterized as nonhazardous would be disposed of in Subtitle D landfill. Soil characterized as hazardous waste would be screened to ensure homogeneity, then treated by S/S: (1) mixing a reagent with the soil, (2) curing the mixed product, and (3) storage or landfilling the treated soil. The end products of S/S have potential reuse value as construction or fill material. If the product can be used, the expenses of disposal or landfilling can be eliminated.

All contaminated soil exceeding concentrations calculated using the USEPA Blood Concentration Model would be excavated and treated onsite. Institutional controls would be required to minimize uncontrolled exposure for the industrial scenario.

To achieve the residential scenario remedial objective (<400 mg/kg lead), approximately 670 yd^3 of soil would require excavation/treatment. To achieve the industrial scenario remedial objective (<1,300 mg/kg lead), approximately 2,950 yd^3 of soil would require excavation/treatment.

5.2.6.1 Ex Situ Solidification/Stabilization: Primary Criteria

Overall Protection of Human Health and the Environment

Ex situ S/S with offsite disposal protects human health and the environment by removing and treating contaminated soil exceeding concentrations calculated using the USEPA Blood Concentration Model. This alternative would eliminate risk to human health and the environment due to dermal and gastrointestinal contact.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and chemical-specific regulations.

Attainment of Cleanup Standards

Ex situ S/S would attain media cleanup standards as established by the Project Team. Contaminated soil would be excavated at select locations until confirmation samples satisfy remedial objectives. Excavated soil would then be treated by S/S to physically bind the contaminants.

Source Control

This alternative would provide effective source control by eliminating the most contaminated media. For the industrial scenario, institutional controls would reduce the likelihood of additional risks by eliminating potential exposure pathways to residual contamination.

Compliance with Waste Management Standards

Ex situ S/S meets chemical-specific regulations for the associated site-wide remedial objectives protective of future industrial site workers. Excavation and treatment activities onsite may require compliance with federal, state, and local air emissions and storm water control regulations. Transportation offsite would trigger DOT regulations. Land disposal restrictions would be triggered if the contaminated soil were determined to be a hazardous waste. TCLP analysis would be performed to verify that the treated soil is nonhazardous. No location-specific regulations would be triggered by this alternative.

5.2.6.2 Ex Situ Solidification/Stabilization: Secondary Criteria

Long-term Reliability and Effectiveness

This alternative would remove and treat the contaminated soil that exceeds concentrations calculated using the USEPA Blood Concentration Model.

Ex situ S/S is a reliable treatment option that eliminates onsite risks. Because the excavated soil is treated to bind contaminants, future liability for this option is less than it would be for the excavation and offsite disposal alternative.

Reduction of Toxicity, Mobility, or Volume

Ex situ S/S eliminates contaminants that exceed remedial objectives by removing them from the site. This alternative includes the removal of the most contaminated soil, treatment to bind the contaminants, and disposal in a Subtitle D landfill. Because the source would no longer remain onsite, this alternative is considered to be irreversible. Contaminant mobility is reduced with this alternative; however, the waste volume could double.

Short-Term Effectiveness

The excavation and treatment remedy would be sufficiently removed from the public to reduce health and safety concerns associated with this operation. Temporary fencing would be installed around the work zone to control site access to remediation workers only. Workers would be exposed to increased particulate emissions and might also have more dermal contact with hazardous constituents. However, worker risks can be reduced by implementing dust control technologies and a site-specific health and safety plan specifying PPE, respiratory protection, etc. Remedial objectives could probably be achieved within one to two months. Consequently, worker exposure to the contaminants would be short-term and minimal.

Implementability

Ex situ S/S with offsite disposal is technically and administratively feasible for this site. Ex situ S/S with offsite disposal is a common remedial alternative that has been applied at previous sites. The potential technical problems that might slow remediation activities are concrete, asphalt, and rail line removal to access contaminated soil, materials handling and disposal (standby time between confirmatory sampling and disposal), and potential foundation support measures (if required). The soil volumes are moderately small (approximately 2,950 yd^3), but approximately 60% of the contaminated soil is beneath reinforced concrete and/or asphalt and/or rail lines. No future remedial actions would be required after this alternative is completed.

Ex situ S/S may require up to 4,000 tons of binding material. The Bee's Ferry Landfill in Charleston, SC is a Subtitle D facility, which has accepted nonhazardous material from interim removal actions on the base.

Currently access to Combined SWMU 2 is through property leased to Carolina Marine Handling. This tenant's traffic, parking, and material storage practices may slow the implementation of this alternative.

Costs

Costs associated with ex situ S/S with offsite disposal are presented in Tables 5.13 and 5.14. The total cost for ex situ S/S with offsite disposal to a nonhazardous, Subtitle D landfill would be $404,480 for the industrial scenario and $1,022,180 for the residential scenario. These costs were calculated based on the worst case, which is all excavated soil is characterized as hazardous waste. If the excavated soil were distributed between the nonhazardous and hazardous based on TCLP characterization, the actual total cost would be less. No O&M costs are associated with this alternative.

Table 5.13
Ex Situ Solidification/Stabilization
Industrial Scenario

Action	Quantity	Cost per Unit	Total Cost
Excavation			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	5,500 ft^2	$4.00/ft^2	$22,000
Hauling to Landfill	21 hrs	$80/hr	$1,680
Disposal	140 yd^3	$20/yd^3	$2,800
Site Preparation	670 yd^3	$1.50/yd^3	$1,000
Soil Excavation	670 yd^3	$20/yd^3	$13,400
Confirmation/TCLP Samples	35 samples	$100/sample	$3,500
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$99,380**
Solidification/Stabilization			
Site Preparation	LS	$40,000	$40,000
Mobilize/Demobilize	LS	$15,000	$15,000
Screening Unit	LS	$15,000	$15,000
Decontaminate	LS	$250	$250
Process Equipment Rental	1 month	$15,000/m	$15,000
Process Labor	96 hours	$45/hr	$4,320
Chemical Additives	900 tons	$100/ton	$90,000
Engineering/Oversight	LS	20% cost	$55,790
Contingency/Miscellaneous	LS	25% cost	$69,740
Subtotal			**$305,100**
Total			**$404,480**

Table 5.14
Ex Situ Solidification/Stabilization
Residential Scenario

Action	Quantity	Cost per Unit	Total Cost
Excavation			
Mobilization/Demobilization	LS	$5,000	$5,000
Existing Surface Cover Excavation	24,000 ft^2	$4.00/$ft^2$	$96,000
Hauling to Landfill	90 hrs	$80/hr	$7,200
Disposal	600 yd^3	$20/$yd^3$	$12,000
Site Preparation	1,000 yd^3	$1.50/$yd^3$	$1,500
Soil Excavation	2,950 yd^3	$20/$yd^3$	$59,000
Confirmation/TCLP Samples	150 samples	$100/sample	$15,000
Subtotal			**$195,700**
Solidification/Stabilization			
Site Preparation	LS	$40,000	$40,000
Mobilize/Demobilize	LS	$15,000	$15,000
Screening Unit	LS	$15,000	$15,000
Decontaminate	LS	$250	$250
Process Equipment Rental	2 months	$15,000/m	$30,000
Process Labor	200 hours	$45/hr	$9,000
Chemical Additives	4,000 tons	$100/ton	$400,000
Engineering/Oversight	LS	20% cost	$140,990
Contingency/Miscellaneous	LS	25% cost	$176,240
Subtotal			**$826,480**
Total			**$1,022,180**

5.3 Comparative Analysis of Soil Alternatives

This section comparatively analyzes soil remedial alternatives, examining potential advantages and disadvantages according to each of the nine criteria. All the alternatives evaluated in Section 5.2 are technically feasible, implementable, and have been developed and used at other sites. All alternatives generally protect human health. All alternatives, except institutional control, protect the environment. State and community acceptance would be determined in the same manner for each alternative. The key criteria that distinguish the soil alternatives focus are long-term reliability and effectiveness, reduction of mobility, toxicity, and volume, short-term effectiveness, implementability, and cost.

5.3.1 Primary Criteria

All alternatives considered for selection must comply with the primary criteria: protection of human health and the environment, attainment of cleanup standards, source control, and compliance with applicable waste management standards.

Overall Protection of Human Health and the Environment

This criterion evaluates the overall degree of protectiveness afforded to human health and the environment. It draws on the assessments conducted under other evaluation criteria, especially the other three primary criteria.

Alternative 1, a low-permeability surface cap, would protect receptors by limiting contact with contaminated soil and reducing mobility by reducing rainwater infiltration. The soil would remain onsite, but risks would be reduced by elimination of dermal contact and ingestion pathways.

Alternative 2, in situ solidification/stabilization, would protect human health and the environment by immobilizing contaminants that contribute to site risk. This alternative eliminates dermal contact and ingestion pathways.

Alternative 3, excavation and offsite disposal, protects human and health and the environment by removing affected soil media. Excavation and offsite disposal aim to remove point risk to remedial objectives.

Alternative 4, excavation and treatment by chemical extraction, protects human health and the environment by transferring contaminants from the soil to an extractant, which is treated and disposed of. This alternative would eliminate dermal contact and ingestion pathways.

Alternative 5, excavation and treatment by soil washing, protects human health and the environment by transferring contaminants from the soil to wash water, which is treated and disposed of. This alternative would eliminate dermal contact and ingestion pathways.

Alternative 6, ex situ solidification/stabilization, protects human health and the environment by removing and immobilizing contaminants that contribute to site risk. This alternative would eliminate dermal contact and ingestion pathways.

Attainment of Cleanup Standards

Alternative 1 would not comply with remedial objectives for protection of human health and the environment because the contaminated soil would remain onsite; however, the risk pathway is eliminated by capping the contaminated soil.

Alternative 2 would comply with remedial objectives by chemically and physically binding contaminants, eliminating dermal and gastrointestinal contact.

Alternative 3 would comply with remedial objectives by removing soil in which contaminants exceed remedial objectives.

Alternatives 4 and 5 would comply with remedial objectives by removing contaminants that exceed remedial objectives from the soil.

Alternative 6 would comply with remedial objectives by removing and immobilizing soil in which contaminants exceed remedial objectives.

Source Control

Alternative 1 would not remove the source. However, this alternative would effectively control the source by eliminating further releases that may threaten human health or the environment. However, contaminated soil would remain onsite.

Alternative 2 would effectively control the source by chemically and physically binding contaminants, limiting contamination exposure pathways.

Alternative 3 would effectively control the source by eliminating soil in which contaminants exceed remedial objectives. Soil below remedial objectives will remain onsite.

Alternatives 4, 5, and 6 would effectively control the source by removing contaminants that contribute to site risk from the soil. Soil below remedial objectives would remain onsite.

Compliance with Waste Management Standards

Alternative 1, a low-permeability surface cap, would isolate contaminants in environmental media that exceed remedial objectives, but not manage solid or hazardous waste. Site grading would need to comply with federal, state, and local air emissions and storm water control regulations.

Alternative 2 meets remedial objectives.

Alternative 3 also meets remedial objectives. Excavation activities onsite might require compliance with federal, state, and local air emissions and storm water control regulations. Transportation and land disposal restrictions would be triggered when contaminated soil is disposed of offsite. Although excavated soil is probably nonhazardous, it would be analyzed by TCLP for verification.

Alternatives 4, 5, and 6 meet remedial objectives. Excavation activities onsite might require compliance with federal, state, and local air emissions and storm water control regulations.

For Alternative 6, transportation and land disposal restrictions would be triggered when treated soil is disposed of offsite. Although the treatment standard for S/S soil is a nonhazardous product, it would be analyzed by TCLP for verification.

5.3.2 Secondary Criteria

Five secondary criteria typically highlight the major differences between the alternatives: long-term reliability and effectiveness; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost.

Long-term Reliability and Effectiveness

Alternative 1 would effectively reduce site worker contact with the contaminated soil. However, institutional controls and routine O&M would required to ensure that any exposure to human and environmental receptors is within protective levels.

The effects of weathering (e.g., freeze-thaw cycles, acid precipitation, and wind erosion), groundwater infiltration, and physical disturbance associated with uncontrolled future land use on Alternative 2's integrity are not certain.

Alternative 3 would remove soil in which contaminant concentrations exceed remedial objectives.

Alternatives 4 and 5 would remove contaminants from soil where contaminant concentrations exceed remedial objectives.

Alternative 6 would remove and immobilize soil in which contaminant concentrations exceed remedial objectives.

Reduction of Toxicity, Mobility, or Volume

Alternative 1, capping, would not remove, treat, or remediate the contaminated soil; it provides containment only. The soil and combination covers are considered reversible since the contaminants exceeding remedial objectives remain onsite. Regular maintenance would be required to ensure continued cover integrity.

Alternative 2, in situ solidification/stabilization reduces mobility effectively by immobilizing contaminants that contribute to site risk in the soil.

Alternative 3, excavation and offsite disposal, would eliminate the contaminants that affect site remedial objectives. However, the waste's overall toxicity, mobility, and volume would not be reduced with this alternative since the contaminated soil would merely be transferred to another location (Subtitle C or D landfill).

Alternatives 4 and 5 would remove the contaminants that affect site remedial objectives and reduce waste volume, but create waste streams requiring further treatment.

Alternative 6, ex situ S/S, would remove and immobilize the contaminants that affect site remedial objectives. However, waste volume can increase as much as double.

Short-term Effectiveness

All six alternatives would expose workers to contaminants, which could be effectively controlled using engineering controls and appropriate PPE during grading, capping, or excavating. Remediation would take from one to three months.

Implementability

All six alternatives are implementable at Combined SWMU 2 and are technically and administratively feasible. Services and materials required for all alternatives are available.

Costs

Capital (indirect and direct), O&M, and net present worth for all six alternatives are presented in Table 5.15. Alternatives range from $199,970 for excavation and offsite disposal at a Subtitle D landfill for the industrial reuse scenario to $1,663,950 for excavation and offsite disposal at a Subtitle C landfill for the residential reuse scenario.

Table 5.15
Soil Alternatives Cost Comparison

Alternative	Reuse Scenario	Capital Costs	Annual O&M	Net Present Worth
1a Low-permeability Soil Cap	Industrial	$132,000	$6,000	$214,600
	Residential	$298,555	$6,000	$381,155
1b Low-permeability Concrete Cap	Industrial	$140,310	$7,000	$236,710
	Residential	$224,025	$7,000	$320,425
2 In Situ Stabilization/ Solidification	Industrial	$375,095	none	$375,095
	Residential	$944,540	none	$944,540
3a Excavation and Offsite Disposal (Subtitle D)	Industrial	$199,970	none	$199,970
	Residential	$228,450	none	$519,460
3b Excavation and Offsite Disposal (Subtitle C)	Industrial	$458,620	none	$318,970
	Residential	$1,663,950	none	$1,159,350

Table 5.15
Soil Alternatives Cost Comparison

Alternative	Reuse Scenario	Capital Costs	Annual O&M	Net Present Worth
4 Excavation and Treatment by Chemical Extraction	Industrial	$1,159,940	none	$1,159,940
	Residential	$1,657,420	none	$1,657,420
5 Excavation and Treatment by Soil Washing	Industrial	$619,310	none	$619,310
	Residential	$914,520	none	$914,520
6 Ex Situ Solidification/ Stabilization	Industrial	$404,480	none	$404,480
	Residential	$1,022,180	none	$1,022,180

5.4 Summary and Ranking of Alternatives

Per the Projects Team's request, each soil alternative was scored for each of the primary and secondary criteria based on the comparative analysis of alternatives in Section 5.3. For primary criteria the scoring methodology is presented as:

- **0** — criteria not met
- **1** — criteria may be met
- **2** — criteria met
- **3** — criteria exceeded

For secondary criteria, the scoring methodology is presented as:

- **0** — poor
- **1** — below average
- **2** — average
- **3** — above average

The scores can be multiplied by a weighting factor to emphasize their importance. At this time, all criteria have been equally weighted. A comment is included to justify each score and summarize the comparative analysis discussed in Section 5.3. Finally, the scores for each criteria are summed to develop an overall score for each alternative, which is used to rank the six remedial alternatives and provide a tool for selecting the final site remedy. The results are summarized in Table 5.16.

The recommended final site remedy is discussed in Section 6.

Table 5.16. Summary of Evaluation of Soil Alternatives

Primary and Secondary Criteria — Alternative 1 Description: Low-Permeability Surface Cap

Evaluation Criteria	Weighting Factor (WF)[1]	Residential Scenario - Lead in Soil < 400 mg/kg: Comments	Score[2]	Score x WF	Industrial Scenario - Lead in Soil < 1300 mg/kg: Comments	Score[2]	Score x WF
Primary Criteria							
Protection of Human Health and Environment	1	Contaminant remains onsite, but human contact with soil is limited and infiltration of rainwater is reduced.	2	2	Contaminant remains onsite, but human contact with soil is limited and infiltration of rainwater is reduced.	2	2
Attainment of Media Cleanup Standards	1	Contaminants are not removed.	0	0	Contaminants are not removed.	0	0
Control the Source of Releases	1	Infiltration of rainwater is reduced, significantly reducing leachate generation.	2	2	Infiltration of rainwater is reduced, significantly reducing leachate generation.	2	2
Compliance with Any Applicable Standards for Waste Management	1	Will comply with LDRs and DOT regulations.	2	2	Will comply with LDRs and DOT regulations	2	2
Secondary Criteria							
Long-term Reliability and Effectiveness	1	Cover must be maintained to ensure that any exposure to human and environmental receptors is within protective levels.	1	1	Cover must be maintained to ensure that any exposure to human and environmental receptors is within protective levels.	1	1
Reduction in Toxicity, Mobility, and Volume	1	Toxicity and volume are not reduced. Mobility is reduced.	1	1	Toxicity and volume are not reduced Mobility is reduced	1	1
Short-term Effectiveness	1	Among alternatives, this technology offers minimal exposure to site workers.	2	2	Among alternatives, this technology offers minimal exposure to site workers.	2	2
Implementability	1	This technology is fully developed and is effective at reducing contact, ingestion, and inhalation risks.	2	2	This technology is fully developed and is effective at reducing contact, ingestion, and inhalation risks.	2	2
Cost	1	37,000 ft² est. cost $320,425	3	3	8500 ft² est. cost $214,600	3	3
Ranking Score				15			15

Alternative 2 Description: In Situ Solidification/Stabilization

Evaluation Criteria	Residential Scenario - Lead in Soil < 400 mg/kg: Comments	Score[2]	Score x WF	Industrial Scenario - Lead in Soil < 1300 mg/kg: Comments	Score[2]	Score x WF
Primary Criteria						
Protection of Human Health and Environment	Contaminant remains onsite, but mobility and ingestion risk are reduced.	2	2	Contaminant remains onsite, but mobility and ingestion risk are reduced.	2	2
Attainment of Media Cleanup Standards	Contaminants are physically bound, eliminating dermal and gastrointestinal contact.	2	2	Contaminants are physically bound, eliminating dermal and gastrointestinal contact.	2	2
Control the Source of Releases	The source (residual lead contamination in soil above the remedial objective) will be physically bound to eliminate further releases.	2	2	The source (residual lead contamination in soil above the remedial objective) will be physically bound to eliminate further releases.	2	2
Compliance with Any Applicable Standards for Waste Management	Will comply with LDRs and DOT regulations.	2	2	Will comply with LDRs and DOT regulations	2	2
Secondary Criteria						
Long-term Reliability and Effectiveness	Future use of the site may degrade the treatment and affect ability to maintain immobilization of contaminants.	1	1	Future use of the site may degrade the treatment and affect ability to maintain immobilization of contaminants.	1	1
Reduction in Toxicity, Mobility, and Volume	Mobility is reduced Volume may double	1	1	Mobility is reduced. Volume may double.	1	1
Short-term Effectiveness	Appropriate PPE should be worn to minimize site worker exposure to contaminants during implementation (about 3 months).	1	1	Appropriate PPE should be worn to minimize site worker exposure to contaminants during implementation (about 1 month).	2	2
Implementability	This technology is fully developed and is effective at reducing contact, ingestion, and inhalation risks	1	1	This technology is fully developed and is effective at reducing contact, ingestion, and inhalation risks.	1	1
Cost	est cost $944,540	2	2	est. cost $375,095	2.5	2.5
Ranking Score			14			15.5

Alternative 3 Description: Excavation and Offsite Disposal at Landfill

Evaluation Criteria	Residential Scenario - Lead in Soil < 400 mg/kg: Comments	Score[2]	Score x WF	Industrial Scenario - Lead in Soil < 1300 mg/kg: Comments	Score[2]	Score x WF
Primary Criteria						
Protection of Human Health and Environment	Removes soil to a restricted access area where exposure pathways are minimal.	3	3	Removes soil to a restricted access area where exposure pathways are minimal.	3	3
Attainment of Media Cleanup Standards	No soil will remain onsite in excess of the remedial objective.	3	3	No soil will remain onsite in excess of the remedial objective.	3	3
Control the Source of Releases	The source (residual lead contamination in soil) will be removed.	3	3	The source (residual lead contamination in soil) will be removed.	3	3
Compliance with Any Applicable Standards for Waste Management	Will comply with LDRs and DOT regulations.	2	2	Will comply with LDRs and DOT regulations.	2	2
Secondary Criteria						
Long-term Reliability and Effectiveness	No lead contamination >400 mg/kg will be left in place.	3	3	No lead contamination >1300 mg/kg will be left in place.	2	2
Reduction in Toxicity, Mobility, and Volume	Waste will be transported to a landfill and buried in it. Mobility will be restricted, but there will be no reduction in volume or toxicity.	1	1	Waste will be transported to a landfill and buried in it. Mobility will be restricted, but there will be no reduction in volume or toxicity.	1	1
Short-term Effectiveness	Among remedial objectives for this alternative, moderate exposure to site workers during excavation.	2	2	Among remedial objectives, least exposure to site workers during excavation	2	2
Implementability	Excavation is a common practice. Project duration = 3 months	3	3	Excavation is a common practice. Project duration = 1 month.	3	3
Cost	2950 yd³; est. cost $318,970 to $1,159,350	2	2	670 yd³; est. cost $199,970 to $519,460	3	3
Ranking Score			22			22

Alternative 4 Description: Excavation and Treatment by Chemical Extr

Evaluation Criteria	Residential Scenario - Lead in Soil < 400 mg/kg: Comments	Score[2]	Score x WF	Remedial Ob Industrial Sce < 1: Comments
Primary Criteria				
Protection of Human Health and Environment	Soil is excavated and a high percentage of the lead contamination is removed by separation.	2	2	Soil is excavated a high percentage of contamination is re by separation.
Attainment of Media Cleanup Standards	No soil will remain onsite in excess of the remedial objective	3	3	No soil will remain excess of the reme objective.
Control the Source of Releases	Soil separated and returned to the site may have a small percentage of contaminants remaining.	2	2	Soil separated and to the site may hav small percentage contaminants rema
Compliance with Any Applicable Standards for Waste Management	Will comply with LDRs end DOT regulations	2	2	Will comply with L DOT regulations.
Secondary Criteria				
Long-term Reliability and Effectiveness	No lead contamination >400 mg/kg will be left in place.	3	3	No lead contamina >1300 mg/kg will b place.
Reduction in Toxicity, Mobility, and Volume	Further treatment or disposal of the process solution is required.	3	3	Further treatment disposal of the pro solution is require Among remedial o for this alternative process solution is generated.
Short-term Effectiveness	Among remedial objectives for this alternative, moderate exposure to site workers during excavation and high exposure during chemical extraction.	1	1	Among remedial o for this alternative, exposure to site w during excavation.
Implementability	This technology is fully developed and is effective at removing inorganics.	2	2	This technology is developed and is e at removing inorga
Cost	2950 yd³; est. cost $1,657,420	1	1	670 yd³; est. cost $1,159,9
Ranking Score			19	

1 - Weighting Factor assigned by project team consensus
2 - Evaluation Score Primary Criteria (0 - criteria not met; 1 - criteria may be met, 2 - criteria met, 3 - criteria exceeded)
Secondary Criteria: (0 - poor; 1 - below average; 2 - average, 3 - above average)
LDR - Land disposal restrictions
DOT - U S Department of Transportation

6.0 RECOMMENDATIONS

Of the six alternatives, Alternative 3, excavation to residential cleanup goals with offsite disposal, appears to be best. This alternative is easier to implement, provides as much or more long-term effectiveness than the other alternatives, and is generally more cost effective .

Due to the Navy's desire for unrestricted future use of the property, Alternatives 1 and 2 — low-permeability surface cap and in situ S/S — and cleanup to industrial goals for the remaining alternatives are disqualified. All of these alternatives would result in residual contamination remaining on the property that exceeds residential cleanup goals and requires implementation of institutional controls restrictive of future property reuse. Alternatives 3 through 6 for residential cleanup goals all result in removal of contaminated soils from the site and allow unrestricted future use of the property.

Alternatives 4, 5, and 6, excavation with pretreatment prior to disposal, are less preferable than Alternative 3 because they involve a more complex treatment train, generate residual wastes that must be managed in addition to excavated soils, and incur similar or greater costs to implement. In addition to stockpiles of saturated soils that must be contained and de-watered prior to transport for disposal, soil washing and chemical extraction produce residual wastewater that must be treated prior to disposal.

7.0 PUBLIC INVOLVEMENT PLAN

7.1 General

The following Public Involvement Plan (PIP) is included as part of this report in accordance with the EPA's guidance on RCRA CMS. This PIP reflects and summarizes information prepared and presented in the Navy's Community Relations Plan (CRP), prepared for Naval Base Charleston in 1995.

Under RCRA, there is no required interaction with the community during the Corrective Measures Study process. Public input is required to be solicited only at the beginning of the permitting process, or during certain permit modifications. Therefore, the Navy has outlined a voluntary program of informing local communities throughout the entire RCRA Corrective Action process. Activities are detailed in the 1995 CRP for the Naval Base Charleston.

However, because the CMS process results in a modification to the facility's RCRA permit, certain provisions are made to solicit the public's input on the preferred alternative (as the reason for the modification). The requirements are identical to those required for a draft permit.

Two primary objectives are stated in the CRP:

- To initiate and sustain community involvement.
- To provide a mechanism for communicating to the public

7.2 RFI Public Involvement Plan

To achieve these objectives, the CRP identifies public involvement and outreach activities at each step of the Corrective Action process. For example, the following activities have been designated for the completion of the RFI. All have been accomplished.

- Update and publicize the information repository.

- Continue to publicize the point of contact.

- Update the mailing list.

- Distribute fact sheets and/or write articles to explain RFI findings.

- Inform community leaders of the completion and results of the RFI.

- Update and continue to provide, whenever possible, presentations for informal community groups.

- Update the community on results of the RFI through public Restoration Advisory Board meetings.

7.3 CMS Public Involvement Plan

During the Corrective Measures Study, the following activities will be carried out as part of the Navy's current and ongoing community involvement program.

- Distribute a fact sheet and/or write articles for publication that report CMS recommendations.

- Continue to update the mailing list.

- Continue to respond to requests for speaking engagements.

- Update the community on CMS status through public Restoration Advisory Board meetings.

7.4 Statement of Basis Public Involvement Plan

Upon completion of the Corrective Measures Study, when the preferred alternative has been proposed, the following activities are required if a modification to the RCRA permit is required. If a permit modification is not necessary, the Navy may choose to implement all, some, or none of the following actions, depending on the level of public interest or concern:

- A Statement of Basis will be prepared, explaining the proposed remedy and the method by which it was chosen.

- A 45-day comment period will be provided to allow community members the opportunity to review and comment on the preferred alternative. The comment period may be as short as 30 days in cases where no permit modification is necessary, but a public comment period is warranted.

- Availability of the comment period and Statement of Basis will be announced in a public notice.

- The community will be provided an update on the proposed remedy through the informal and publicized Restoration Advisory Board meetings.

In addition, the following activities will be carried out, as identified in the CRP:

- Update and publicize the information repository.
- Publicize the environmental point of contact.

- Continue to update the mailing list.

7.5 Restoration Advisory Board

The RAB is a key component of this community outreach program. It is through the RAB that the Navy has a regular, scheduled, and publicized forum for interfacing with community members on the progress of the environmental program, including CMS. In addition, RAB members are key instruments in measuring community interest in specific issues and knowledge of them. A Community Relations Subcommittee to the RAB has been tasked with identifying issues and information to be addressed by the Navy.

8.0 REFERENCES

Delta Technologies Group, Inc. (1998). *Environmental Remediation Cost Data — Assemblies*, 4th Annual Edition, Kingston, MA: R.S. Means Company, Inc.

Delta Technologies Group, Inc. (1998). *Environmental Remediation Cost Data — Unit Price*, 4th Annual Edition, Kingston, MA: R.S. Means Company, Inc.

E/A&H. (1995). *Final Zones A&B RFI Work Plan*. Prepared for Department of the Navy, Southern Division Naval Facilities Engineering Command, Charleston, SC. Contract N62467-89-D-0318, September 6.

EnSafe, Inc. (1998). *Zone A RCRA Facility Investigation Report, NAVBASE Charleston,* Memphis, TN, August 7.

Federal Remediation Technologies Roundtable. (1997). *Remediation Technologies Screening Matrix and Reference Guide, 3rd Addition*, Arlington, Virginia, October.

Remedial Technologies Network, L.L.C. (1998). *Remediation Information Management System (RIMS),* Reston, Virginia.

Smith, L.A. *et al.* (1995). *Remedial Options for Metals-Contaminated Sites*, Library of Congress Catalogue Number 95-14984, CRC Press, Inc., Boca Raton, Florida.

USEPA. (1994). *RCRA Corrective Action Plan (Final)*, OSWER Directive 9902.3-2A, Office of Waste Programs Enforcement, Office of Solid Waste, May.

USEPA. (1997). *Technology Alternatives for the Remediation of Soils Contaminated with As, Cd, Cr, Hg, and Pb*, Engineering Bulletin, EPA/540/S-97/500, Office of Emergency and Remedial Response, Office of Research and Development, August.

USEPA. (1998). *Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, OSWER Directive 9200.4-27, Office of Solid Waste and Emergency Response, August.

USEPA. (1998). *Management of Remediation Waste Under RCRA* , EPA/530-F-98-026, Office of Solid Waste and Emergency Response, October.

USEPA Region III. (1998). *Risk-Based Concentration Table, July-December 1998*. October 1.

9.0 SIGNATORY REQUIREMENT

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of RCRA Part B Permit (EPA SCO 170 022 560) states: *All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with 40 CFR §270.11.* The certification reads as follows:

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

William A. Drawdy FOR
Henry N. Sheppard II, P.E.
Caretaker Site Office, Charleston

6/21/99
Date

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
CTO-029**

DRAFT ZONE A, SWMU 38
CORRECTIVE MEASURES STUDY REPORT

**Southdiv Contract Number:
N62467-89-D-0318**

Prepared for:

**Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina**

Prepared by:

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

**June 21, 1999
Revision No.: 0**

Table of Contents

List of Figures

List of Tables

ABBREVIATIONS, ACRONYMS AND SYMBOLS

CMS	Corrective Measures Study
CNC	Charleston Naval Complex
COCs	Chemicals of Concern
CRP	Community Relations Plan
DET	Navy Environmental Detachment
DRMO	Defense Reutilization Marketing Office
E/A&H	EnSafe/Allen & Hoshall
HSWA	Hazardous and Solid Waste Amendments
ISM	Interim Stabilization Measures
MCL	Maximum Contaminant Level
mg/kg	Milligrams per Kilogram
NA	Not Applicable
ND	Not Detected
NS	Sample not analyzed
OSWER	Office of Solid Waste and Emergency Response
PCBs	Polychlorinated Biphenyls
PIP	Public Involvement Plan
RAB	Restoration Advisory Board
RBC	Risk-based Concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RGO	Remedial Goal Option
SCDHEC	South Carolina Department of Health and Environmental Control
SOB	Statement of Basis
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SVOCs	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TPH	Total Petroleum Hydrocarbon
USEPA	United States Environmental Protection Agency

VOCs	Volatile Organic Compounds
$\mu g/L$	micrograms per liter
$\mu g/kg$	micrograms per kilogram
yd^3	cubic yards

1.0 INTRODUCTION

Zone A, SWMU 38 at the Charleston Naval Complex (CNC) was designated for a Corrective Measures Study (CMS) based on the presence of pesticides in soil from past application practices. An interim stabilization measures (ISM) was implemented by the Environmental Detachment Charleston (DET), Charleston, South Carolina, to remove pesticide contaminated soil.

As a result of the DET ISM and supplemental CMS sampling, this CMS Report does not include the evaluation of additional corrective measures at SWMU 38. This CMS addresses the DET ISM results and supplemental CMS sampling results in terms of a final site remedy. Because the pesticide contaminated soil at this site was removed by the ISM, technology screening and alternative evaluations (Sections 4.0 and 5.0) are not addressed in their entirety. However, at the request of SCDHEC, the statement of basis (SOB) will be completed for SWMU 38 following approval of this report.

2.0 SWMU 38 SITE DESCRIPTION

2.1 General

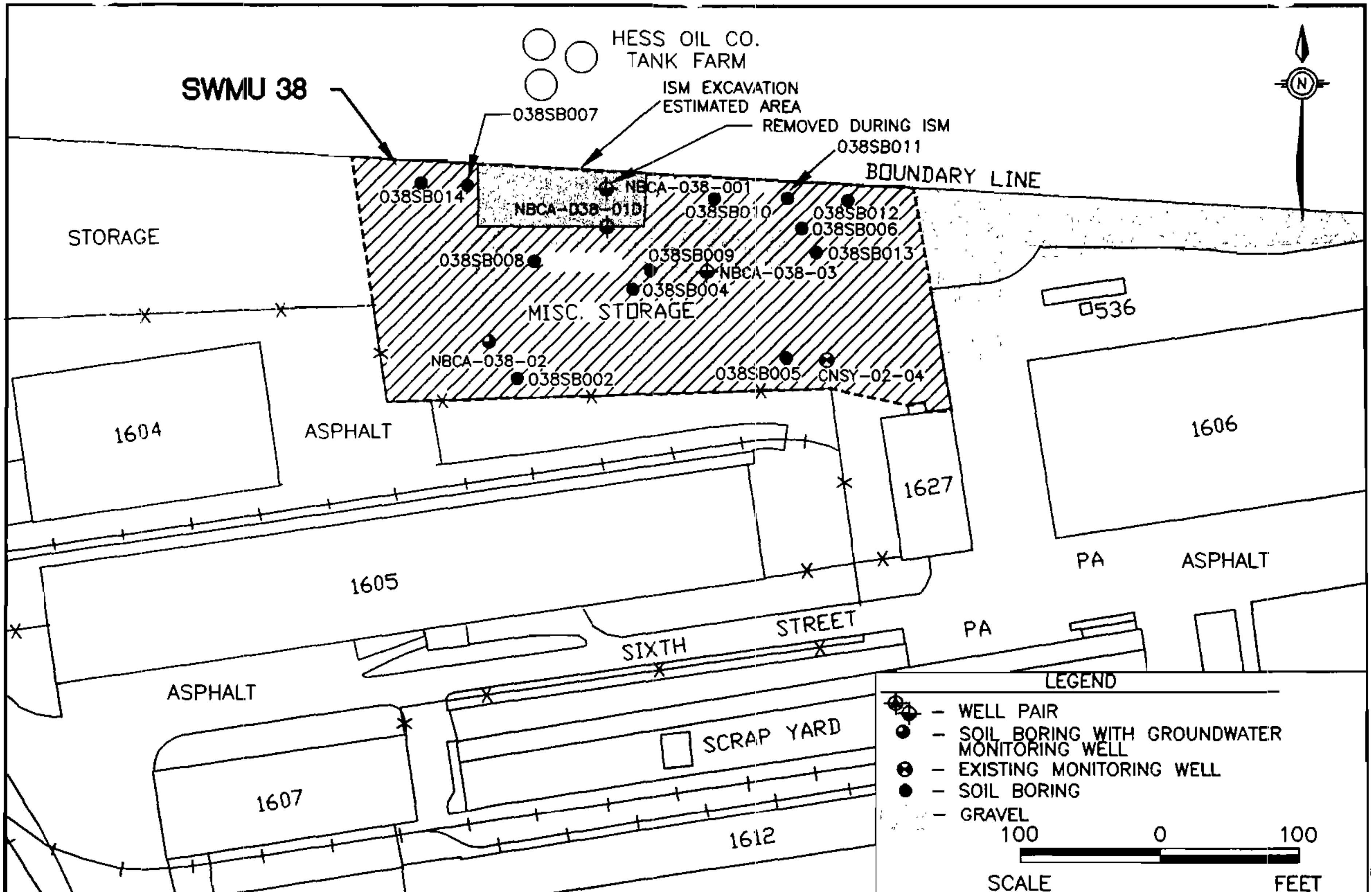
SWMU 38 is located north of Building 1605, near the northern boundary of the former naval base and just south of the Hess Oil, Inc., tank farm adjacent to this boundary. The site is immediately east of SWMU 39, and northwest of SWMU 2. Figure 2.1 shows site features as well as RCRA Facility Investigation (RFI) soil boring and monitoring well locations.

For approximately 50 years, SWMU 38 and the surrounding area were used as a storage yard associated with Buildings 1604 and 1605. Although originally used by the Supply Department, and before base closure in 1996, the Defense Reutilization Marketing Office (DRMO) used the SWMU 38 area to store empty drums and miscellaneous ship- and shore-based naval equipment and supplies. Most recently, the SWMU 38 area was used to store wooden pallets, automobiles, and boats. Routine pesticide applications prior to 1970 were reported to include DDT-based pesticides to treat areas likely to pond during rain.

The site is currently used by Carolina Marine Handling for storage of miscellaneous items. This reuse tenant occupies Building 1605, as well as other buildings in the immediate area and throughout the former naval base. According to the Naval Complex Redevelopment Authority, the site could be redeveloped for residential or industrial purposes.

2.2 Interim Stabilization Measures

The DET performed two ISM phases to remove contaminated soil in the area where pesticides were applied. The DET's *Completion Report* (*Interim Measure for SWMU 38, Naval Base Charleston, Charleston, South Carolina*, October 29, 1998) has been submitted to SCDHEC. A summary of each excavation follows.



ZONE A
RCRA CMS REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2.1
SWMU 38
SITE MAP

DWG DATE: 05/26/99 | DWG NAME: 2901M003

2.2.1 Initial Excavation

In April 1997, the DET excavated and disposed of two areas of pesticide- and polychlorinated biphenyls (PCB)-contaminated soil near RFI sample locations 038SB001 and 038SB003. Each excavation was 6 feet by 6 feet by 4 feet. According to the DET's *Completion Report*, excavated soil was characterized as hazardous U-listed waste and disposed at a certified Subtitle C landfill.

Confirmation samples collected after the excavation reflected the continued presence of pesticides in an area approximately 120 feet by 25 feet and approximately 3 to 4 feet deep. SCDHEC agreed that the soil was contaminated from pesticide application and therefore should not be considered a hazardous waste. A site-specific risk evaluation was conducted and residential risk-based cleanup goals were established for the pesticide constituents at 6.5 milligrams per kilogram (mg/kg) for DDT and DDE and 9.2 mg/kg for DDD. The DET's ISM work plan for the excavation was amended to include these goals and to excavate the 120 foot by 25 foot area to a depth of 4 to 5 feet.

2.2.2 Final Excavation

The work plan was approved by SCDHEC and the 120 foot by 25 foot area was excavated in August 1998, resulting in the removal of 519 cubic yards (yd^3) from the two excavations. Because groundwater was encountered, excavation was discontinued and, with SCDHEC approval in the October, 1998 Project Team Meeting, the site was backfilled and perimeter samples were collected and analyzed. The backfill was compacted, covered with gravel, and graded. Confirmatory sample results from the excavated area, as well as the area around the perimeter, are presented in Section 2.3.1. Most of the excavated soil, 503 yd^3, was disposed of at a Subtitle D Landfill. The other 16 yd^3 were classified as hazardous and disposed of at a Subtitle C Landfill.

2.2.3 DET ISM Conclusion

Based on confirmation sample results, the SWMU 38 excavation was successful in removing the dominant residential risk contributors at this site. However, the results from one confirmation sample (DET 37) exceeded the DDT residential risk-based remedial goal (6.5 mg/kg). This sample was from the surface of the north side of the excavated area next to the fence line separating SWMU 38 from the Hess Oil property. The residential point risk associated with the DDT concentration at this point (50.9 mg/kg) is 3.9E-05 and the industrial point risk is 8.7E-06. The residential site risk calculated with the 95% UCL using confirmation and perimeter samples (30mg/kg) is 2.5E-05.

Additional excavation to achieve a residential risk below 1E-06 was not attempted since groundwater was encountered and the excavation was at the fence line. During the October 1998 Project Team Meeting, SCDHEC agreed with backfilling the excavated site. Since the residential site risk is within the USEPA acceptable range of 1E-06 to 1E-04 and the residual contamination is representative of routine pesticide applications rather than a spill or release, additional excavation is not warranted.

2.3 RFI/CMS Sampling Results

During the RFI, soil was sampled to define the nature and extent of pesticide contamination and to evaluate the potential for petroleum-based groundwater contaminant plume migration from the Hess Oil, Inc., tank farm. In addition, confirmation sampling was conducted after each ISM. Results of RFI sampling reported in the *Zone A RFI Report* (EnSafe, 1998) and confirmation surface soil sampling as reported in the DET's *Completion Report* (U.S. Navy, 1998) are summarized below.

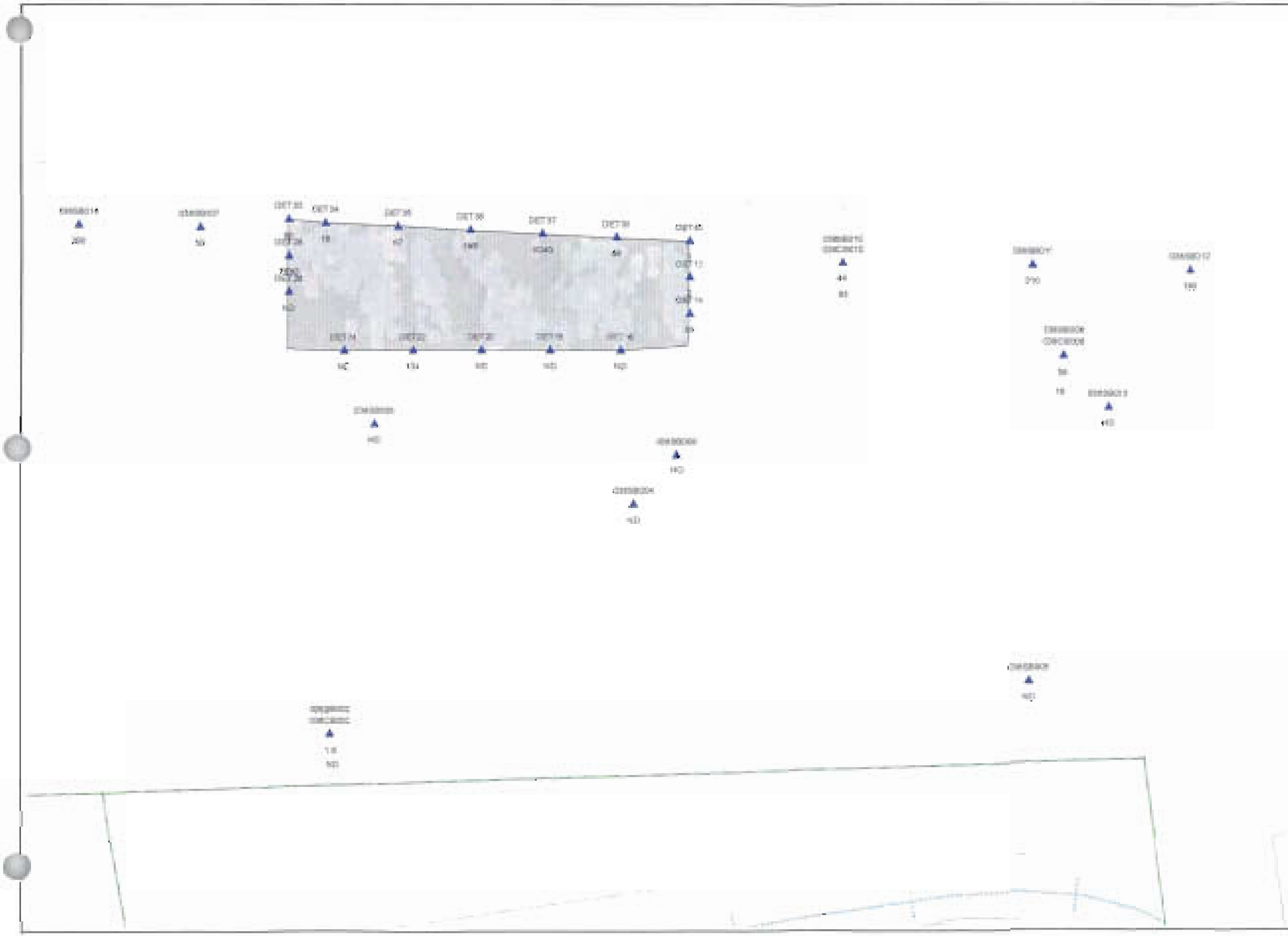
2.3.1 Soil

Three rounds of soil sampling were conducted during the RFI. The first and second rounds consisted of 10 upper-interval samples (0' to 1') and nine lower-interval samples (3' to 5'). The six first round samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, PCBs, total petroleum hydrocarbons (TPH), and metals. Second-round samples were analyzed for pesticides and PCBs. Based on the presence of Arochlor-1260 in samples from locations 038SB006 and 038SB007, a third round of sampling was conducted, including the collection of four additional samples analyzed for pesticides and PCBs. Figures 2.2 through 2.6 and Table 2.1 show the RFI sampling results for SWMU 38.

As previously stated, the DET implemented two interim measures at SWMU 38 removing a total of 519 cubic yards of pesticide-contaminated soil. At the end of the second interim measure, the DET collected confirmation and perimeter samples in the excavation area. Except for a single surface sample (DET 37), concentrations were below the residential risk-based goals. Therefore, the site was backfilled, compacted, covered with gravel, and graded to existing conditions.

2.3.2 Groundwater

During the RFI, three monitoring wells (two shallow and one deep), were installed to evaluate SWMU 38 groundwater (Figure 2.1). In addition, well NBCA-002-004 (SWMU 2) was used during this evaluation due to its location near SWMU 38. The first-round samples collected from these wells were analyzed for VOCs, SVOCs, metals, pesticides, PCBs, and TPH. In addition, the deep well was sampled for chlorides, sulfate, and TDS. Based on the results of the first-round samples, the second-round samples were analyzed for metals, pesticides, and PCBs. The third- and fourth-round samples were analyzed for metals, pesticides, PCBs, TDS, chlorides, and sulfate. Groundwater sampling results are presented in Table 2.2.



N

20 0 20 Feet

LEGEND

DDD

- 0 - 6200 (ISM SCDHEC Approved RGO)

Area of Excavation

BUILDING
BOUNDARY
FENCE
ROAD
RR
WATER

ENSAFE

SWMU 38
CMS REPORT
CHARLESTON NAVAL COMPLEX
Charleston, SC

Figure 2.2
DDD in Upper Interval Surface Soil

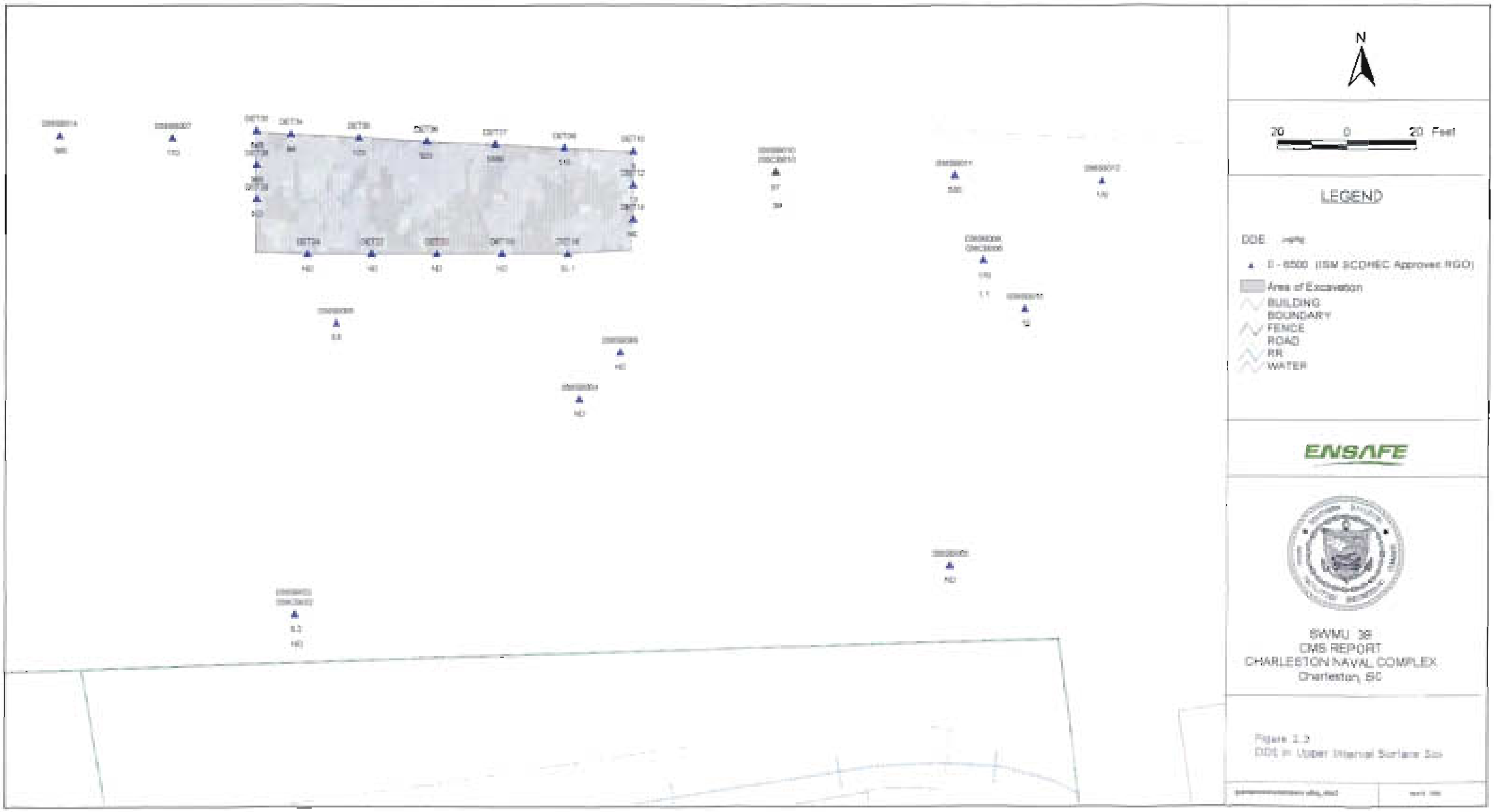


Figure 1.3
DDE in Upper Interval Surface Soil

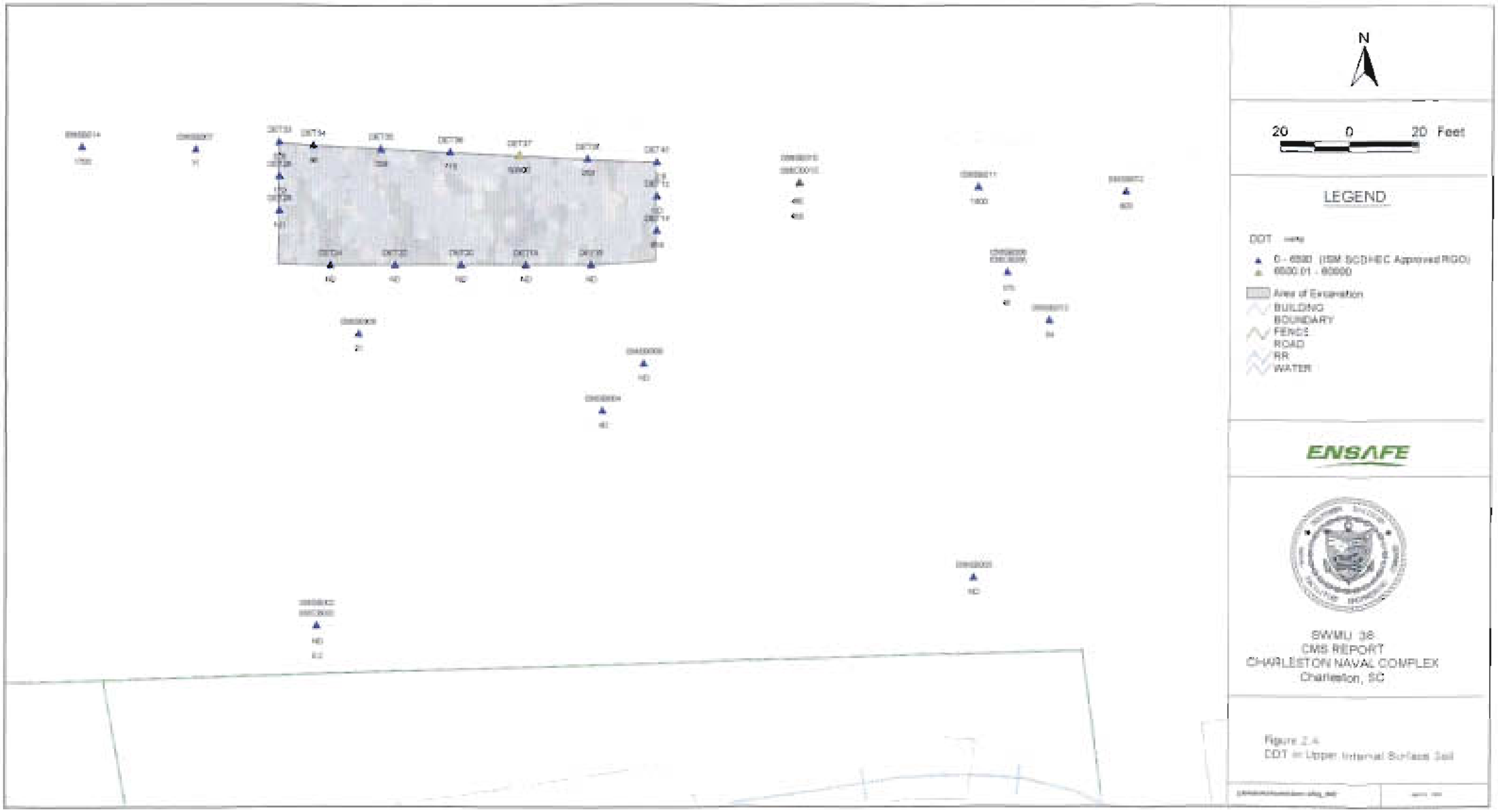


Figure 2.4
DDT in Upper Interval Surface Soil

Figure 2.5
Aroclor 1260 in Upper Interval Surface Soil

SWMU 38
CMS REPORT
CHARLESTON NAVAL COMPLEX
Charleston, SC

Figure 2.6
Arsenic in Upper Interval Surface Soil

Table 2.1
Surface Soil Data for COCs at SWMU 38

Sample Number	4,4'-DDD (µg/kg)	4,4'-DDE (µg/kg)	4,4'-DDT (µg/kg)	Aroclor-1260 (µg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Beryllium (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
RBC or Remedial Goal	**9200[a]**	**6500[a]**	**6500[a]**	**320[b]**	**0.43[b]**	**78,000[b]**	**160[b]**	**NA**	**NA**
Background	**NA**	**NA**	**NA**	**NA**	**9.44**	**12,800**	**NA**	**NA**	**NA**
038-S-B001	This boring location was excavated during Interim Stabilization Measures by the Navy Detachment Charleston								
038-S-B002	1.6 J	8.2	ND	ND	21.5	7810	ND	ND	ND
038-C-B002	ND	ND	9.2	ND	14	10800	ND	ND	ND
038-S-B003	This boring location was excavated during Interim Stabilization Measures by the Navy Detachment Charleston								
038-S-B004	ND	ND	ND	ND	14.3	16600	ND	ND	ND
038-S-B005	ND	ND	ND	ND	7.8	13200	ND	ND	ND
038-S-B006	59	170 D	370 D	500	15.6	8440	ND	ND	ND
038-C-B006	18 J	1.1 J	48 J	ND	11.1	8600	ND	ND	ND
038-S-B007	50 DJ	170 DJ	77 DJ	410 J	NS	NS	NS	NS	NS
038-S-B008	ND	6.8 J	21 J	ND	NS	NS	NS	NS	NS

Table 2.1
Surface Soil Data for COCs at SWMU 38

Sample Number	4,4'-DDD (μg/kg)	4,4'-DDE (μg/kg)	4,4'-DDT (μg/kg)	Aroclor-1260 (μg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Beryllium (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
RBC or Remedial Goal	**9200[a]**	**6500[a]**	**6500[a]**	**320[b]**	**0.43[b]**	**78,000[b]**	**160[b]**	**NA**	**NA**
Background	**NA**	**NA**	**NA**	**NA**	**9.44**	**12,800**	**NA**	**NA**	**NA**
038-S-B009	ND	ND	ND	ND	NS	NS	NS	NS	NS
038-S-B010	44 J	57 DJ	460 J	ND	NS	NS	NS	NS	NS
038-C-B010	63 DJ	39 DJ	450 D	ND	NS	NS	NS	NS	NS
038-S-B011	210 D	530 D	1400 D	720	NS	NS	NS	NS	NS
038-S-B012	190 DJ	170 D	800 D	1300	NS	NS	NS	NS	NS
038-S-B013	ND	12	54	18	NS	NS	NS	NS	NS
038-S-B014	290 D	580 D	1700 D	79 D	NS	NS	NS	NS	NS
DET12	2	12.7	ND	NS	NS	NS	NS	NS	NS
DET14	85	ND	619	NS	NS	NS	NS	NS	NS
DET16	ND	33.1 J	57.3 J	NS	NS	NS	NS	NS	NS

Table 2.1
Surface Soil Data for COCs at SWMU 38

Sample Number	4,4'-DDD (μg/kg)	4,4'-DDE (μg/kg)	4,4'-DDT (μg/kg)	Aroclor-1260 (μg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Beryllium (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
RBC or Remedial Goal	**9200[a]**	**6500[a]**	**6500[a]**	**320[b]**	**0.43[b]**	**78,000[b]**	**160[b]**	**NA**	**NA**
Background	NA	NA	NA	NA	9.44	12,800	NA	NA	NA
DET18	ND	ND	ND	NS	NS	NS	NS	NS	NS
DET20	ND	ND	ND	NS	NS	NS	NS	NS	NS
DET22	134	ND	ND	NS	NS	NS	NS	NS	NS
DET24	ND	ND	ND	NS	NS	NS	NS	NS	NS
DET26	ND	ND	ND	NS	NS	NS	NS	NS	NS
DET28	7630	305 J	170 J	NS	NS	NS	NS	NS	NS
DET33	99.9 J	546	376	NS	NS	NS	NS	NS	NS
DET34	13 J	63.9	46	NS	NS	NS	NS	NS	NS
DET35	66.6	123	338	NS	NS	NS	NS	NS	NS
DET36	193	523	713	NS	NS	NS	NS	NS	NS

Table 2.1
Surface Soil Data for COCs at SWMU 38

Sample Number	4,4'-DDD (µg/kg)	4,4'-DDE (µg/kg)	4,4'-DDT (µg/kg)	Aroclor-1260 (µg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Beryllium (mg/kg)	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
RBC or Remedial Goal	**9200[a]**	**6500[a]**	**6500[a]**	**320[b]**	**0.43[b]**	**78,000[b]**	**160[b]**	**NA**	**NA**
Background	**NA**	**NA**	**NA**	**NA**	**9.44**	**12,800**	**NA**	**NA**	**NA**
DET37	**8040**	**5880 J**	**50900**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
DET38	47.9	115	250	NS	NS	NS	NS	NS	NS
DET43	**0.679 J**	**4.23**	**2.9**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:
NA — Not Applicable
ND — Not Detected
NS — Sample Not Analyzed
D — Diluted Result
J — Estimated Value
DJ — Diluted Result/Estimated Value
a — Risk-based remedial goal developed during the ISM
b — RBC
µg/kg — micrograms per kilogram
mg/kg — milligrams per kilogram

Table 2.2
Groundwater Data for COCs at SWMU 38

Sample Number	Date	4,4'-DDD (µg/L)	4,4'-DDE (µg/L)	4,4'-DDT (µg/L)	Arsenic (µg/L)	Thallium (µg/L)
MCL					**50**	**2**
Risk Based Screening Level		**0.28**	**0.2**	**0.2**	**0.045**	**0.26**
Background		**NA**	**NA**	**NA**	**7.4**	**ND**
038-G-W001-01	12/7/95	3.8 D	0.045 J	1.5 J	6 J	ND
038-G-W001-02	4/22/96	4 D	0.092 J	2.6	ND	ND
038-G-W001-03	6/19/96	2.9	ND	0.23	12.5	ND
038-G-W001-04	10/9/96	3.18	ND	ND	14.9	ND
038-G-W002-01	12/7/95	ND	ND	ND	ND	4 J
038-G-W002-02	4/22/96	ND	ND	ND	ND	ND
038-G-W002-03	6/19/96	ND	ND	ND	3.1 J	ND
038-G-W002-04	10/9/96	ND	ND	ND	ND	ND
038-G-W002-C1	3/18/99	ND	ND	ND	NS	NS
038-G-W003-C1	10/19/98	ND	ND	ND	2.6 J	ND
038-G-W01D-01	12/7/95	ND	ND	ND	ND	ND
038-G-W01D-02	4/23/96	ND	ND	ND	ND	ND
038-G-W01D-03	6/19/96	ND	ND	ND	ND	ND
038-G-W01D-04	10/8/96	ND	ND	ND	ND	ND
038-G-W01D-C1	3/18/99	ND	ND	ND	NS	NS
002-G-W004-01	11/15/93	NS	NS	NS	ND	ND
002-G-W004-02	4/23/96	ND	ND	ND	ND	ND
002-G-W004-03	7/8/96	NS	NS	NS	4.6 J	ND
002-G-W004-04	10/4/96	NS	NS	NS	10.3 J	ND
002-G-W004-C1	10/15/98	ND	ND	ND	7 J	NS

Notes:
NA — Not Applicable
ND — Not Detected
NS — Sample not analyzed
D — Diluted Result
J — Estimated Value Table 2.2
µg/L — micrograms per liter

Arsenic, thallium, DDD, DDE, and DDT exceeded screening levels and were identified as chemicals of concern (COCs) for SWMU 38 groundwater. Although concerns regarding fate and transport of selenium and antimony were addressed in SCDHEC's conditional approval of the Zone A RFI Report, theses constituents were not detected in SWMU 38 groundwater samples. Arsenic did not exceed its MCL of 50 μg/L and thallium had one detection above its MCL (2 μg/L). This detection was in the first round sample from well 038GW002 (4 μg/L). The three samples taken from that well after the first round were nondetect for thallium. Therefore, antimony, selenium, and thallium will not be further addressed in the CMS.

During the CMS, additional groundwater samples were collected and analyzed for DDD, DDE, and DDT. Since shallow monitoring well NBCA-038-001 was destroyed during the interim measures, a new well, NBCA-038-003 (Figure 2.1), was installed and sampled for inorganics, pesticides, and PCBs. The replacement well was nondetect for pesticides and PCBs and the detected arsenic concentration (2.6 μg/L) is well below the MCL (50 μg/L). The CMS sampling results are presented in Table 2.2. In addition to the replacement well results, these data show that shallow monitoring wells 038-002 and 002-004 and deep well 038-01D did not reflect the presence of DDD, DDE, or DDT. Therefore, arsenic, DDD, DDE, and DDT will not be further addressed in the CMS.

2.3.3 Sediment

Sediment has not been sampled at SWMU 38.

2.3.4 Surface Water

Surface water has not been sampled at SWMU 38.

3.0 REMEDIAL OBJECTIVES

3.1 Soil Remedial Objectives

Soil remedial objectives were first developed during the RFI. However, after the initial DET ISM excavation, remedial goal options (RGOs) were re-established for DDD, DDE, and DDT based on risk calculations EnSafe conducted. The remedial goal for DDE and DDT is 6.5 mg/kg; for DDD it is 9.2 mg/kg.

In addition to the pesticides, the following were also identified as COCs during the RFI: aluminum, arsenic, Aroclor-1260, beryllium, and TPH These constituents were identified as COCs because they exceeded at least one RFI screening criterion, including regulatory, risk-based, or background values.

Aluminum exceeded its risk-based concentration (RBC) and background reference concentration in two of six RFI upper-interval samples (038SB004 and 038SB005). In the sample from 038SB004, it was detected at 16,600 mg/kg, which is 30% higher than the background reference concentration (12,800 mg/kg). In the sample from 038SB005, aluminum was detected at 13,200 mg/kg, or 3% higher than background. The magnitude of these concentrations relative to background and the apparent random distribution of detections does not reflect evidence of a spill or other point release. Therefore, aluminum will not be further addressed during the CMS.

Aroclor-1260 exceeded its residential RBC (0.32 mg/kg) in four of 14 RFI upper-interval samples. However, the 1E-05 residential RGO (2.2 mg/kg) was not exceeded. The highest concentration detected, 1.3 mg/kg at 038SB012, reflects a point risk of 5.9E-06. Since these detections are within the USEPA acceptable residential risk range (1E-06 to 1E-04), Aroclor-1260 will not be further addressed in the CMS.

Arsenic exceeded its background reference concentration (9.4 mg/kg) in three of four upper-interval soil samples. The maximum calculated residential point risk above background for arsenic is 2.1E-05 at 038SB002. Since arsenic does not contribute to residential point risk outside of the acceptable range (1E-06 to 1E-04) and its concentration relative to background is not indicative of a spill or other release, it will not be further addressed during the CMS.

Beryllium was identified as a COC before USEPA released the new RBC (160 mg/kg). This RBC was not exceeded and beryllium will not be further addressed during the CMS.

While **TPH** was identified as a COC, sample results were nondetect for gasoline and diesel range organics. Therefore, TPH will not be further addressed during the CMS.

3.2 Groundwater Remedial Objectives

Although pesticides were identified as COCs during the RFI based on detections in abandoned well 038-001, DDD, DDE, and DDT were not detected in the replacement well and surrounding wells. Based on the absence of DDD, DDE, and DDT detections in groundwater samples, remedial objectives for these constituents are not warranted. Therefore, remedial objectives will not be developed for pesticides.

In addition to the pesticides, arsenic and thallium were identified as COCs during the RFI because they exceeded at least one RFI screening criterion, including regulatory, risk-based, or background values.

Arsenic did not exceed its maximum contaminant level (MCL) in groundwater samples. Therefore, arsenic in groundwater will not be further addressed during the CMS.

Thallium was detected in one first-round sample (NBCA-038-GW-002) at a concentration exceeding its MCL of 2 μg/L. Since the detection (4 μg/L) was followed by three sample rounds in which thallium was nondetect, it will not be further addressed in the CMS.

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

4.1 Soil Remedial Technologies

Identification and screening of soil remedial technologies is not warranted for this CMS based on the post-ISM confirmation sample results and residential point risk values within the acceptable USEPA range (1E-06 to 1E-04).

4.2 Groundwater Remedial Technologies

Identification and screening of remedial technologies for SWMU 38 groundwater is not warranted for this CMS because arsenic was not detected above its MCL (50 μg/L) and DDD, DDE, and DDT were not detected in the existing three SWMU 38 wells and the nearby SWMU 2 well.

5.0 DETAILED EVALUATION OF ALTERNATIVES

5.1 Evaluation of Soil Remedial Alternatives

Detailed evaluation of soil remedial alternatives is not warranted for this CMS based on the post-ISM confirmation sample results and residential point risk values within the acceptable USEPA range (1E-06 to 1E-04).

5.2 Evaluation of Groundwater Remedial Alternatives

Detailed evaluation of groundwater remedial alternatives is not warranted for this CMS because arsenic was not detected above its MCL (50 μg/L) and DDD, DDE, and DDT were not detected in the existing three SWMU 38 wells and the nearby SWMU 2 well.

6.0 RECOMMENDATIONS

6.1 Soil Recommendations

SWMU 38 soil is recommended for no further corrective action under the RCRA process based on the post-ISM confirmation sample results and residential point risk values within the acceptable USEPA range (1E-06 to 1E-04).

6.2 Groundwater Recommendations

Groundwater is recommended for no further corrective action under RCRA because arsenic was not detected above its MCL (50 μg/L) and DDD, DDE, and DDT were not detected in the existing three SWMU 38 wells and the nearby SWMU 2 well.

7.0 PUBLIC INVOLVEMENT PLAN

7.1 General

The following Public Involvement Plan (PIP) is included as part of this report in accordance with the USEPA's guidance on RCRA CMS. This PIP reflects and summarizes information prepared and presented in the Navy's Community Relations Plan (CRP), prepared for Naval Base Charleston in 1995.

Under RCRA, there is no required interaction with the community during the Corrective Measures Study process. Public input is required to be solicited only at the beginning of the permitting process, or during certain permit modifications. Therefore, the Navy has outlined a voluntary program of informing local communities throughout the entire RCRA Corrective Action process. Activities are detailed in the 1995 CRP for the Naval Base Charleston.

However, because the CMS process results in a modification to the facility's RCRA permit, certain provisions are made to solicit the public's input on the preferred alternative (as the reason for the modification). The requirements are identical to those required for a draft permit.

Two primary objectives are stated in the CRP:

- To initiate and sustain community involvement.
- To provide a mechanism for communicating to the public.

7.2 RFI Public Involvement Plan

To achieve these objectives, the CRP identifies public involvement and outreach activities at each step of the Corrective Action process. For example, the following activities have been designated for the completion of the RFI. All have been accomplished.

- Update and publicize the information repository.
- Continue to publicize the point of contact.
- Update the mailing list.
- Distribute fact sheets and/or write articles to explain RFI findings.
- Inform community leaders of the completion and results of the RFI.
- Update and continue to provide, whenever possible, presentations for informal community groups.
- Update the community on results of the RFI through public Restoration Advisory Board meetings.

7.3 CMS Public Involvement Plan

During the Corrective Measures Study, the following activities will be carried out as part of the Navy's current and ongoing community involvement program.

- Distribute a fact sheet and/or write articles for publication that report CMS recommendations.
- Continue to update the mailing list.
- Continue to respond to requests for speaking engagements.
- Update the community on CMS status through public Restoration Advisory Board meetings.

7.4 Statement of Basis Public Involvement Plan

Upon completion of the Corrective Measures Study, when the preferred alternative has been proposed, the following activities are required if a modification to the RCRA permit is required. If a permit modification is not necessary, the Navy may choose to implement all, some, or none of the following actions, depending on the level of public interest or concern:

- A Statement of Basis will be prepared, explaining the proposed remedy and the method by which it was chosen.

- A 45-day comment period will be provided to allow community members the opportunity to review and comment on the preferred alternative. The comment period may be as short as 30 days in cases where no permit modification is necessary, but a public comment period is warranted.

- Availability of the comment period and Statement of Basis will be announced in a public notice.

- The community will be provided an update on the proposed remedy through the informal and publicized Restoration Advisory Board meetings.

In addition, the following activities will be carried out, as identified in the CRP:

- Update and publicize the information repository.
- Publicize the environmental point of contact.
- Continue to update the mailing list.

7.5 Restoration Advisory Board

The RAB is a key component of this community outreach program. It is through the RAB that the Navy has a regular, scheduled, and publicized forum for interfacing with community members on the progress of the environmental program, including CMS. In addition, RAB members are key instruments in measuring community interest in specific issues and knowledge of them. A Community Relations Subcommittee to the RAB has been tasked with identifying issues and information to be addressed by the Navy.

8.0 REFERENCES

EnSafe/Allen & Hoshall, Inc. (1997). *Final Comprehensive Corrective Measures Study Project Management Plan and Work Plan,* Volumes I and II, Memphis, Tennessee, June 25, 1997.

EnSafe/Allen & Hoshall, Inc. (1998). *Final RCRA Facility Investigation Report Zone A Naval Base Charleston*, Memphis, Tennessee, 1998.

EnSafe Inc. (1998). *Zone A Corrective Measures Study Work Plan*, Memphis, Tennessee, 1998.

Environmental Detachment Charleston, Charleston, South Carolina (1998), *Completion Report, Interim Measure for SWMU 38*, Naval Base Charleston, Charleston, South Carolina; October 29, 1998.

SCDHEC *Bureau of Solid Waste Management Assessment and Remediation Criteria*, Memorandum issued from H.W. Truesdale, Bureau Chief, to Division Directors, July 31, 1995.

9.0 SIGNATORY REQUIREMENT

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA Part B Permit (USEPA SCO 170 022 560) states: All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with Section 40 CFR 270.11. The certification reads as follows:

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

Date 6/21/99

Henry N. Sheppard II, P.E.
Caretaker Site Office, Charleston